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Bank culture☆

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ABSTRACT

We develop a model in which bank culture improves upon outcomes attainable with incentive contracting. The bank designs a second-best incentive contract to induce the desired managerial effort allocation across growth and safety, but this induces excessive growth relative to the first best, a distortion exacerbated by interbank competition. Bank culture has two effects: it matches managers to banks with similar beliefs, and a safety-oriented culture reduces the competition-induced excessive growth focus. Culture is also contagious – a safety-oriented culture in some banks causes others to follow suit – this effect strengthens with higher bank capital and weakens with stronger safety nets.

> "Banks and banking rely on trust. And while trust takes years to establish, it can be lost in a moment through failures caused by problematic ethics, values, and behaviors. Events that precipitated the global financial crisis and the subsequent issues that have emerged have revealed a multitude of cultural failures... A great deal rests on a firm's culture... The banking community as a whole needs to repair the damage done by failures in culture, values, and behaviors, and should tackle the challenge with renewed vigor and purpose to achieve tangible improvements in outcomes and reputation."
>
> – Group of Thirty, Washington, D.C., July 2015

1. Introduction

Largely ignored for decades in public discourse about banking risks and financial stability, the issue of bank culture has emerged as an important topic of discussion since the 2007–2009 financial crisis (e.g., Dudley, 2014; Group of Thirty, 2015; Ochs, 2014). Banking failures that elevate systemic risk are no longer viewed as isolated events attributable to a handful of rogue employees who took unsanctioned risks that turned out badly. Rather, many now believe that these are systematic lapses, condoned and perhaps even encouraged by the culture in these banks. In this view, there is tacit acknowledgement of the limitations of explicit intra-firm mechanisms like wage contracts and prudential regulation tools like capital requirements and portfolio restrictions to control excessive and socially inefficient risk taking. Given these limitations, it seems natural to turn to culture, which is widely acknowledged as an influential factor in the behavior of individual employees. As Group of Thirty (2015) report points out: "Culture is defined as 'the ideas, customs, and social behavior of a particular people or society.' Culture is the glue that binds individuals to an institution; it creates a consistent framework for behaviors and business practices." The report goes on to state that a bank's risk is an inevitable consequence of its culture: "First, a bank's risk culture cannot be isolated from its overall culture." Thus, bank regulators should (and do) care about bank culture because it may affect bank risk.

But what is bank culture, in a formal economic sense, and how do we use this economic view of bank culture to improve our understanding of how banks choose culture, how it affects the behavior of

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their employees, and how it interacts with forces like interbank competition, safety nets and bank capital? Our goal is to address these questions theoretically.

While there is a long-standing literature on corporate culture in organization behavior (e.g., Cameron and Quinn, 2011; Cameron et al., 2014; Cartwright and Cooper, 1993; Quinn and Rohrbaugh, 1983), the literature in economics is more recent and less voluminous (e.g., Crémer, 1993; Hermalin, 2001; Kreps, 1990; Van den Steen, 2010a,b). Bouwman (2013) and Thakor (2016a) discuss the connections between these two strands of literature. We know of no formal theoretical model of *bank* culture, however. While the economic insights from theories of corporate culture developed for firms in general are obviously useful in thinking about bank culture, there are numerous special features of banks that require a specialized model of bank culture. Public safety nets that distort bank risk taking represent the most prominent of these features, so not surprisingly much of the focus in discussions of bank culture is on the safety and soundness of banks, and this is what bank regulators are focused on too. Features like capital requirements also come up as essential aspects of banking. Because culture is a somewhat nebulous concept, in the absence of a formal theory of bank culture it is difficult to understand how these features interact to affect bank culture and consequently employee behavior in banking.

We develop a theoretical model of bank culture in a principal-agent setting that rests on three important pillars. The first pillar is the modeling of a resource-allocation problem within the bank. Our view is that corporate culture is a choice, and for banks the most pertinent choice is between growth and safety; hence, the choice of culture we focus on is designed to influence the bank's allocation of resources to growth relative to the allocation to safety. We focus first on the problem of motivating the manager (agent) to expend effort,[1] and then on the tradeoff involved in how much of this effort is allocated to growth and how much to safety – safety can only be enhanced by sacrificing growth, and vice versa. We think this tradeoff is an essential aspect of bank culture choice.[2] Indeed, this has been emphasized quite a bit recently. In a report based on a global survey of banks, Ernst & Young (2014) reports:

> "The new message this year is the almost universal focus on risk culture, with the emphasis on conduct... This has shaken boards' certainty that they know the prevailing culture across a whole firm and has raised fundamental concerns about the quality of business-line controls and risk accountability... At the same time, the industry is trying to deal with a seismic shift in business models caused by the reluctance of investors to accept the lower ROEs resulting from Basel III."

Thus, while the cultural focus is shifting toward enhanced safety, there is also concern about possibly diminished growth and ROE. Indeed, the tension between growth and safety in banking shows up time and again in different contexts.[3] Fahlenbrach et al. (2018) document that during 1973–2014, high-growth U.S. banks exhibited significantly higher crash risk. The banks that grew their loan portfolios faster also made riskier loans and failed to adequately price this risk, indicating a weak focus on safety. Altunbas et al. (2017) document that aggressive credit growth prior to the 2007–2009 crisis is consistently related to the systemic dimensions of bank risk during the crisis. The empirical results in Grennan (2014) also highlight the tension between growth ("results-orientation" in her paper) and safety ("integrity" in her paper).

The growth versus safety tradeoff we model is similar in spirit to, but yet distinct from, the tradeoff between return and risk. In Finance, risk is typically thought of as covariance with some aggregate shock. In banking, the focus is typically on *downside* risk, as opposed to covariance with aggregate risk. As Rancière et al. (2008) point out, downside risk in banking is better measured by the skewness of credit growth.[4] We thus use the terms "growth" and "safety" to indicate the bank's choice between a higher profit and a lower downside risk.

The second pillar in our model is that both the manager a bank could hire and the bank itself have *beliefs* about the borrower pool quality that determine the optimal allocation of effort across the pursuit of growth and the pursuit of safety, and these beliefs may be different. The idea that beliefs play a central role in culture is familiar from earlier work, where culture has been defined as shared beliefs or shared preferences (see Crémer, 1993; Lazear, 1995; Van den Steen, 2010a; Van den Steen, 2010b). The notion of culture interacting with heterogeneous beliefs has been introduced in earlier work as well. Van den Steen (2010a) argues that corporate culture "homogenizes" *a priori* heterogeneous beliefs via employee screening, self-selection and joint learning.[5] The idea that belief alignment is an important element of culture also appears in a very influential management book by Schein (1985). The book explains that organizational culture can be divided into three levels: artifacts, espoused values and basic underlying assumptions and values. Artifacts are organizational requirements that are at the surface and easy to discern, such as a dress code. Beneath the artifacts are espoused values, which are conscious strategies, goals and philosophies. Beneath the espoused values are basic underlying assumptions and values, which are essentially *beliefs*, perceptions, thoughts and feelings. These are difficult to discern and yet provide the key to understanding why things happen the way they do. Kane (2017) discusses the relevance of the Schein (1985) model for understanding bank culture and related issues in the behavior and regulation of banks.

The third pillar is our use of Akerlof and Kranton (2005, 2010) notion of "identity economics." A bank's culture creates an identity for its employees, so that a choice of (unverifiable) action by an employee that is not consonant with the culture generates a disutility for the employee.[6] This is meant to capture the idea that culture can address distortions that cannot be diminished by explicit contracting based on verifiable outcomes. This is consistent with the idea that an important aspect of culture is implicit contracting. In addition to modeling culture, we also solve endogenously for the optimal managerial wage contract, so the role of culture in going beyond explicit wage contracting can be analyzed. Developing a culture in our model is costly for the bank; it requires an investment and the bigger the investment, the stronger the culture.

[1] Udell (1989) provides evidence that banks are cognizant of the moral hazard problem for the bank in providing appropriate incentives to loan officers and documents that the creation of "commercial loan review" departments by banks in the 1980s was to deal squarely with this moral hazard.

[2] The tension between growth and safety is a recurring theme in banking. For example, the proposals designed to improve bank safety in Hoenig and Morris (2012) have the explicit feature that they limit bank growth in certain areas. Group of Thirty (2015) report states "Building a strong bank culture can be thought of as a form of risk reduction." As will be made clear in the analysis, introducing the layer of effort motivation into the model essentially leads to a multi-tasking problem à la Holmstrom and Milgrom (1991). Garicano and Rayo (2016) link a flawed allocation of authority in multi-tasking problems to culture-related organizational failures.

[3] For example, this tension has also been explored in international finance (see Rancière et al., 2008). Rancière and Tornell (2016) examine the role of regulation in affecting the growth-safety tradeoff.

[4] Rancière et al. (2008) explain that: "Unlike variance, negative skewness isolates the impact of the large, infrequent, and abrupt credit busts associated with crises." An increase in "safety" in our model (the probability of loan repayment) may actually imply higher variance of bank return for some parameter values.

[5] There is now an extensive literature that explains how heterogeneous prior beliefs can be rational, and examines the many implications of heterogeneous priors (e.g., Boot et al., 2006; Boot et al., 2008; Kurz, 1994a; 1994b; Van den Steen (2010a, 2010b, 2010c)).

[6] It may seem a bit unusual to assume that the employee's effort is unobservable and yet actions that deviate from the bank's culture norms can generate a negative utility for the employee. The idea here is that the employee's actions may be noisily observed by others – as is typical in most organizations – but are not verifiable for contracting purposes. Thus, inferred deviations from what the bank's culture requires may be sanctioned in ways other than through compensation or other contractual mechanisms that rely on verifiability.

These three pillars lead to a simple model of bank culture. Our analysis begins with a hypothetical case with no investment in culture. We call this case "hypothetical" because, in reality, every organization invests (more or less) in culture. The analysis of this case, however, serves as a useful benchmark that helps us assess the *incremental* value of bank investment in culture from some base level that we normalize to zero. Three main results emerge from the benchmark analysis:

1 The second best always involves an excessive focus on growth at the expense of safety, i.e., the second-best wage contract has an inefficiency associated with it.
2 Interbank competition exacerbates this excessive focus on growth, so banks herd even more on growth, increasing systemic risk.
3 A mismatch of beliefs (about the quality of the borrower pool) between the bank and its manager increases the focus on growth when the manager is more optimistic than the bank.

The next step of our analysis introduces culture by allowing banks to choose what cost to incur to develop culture. This generates three more key results:

4 A sufficiently large investment in bank culture induces managers to sort themselves, so that in equilibrium the beliefs of the bank match those of its manager.
5 Culture can reduce the growth-focused herding behavior induced by interbank competition. The development of a strong safety culture by one bank induces a competing bank to also reduce its focus on growth and increase its focus on safety. That is, culture is "contagious."
6 This contagion effect of culture is stronger when banks have more capital and weaker when the public safety net (e.g., deposit insurance coverage) is stronger.

Our paper has implications for bank regulatory policy. First, the contagious nature of culture (Result 5) means that not all banks in the economy need to be targeted by regulators. If regulators can influence a change in culture at just a few highly visible banks – these would typically be the largest banks – it will have a ripple effect on culture at other banks as well. Second, even though bank regulators have recognized the importance of bank culture, it is difficult to know *how* to condition regulatory policy on it, especially given measurement difficulties and cross-sectional comparison challenges related to culture.[7] Our analysis indicates, however, that *existing* regulatory tools like capital requirements and deposit insurance can be used to influence bank culture. The idea is that if big banks lose more from their own failures, as in the cases with higher bank capital levels and weaker public safety nets, they will react by allocating more resources toward safety (Result 6); this, in turn, diminishes the competition-induced excessive growth focus in culture choice, inducing other (smaller) banks to also focus more on safety (Result 5). Our policy recommendation is that, at least at the outset, contemplating how these familiar regulatory tools might be deployed differently from current practice may be more fruitful than nailing down culture measurement issues. Third, our model implies that the choice of culture involves a tradeoff. If regulators take steps to induce a stronger safety-oriented culture in banking, it will be at the expense of lending growth in banks. This means that there is an inherent *culture-driven* tension between the current regulatory focus on strengthening bank risk culture to improve safety on the one hand and the push to elevate economic growth by stimulating bank lending on the other.

This paper is related to previous work on organization culture and builds on the many insights provided by that literature. Kreps (1990) develops a model in which a strong organization culture can help eliminate undesirable Nash equilibria, so it can work as a "coordination" mechanism. Lo (2016) provides an "Adaptive Market Hypothesis" view of corporate culture as something that survives evolution, and discusses its risk management implications. Crémer (1993) views culture as knowledge shared by members of the organization that is unavailable to those outside it. Hermalin (2001) models the decision about the strength of culture as a choice between high fixed cost and low marginal cost (strong culture) on the one hand and low fixed cost and high marginal cost (weak culture) on the other hand. In his model, competition affects the benefit of developing a strong culture. Van den Steen (2010a) views culture as being about shared values and beliefs, and shows that culture can reduce belief heterogeneity among employees, thereby reducing disagreement about the right course of action. In a companion paper, Van den Steen (2010b) shows that shared beliefs (fostered by culture) lead to increased delegation, higher utility and greater effort, and goes on to examine the implications of cultural differences between merging firms.

The similarities between these papers and ours are that we also endogenize the strength of the firm's culture and the impact of competition on this choice, as Hermalin (2001) does, and we also view culture as being about shared beliefs and values, with possibly heterogeneous beliefs, as in Van den Steen (2010a). However, there are numerous significant differences as well. Our definition of the strength of culture is different from Hermalin's (2001), and we show in contrast that a strong culture attenuates the competition-induced propensity for banks to focus excessively on growth at the expense of safety. And unlike (Van den Steen, 2010a; 2010b), we focus on the growth versus safety choice aspect of bank culture, so we examine a different set of issues.

Our approach in modeling the bank's choice between growth and safety is somewhat related to Heider and Inderst (2012), who analyze a multi-tasking agency problem in which a loan officer performs two tasks: prospecting for borrowers and (truthfully) reporting to the bank the soft information about the borrower that she possesses. Their focus is on how the inherent conflict between the two tasks may induce the loan officer to misreport the soft information. By contrast, our focus is on bank culture choice and the consequent resource allocation between growth and safety, with an analysis of how (endogenously-determined) culture can reduce misallocation.

The setup in our model that culture is determined from the top and employees respond to organization culture is consistent with the evidence from empirical studies (e.g., Guiso et al., 2015), surveys (e.g., Graham et al., 2015), as well as experiments (e.g., Cohn et al., 2014). In particular, the implication of our model that organization culture can shape an employee's identity and influence that employee's decisions is echoed in the findings of Cohn et al. (2014). They conducted an experiment in a large international bank and showed that although employees behaved honestly on average in a control condition in which priming questions focused them on social issues unconnected with their profession, they became dishonest when their professional identity as bank employees was rendered salient with a different set of priming questions. They conclude that the prevailing business culture in banking weakens the honesty norm. This is also consistent with Lo's (2016) view that culture matters in banking and that it can be changed to improve risk management. He also emphasizes the roles of leadership and the external environment in shaping the transmission of culture, ideas that are consistent with our model. Many of the case studies of bank failures that he provides correspond to an excessive focus on growth (at the expense of safety) in our theory. Indeed, if we interpret a safety-focused culture in our model more broadly as one that focuses on curbing wrong/reckless employee behavior, then Lo's prescriptions are in line with the adoption of a safety-focused culture. Our results are also consistent with the empirical evidence in Ellul and Yerramilli (2013) that a strong and independent risk management function in banks – which we interpret as being a component of a strong safety-oriented

[7] Grennan (2014) and Fiordelisi and Ricci (2014) are part of an emerging literature that attempts to empirically "measure" culture.

culture – leads to lower risk exposure at banks (see also Ellul, 2015).

The rest is organized as follows. Section 2 develops the base model. Section 3 analyzes the model. Section 4 examines culture in the one-bank case. Section 5 models two banks to study the effect of competition, as well as the contagious nature of culture. Section 6 discusses empirical predictions and policy implications. Section 7 concludes. Proofs are in the Appendix.

2. Base model

Model overview: We develop a model in which the bank's choice of culture is either growth-focused or safety-focused. This cultural choice then determines the optimal wage contract the bank designs to first elicit managerial effort and then induce the desired allocation of this effort to growth and safety. Given a choice of high total effort, higher effort allocation to growth increases the probability that the bank will find a loan to make. Higher effort allocation to safety means a lower probability of loan default. This introduces a tradeoff which is a key element in our modeling of culture, namely that, given a total amount of effort elicited, there is a tension between growth and safety. A greater allocation of effort to growth means a smaller allocation to safety, and vice versa.[8] In the base model developed here, we simply model the agency problem in the bank. That is, as mentioned in the Introduction, we keep culture out of the picture for now and consider a hypothetical benchmark case with no investment in culture. We solve the bank's optimal effort allocation problem in the first-best and second-best cases with the loan production function the bank is endowed with. After completing our analysis of this base model with a single bank (Section 3), we introduce culture (Section 4) and multiple banks (Section 5).

One might argue that modern banks explicitly separate the loan origination function from the credit analysis function to overcome the growth-safety tension. The loan originators focus on growth and those involved in credit analysis and loan approval focus on safety. For this reason, our modeling of these two functions as being entrusted to the same agent should not be taken too literally. Rather, one should view it as a bank with limited human and capital resources recognizing a tradeoff – the more resources it allocates to prospecting for loans, the less resources it has available for ensuring safety, with culture being the mediating variable in determining this tradeoff.

Model specifics: The model has three dates ($t = 0, 1, 2$) with the following timeline: the bank decides on its culture at $t = 0$ (growth-focused or safety-focused and the investment in the culture, which determines the "strength" of the culture; we formalize this later), and then designs a wage contract to elicit managerial effort at $t = 1$; at $t = 2$ payoff is realized and agents get paid off.

The manager chooses effort $e \in \{0, 1\}$ at $t = 1$, where $e = 0$ means shirking and $e = 1$ means working. The manager's personal cost of effort is $c > 0$. Thus, the manager is effort averse and the first goal of the incentive contract is to induce the manager to choose $e = 1$. Conditional on inducing a choice of $e = 1$, the second goal of the incentive contract is to induce the desired allocation of this effort across growth (e_g) and safety (e_s), where $e_g + e_s = 1$. Obviously, if $e = 0$, then $e_g = e_s = 0$. The probability of finding a loan opportunity is e_g. If a loan is made, the financing need is I. The sequence of events is summarized in Fig. 1.

We can visualize the growth versus safety allocation of effort as the manager being confronted with many urns, only one of which contains balls, with the rest being empty. The harder the manager works on growth (higher e_g), the higher is the probability (e_g) with which she will locate the urn with the balls.[9] Once such an urn is located, the manager has to expend effort (e_s) to make sure that the bank is making a good loan. Imagine that all the balls (potential borrowers) in the urn look alike, and it takes effort to find out which ball represents a good borrower and which represents a bad borrower. A good borrower repays the bank X on the loan at $t = 2$, whereas a bad borrower repays nothing. The prior probability of a borrower being good is $\lambda \in (0, 1)$, and the probability of a borrower being bad is $1 - \lambda$. In terms of the urn analogy, if there is a countably infinite number of balls in the urn, then λ is the fraction of balls that represent good borrowers.

Conditional on the borrower being bad, the probability that the bank will identify it as being bad is e_s. Confronted with a good borrower, the manager will identify the borrower as such. Therefore, conditional on finding a loan, the probability the bank will make a good loan is λ, the probability it will make no loan is $(1 - \lambda)e_s$, and the probability it will make a bad loan is $(1 - \lambda)(1 - e_s)$. The manager's safety effort thus helps reduce type-II errors, i.e., it reduces the probability that she will mistakenly identify a bad borrower as good. The bank raises financing I only if it makes a loan. Therefore, a loan that is funded is good with probability (w.p.) $\frac{\lambda}{\lambda + (1-\lambda)(1-e_s)}$.

When no loan is financed, there are three possibilities: (a) the manager did not work ($e = 0$), so there was no loan for sure; (b) the manager worked ($e = 1$), but w.p. $1 - e_g$ she failed to find a loan; or (c) a loan was found but rejected because the manager discovered it was a bad loan. The bank cannot distinguish among these three possibilities, while the manager knows.

The bank designs its compensation for the manager to be different across the following three states that are observationally distinct to the bank: (i) no loan was made (state $\{\varnothing\}$); (ii) a loan was made and it paid off (state $\{X\}$); and (iii) a loan was made and it defaulted (state $\{0\}$). Therefore, there are three possible wage outcomes: $w_\varnothing$ in state $\{\varnothing\}$, w_X in state $\{X\}$, and w_0 in state $\{0\}$. All agents are risk neutral, but the manager has limited liability (i.e., her pay cannot be negative), and her reservation utility is zero. Clearly, $w_X \geq w_\varnothing \geq w_0$, and the bank should set $w_0 = 0$.[10]

One might argue that among the three possibilities underlying state $\{\varnothing\}$ (discussed above), (c) should be easy to distinguish from (a) and (b): the bank only needs to be able to verify that a loan application was generated to distinguish (c) from the other possibilities. This would permit the bank to condition the manager's wage on whether there was a loan application. This, however, creates another problem: if the manager does not find a loan, she can simply seek out a low-credit-quality borrower who is eager to apply but almost certain to be rejected. Imagine a manager (loan officer) calling a friend to apply for a loan and then rejecting the application.[11] For this reason, we stipulate in the model that the manager receives the same wage $w_\varnothing$ across the three possibilities (a) - (c) in state $\{\varnothing\}$ even if loan applications are verifiable.

Special banking features: The following three features capture the notion that it is a bank we are modeling. First, financing comes from both (inside) equity capital (E) and deposits (D), so $I = D + E$, and E is chosen by the regulator as a capital *requirement*.[12] Second, there is

[8] The decision of how to allocate effort across growth and safety in our framework is similar to the problem studied in Aghion and Stein (2008), in which the relative emphasis the stock market puts on growth versus cost productivity affects the firm's strategic focus. Another way to think about the choice of culture is along the time dimension, i.e., the choice of culture may be a choice of the "internal discount rate" for future payoffs, so that some firms tend to have shorter time horizons over which they maximize an objective function compared to other firms. We leave an analysis of this aspect of culture for future research.

[9] We could stipulate a positive probability, say $\epsilon > 0$, of the manager finding a loan even with zero effort ($e_g = 0$) and then write the probability of finding a loan as a function of e_g as $\epsilon(1 - e_g) + e_g$.

[10] The manager would deliberately reject a good loan if $w_X < w_\varnothing$, and accept a bad loan if $w_\varnothing < w_0$.

[11] The manager would face no risk of sanction since there would be no loan made to an applicant who is not creditworthy. In other words, the manager cannot be punished for not making a bad loan, and proving that the manager "manufactured" an application just to reject it may be very difficult, if not impossible.

[12] If no loan is financed, the bank still raises equity (E) and deposits (D) but invests I in a competitively-priced security.

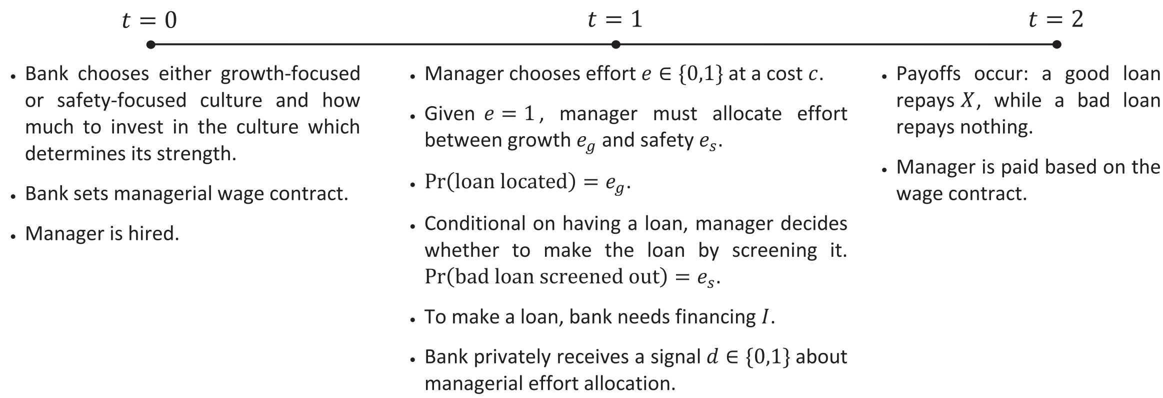

Fig. 1. Sequence of events.

(possibly partial) deposit insurance, which repays depositors $\phi \in (0, D]$ if a bad loan is financed; note that $\phi = D$ corresponds to full deposit insurance.[13] Deposit insurance is free in the model, but all the model's results regarding deposit insurance sustain qualitatively as long as deposit insurance is risk-independent and not fairly priced.[14] The deposit market is competitive, so depositors provide financing as long as it yields them an expected return of zero. Given that a loan that is financed is good w.p. $\frac{\lambda}{\lambda + (1-\lambda)(1-e_s)}$, the bank's deposit repayment obligation is:[15]

$$R = D + \frac{(1-\lambda)(1-e_s)(D-\phi)}{\lambda}, \tag{1}$$

which is decreasing in e_s and ϕ. Third, while many features of the way we model culture also apply to non-banks, the choice of growth versus safety is the most applicable to banks. For non-banks, there are many other relevant choices, such as innovation versus efficiency.

3. Analysis of the base model

In our analysis of the base model, we shut down the culture channel by assuming that the bank does not invest in culture and does not link implicit rewards and punishments to managerial behavior.

3.1. The bank's problem

The bank chooses wages w_X and $w_\varnothing$ (note $w_0 = 0$) to maximize its expected net profit:

$$\begin{aligned}\pi \;=\; & e_g[\lambda(X-R-E-w_X) + (1-\lambda)e_s(-w_\varnothing) + (1-\lambda)(1-e_s)(-E)] \\ & + (1-e_g)(-w_\varnothing),\end{aligned} \tag{2}$$

where R is given by (1). The bank has a loan w.p. e_g, in which case: (i) w.p. λ the loan is good, which yields the bank a net profit (the bank itself contributes E to loan) $X - R - E - w_X$ after paying depositors (R) and the manager (w_X); (ii) w.p. $(1-\lambda)e_s$ the borrower is bad but screened out by the manager, so no financing is raised and the bank's net payoff is $(-w_\varnothing)$ after paying the manager; and (iii) w.p. $(1-\lambda)(1-e_s)$ the borrower is bad but not screened out by the manager, so the bank pays nothing to the manager ($w_0 = 0$), its deposit repayment is (partially) covered by insurance but the bank loses its capital E. The second term corresponds to the case in which the bank does not have a loan (w.p. $1 - e_g$), so its net payoff is $(-w_\varnothing)$ after paying the manager.

The manager's expected utility from working is:

$$u = e_g[\lambda w_X + (1-\lambda)e_s w_\varnothing] + (1-e_g)w_\varnothing - c. \tag{3}$$

The manager's individual rationality (IR) constraint to participate, incentive compatibility (IC) constraint to exert effort, and IC constraint related to effort allocation (conditional on working) are given by (4), (5), and (6), respectively:

$$u \;\ge 0, \tag{4}$$

$$u \;\ge w_\varnothing \Rightarrow \lambda\frac{w_X}{w_\varnothing} \ge 1 - (1-\lambda)e_s + \frac{c}{e_g w_\varnothing}, \tag{5}$$

$$\begin{aligned}\{e_g, e_s\} \;\in\; & \underset{\{e_g+e_s=1\}}{\operatorname{argmax}} u \Rightarrow e_g = \frac{\lambda}{2(1-\lambda)}\left(\frac{w_X}{w_\varnothing} - 1\right) \text{ and} \\ e_s \;=\; & \frac{\lambda}{2(1-\lambda)}\left(\frac{2-\lambda}{\lambda} - \frac{w_X}{w_\varnothing}\right).\end{aligned} \tag{6}$$

The right-hand side (RHS) of (5), $w_\varnothing$, is what the manager would get even if she does not exert any effort, leading to the guaranteed absence of a loan. This is because in this case, without investment being made in any loan, the bank cannot tell whether it is because no loan was generated, or a loan was generated but was screened out as bad by the manager. Note that if (5) is satisfied, (4) will be automatically satisfied, given that $w_\varnothing \ge 0$.[16] Moreover, (5) ensures that the manager always finances a loan unless she identifies it as bad: (5) implies (given that $c > 0$) $\lambda\frac{w_X}{w_\varnothing} > 1 - (1-\lambda)e_s$, i.e., $\frac{\lambda}{\lambda+(1-\lambda)(1-e_s)}w_X > w_\varnothing$, where the left-hand side (LHS) is the manager's expected wage from financing a loan that is not identified as bad, and the RHS is her wage if she rejects the loan.

Effort allocation is driven by the pay wedge $\frac{w_X}{w_\varnothing}$ (see (6)). An increase in $\frac{w_X}{w_\varnothing}$ causes a shift in effort away from safety (e_s decreases) and toward growth (e_g increases), since the manager is paid $w_\varnothing$ even when she works and screens out a bad loan (due to the bank's inability to tell between the manager shirking and working but screening out a bad loan). Combining (5) and (6) yields:

[13] Lambert et al. (2017) provide evidence that an increase in insured deposits leads to greater risk-taking by banks.

[14] Chan et al. (1992) establish conditions under which fairly-priced deposit insurance is impossible.

[15] Although depositors do not observe e_s, they can infer it in equilibrium from the managerial wage contract.

[16] If the manager's reservation utility is very high (much bigger than 0), her choice will be between working ($e = 1$) and her outside opportunity, rather than between working and shirking ($e = 0$). The IC constraint of effort exertion (5) is then redundant in both the first-best and second-best cases analyzed below; only the IR constraint binds (at that high reservation utility). As a result, the first-best and second-first outcomes would be identical. To avoid this trivial and uninteresting case, we assume a sufficiently low reservation utility (0 in our model).

$$\frac{w_X}{w_\varnothing} \geq 1 + \frac{4(1-\lambda)}{\lambda^2}\frac{c}{w_X - w_\varnothing}. \tag{7}$$

Although increasing $\frac{w_X}{w_\varnothing}$ induces more growth but less safety, we see from (7) that the bank has to maintain a certain wedge between w_X and $w_\varnothing$ in order to induce managerial effort in the first place. If $\frac{w_X}{w_\varnothing}$ is too low, the manager has no incentive to work at all, since she gets paid $w_\varnothing$ even if she did not generate a loan. Thus, the bank is essentially confronted with a classic multi-tasking problem: higher $\frac{w_X}{w_\varnothing}$ induces effort but also shifts effort away from safety and toward growth.

3.2. First best

We begin by analyzing a benchmark case, assuming the bank can observe and contract on both managerial effort exertion ($e \in \{0, 1\}$) and allocation (choices of e_g and e_s). To elicit effort ($e = 1$), the bank only needs to pay a fixed wage equal to c to compensate for the manager's effort cost. The bank then dictates the allocation of managerial effort to maximize its expected net profit:

$$\max_{\{e_g+e_s=1\}} \pi = e_g[\lambda(X - R - E) - (1-\lambda)(1-e_s)E] - c, \tag{8}$$

where $R = D + \frac{(1-\lambda)(1-e_s)(D-\phi)}{\lambda}$ is given by (1). The solutions are:[17]

$$e_g^* = \frac{\lambda(X - I)}{2(1-\lambda)(I-\phi)} \text{ and } e_s^* = 1 - e_g^*. \tag{9}$$

We denote the allocation in (9) as "first best." However, one should keep in mind that the solution is the bank's privately optimal choice of allocation with effort observability, but not the first best from a social planner's point of view. This is because potential deposit insurance losses (incurred by taxpayers) are not taken into account in the solution in (9) due to free deposit insurance in the model.[18] The first-best allocation balances the need for growth (to gain from financing a good loan, $X - I$) against the need for safety (to avoid the loss from default, $I - \phi$). Safety increases in importance when the borrower pool quality worsens (lower λ) or deposit insurance coverage drops (smaller ϕ).

Our subsequent analysis of the bank's problem crucially relies on the *joint unobservability* of managerial effort exertion and allocation. In particular, we show below that the first-best outcome is attainable as long as the bank can observe and contract on effort exertion $e \in \{0, 1\}$, even if it does not observe the manager's allocation of e to e_g and e_s. In this case, only the IR constraint (4) matters (and it must be binding), while the IC constraint (5) is irrelevant. The bank's problem is thus the same as the one in (8). The only difference is that now the bank cannot dictate effort allocation, but needs to incentivize the manager to choose the first-best allocation in (9) by selecting $\frac{w_X}{w_\varnothing}$ according to the effort-allocation IC constraint (6).

Proposition 1 (*First best*). *The first-best outcome in (9) can be obtained as long as the bank can observe and contract on managerial effort exertion, even if it cannot observe the manager's effort allocation, in which case the wages are* $w_\varnothing^* = \frac{c}{1+(1-\lambda)(e_g^*)^2}$ *and* $w_X^* = \left[1 + \frac{2(1-\lambda)}{\lambda}e_g^*\right]w_\varnothing^*$.

3.3. Second best

We now consider the case in which managerial effort exertion and allocation are *jointly* unobservable to the bank, so (5) needs to be satisfied ((4) is now redundant). Since the first best can be obtained as long as effort exertion is observable and contractible (see Proposition 1), we designate the outcome in this case as the second best. First, (5) must be binding. Combining (5) and (6) yields:

$$w_\varnothing = \frac{c}{(1-\lambda)e_g^2} > 0. \tag{10}$$

Note that $w_\varnothing$ is decreasing in e_g, for the following reason. The no-loan state $\{\varnothing\}$ implies three possibilities: (i) the manager shirked, in which case she should get zero pay; (ii) the manager worked, but w.p. $1 - e_g$ she failed to find a loan; and (iii) the manager generated a loan, found it bad, and rejected it, in which case she should be rewarded. The bank cannot tell (i) – (iii) apart. However, (i) becomes more likely when e_g is bigger, so the bank optimally lowers $w_\varnothing$. This is a useful observation for the analysis in Section 4.2.

The bank's expected net profit π (as given by (2)) can be rewritten as:

$$\begin{aligned} \pi &= e_g[\lambda(X - R - E) - (1-\lambda)(1-e_s)E] \\ &\quad - \{e_g[\lambda w_X + (1-\lambda)e_s w_\varnothing] + (1-e_g)w_\varnothing\} \\ &= e_g[\lambda(X - R - E) - (1-\lambda)(1-e_s)E] - w_\varnothing - c \\ &= e_g[\lambda(X - R - E) - (1-\lambda)(1-e_s)E] - \frac{c}{(1-\lambda)e_g^2} - c, \end{aligned} \tag{11}$$

where the second equality follows from (3) and (5), and the last equality follows from (10). Thus, the bank's problem is equivalent to:

$$\max_{\{e_g+e_s=1\}} \pi = e_g[\lambda(X - R - E) - (1-\lambda)(1-e_s)E] - \frac{c}{(1-\lambda)e_g^2} - c, \tag{12}$$

where $R = D + \frac{(1-\lambda)(1-e_s)(D-\phi)}{\lambda}$ is given by (1). Because of the bank's inability to pin down the cause of the no-loan outcome, the manager enjoys a rent $w_\varnothing = \frac{c}{(1-\lambda)e_g^2}$, which she can secure even without working. The bank's expected wage cost thus equals $w_\varnothing + c$, including the compensation for the manager's effort exertion c and the rent $w_\varnothing$.

Analyzing the problem in (12) and comparing the second-best outcome (labeled using the superscript "**") with that of the first best, we have:

Proposition 2 (*Second best*). *Compared to the first best, in the second best: (i) more effort is allocated to growth and less effort is allocated to safety, i.e.,* $e_g^{**} > e_g^*$ *and* $e_s^{**} < e_s^*$, *where* e_g^{**} *and* e_s^{**} *are given by (A.2) in the Appendix; and (ii) the wage contract has a larger pay wedge, i.e.,* $\frac{w_X^{**}}{w_\varnothing^{**}} > \frac{w_X^*}{w_\varnothing^*}$. *These differences become bigger when the deposit insurance coverage* ϕ *increases.*

Proposition 2 shows that there is excessive growth in the second best compared to the first best. This is due to the fact that the bank faces a multi-tasking problem in the second best, which is absent in the first best. Recall that if the bank can observe e but not its allocation, then it can achieve the first best by choosing $\frac{w_X}{w_\varnothing}$ to incentivize the manager to efficiently allocate her effort between growth and safety. In the second best, when both e and its allocation are unobservable, the bank's choice of $\frac{w_X}{w_\varnothing}$ also affects the manager's incentive to exert $e = 1$ in the first place, so the bank needs to strike a balance between effort elicitation and allocation. The former needs a big enough $\frac{w_X}{w_\varnothing}$, which inevitably shifts effort away from safety and toward growth. The consequent increase in loan risk is priced in the bank's higher deposit repayment obligation (i.e., R increases as e_s decreases; see (1)), which tempers the bank's growth inclination. However, a higher (free) deposit insurance coverage (larger ϕ) weakens this pricing effect, leading to a stronger growth focus (and an even larger pay wedge) relative to the first best (i.e., both $e_g^{**} - e_g^*$ and $\frac{w_X^{**}}{w_\varnothing^{**}} - \frac{w_X^*}{w_\varnothing^*}$ increase).[19]

The effect of (risk-independent) deposit insurance on the bank's

[17] We assume that the expected net bank profit obtained under the allocation in (9) exceeds that without managerial effort ($e = 0$), which is simply zero; this holds if c is not too big.

[18] The *socially optimal* "first-best" allocation would be tilted more toward safety relative to the one in (9); it would be chosen by the bank only when $\phi = 0$ in the model.

[19] As pointed out earlier in Section 2, this result holds qualitatively as long as deposit insurance is non-risk-rated.

growth-versus-safety choice highlights the special role that mispriced (or non-risk-rated) safety nets play in shaping bank strategies. As we will see later, safety nets also influence bank culture, illuminating another aspect of the difference between banks and non-financial firms.

4. The role of culture: one-bank case

In this section, we provide an endogenous rationale for bank culture.

Beliefs and types: Suppose agents believe that the borrower pool quality is $\lambda \in \{\bar{\lambda}, \underline{\lambda}\}$, where $1 > \bar{\lambda} > \underline{\lambda} > 0$. Clearly, an agent with belief $\lambda = \bar{\lambda}$ views growth as relatively more important than an agent who believes $\lambda = \underline{\lambda}$. A bank-manager match is indicated by the pair $\{\lambda_B, \lambda_M\}$, where λ_B and λ_M represent the bank's belief and the manager's belief about λ, respectively; λ_B and λ_M may be the same or different. We denote an agent's belief as the agent's type, and simply call a bank (manager) with the optimistic belief $\lambda_B = \bar{\lambda}$ ($\lambda_M = \bar{\lambda}$) an "optimistic" bank (manager), and a bank (manager) with the pessimistic belief $\lambda_B = \underline{\lambda}$ ($\lambda_M = \underline{\lambda}$) a "pessimistic" bank (manager).

The analysis in Section 4.1 mutes the culture channel and assumes an exogenously given match $\{\lambda_B, \lambda_M\}$. Section 4.2 then opens the culture channel and studies its role in endogenous matching.

Remarks: When we refer to the "bank's beliefs," we mean the beliefs of its CEO and Board of Directors.[20] It is natural to posit that such a group will develop homogeneous beliefs through screening and shared learning (see Van den Steen, 2010a).[21] The manager is a loan officer the bank hires to locate and screen loans. We allow the manager's beliefs to be possibly different from the bank's beliefs to analyze the importance of culture in playing a sorting role in employee selection. In other words, we examine the role of bank culture in selecting a *de novo* manager, one whose beliefs may not be the same as the bank's. The idea that an important role of bank culture is to align employee beliefs with those that shape the organization's choice of culture is also well recognized by policymakers and regulators. For example, the Group of Thirty (2015) report states:

> "Banks should... develop programs for staff across all areas of the bank, tailored to the bank's circumstances that regularly reinforce what the desired values and conduct mean in practice. Changing behaviors is a developmental program... All employees and all levels of management should adhere to values, conduct, and behavioral expectations."

4.1. Exogenous bank-manager match

The analysis with generic beliefs ($\lambda_B, \lambda_M \in \{\bar{\lambda}, \underline{\lambda}\}$) is similar to that in Section 3, so we relegate details to the Appendix. Below we present and discuss the results corresponding to various combinations of λ_B and λ_M; in each case, the second-best (resp. first-best) effort allocations to growth and safety are denoted by $e^{**}_{g\{\lambda_B,\lambda_M\}}$ and $e^{**}_{s\{\lambda_B,\lambda_M\}}$ (resp. $e^{*}_{g\{\lambda_B,\lambda_M\}}$ and $e^{*}_{s\{\lambda_B,\lambda_M\}}$), respectively.

Homogeneous (matched) beliefs: We first consider two cases wherein the bank and the manager have homogenous beliefs: $\{\lambda_B = \underline{\lambda}, \lambda_M = \underline{\lambda}\}$ and $\{\lambda_B = \bar{\lambda}, \lambda_M = \bar{\lambda}\}$. It follows immediately from Proposition 2 that in each case, compared to the first best, the second best always involves excessive growth (i.e., $e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}} > e^{*}_{g\{\underline{\lambda},\underline{\lambda}\}}$ and $e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}} > e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}}$) and a larger pay wedge.[22]

Heterogeneous (mismatched) beliefs – limitation of wage contracts: Next, we consider two cases with mismatched beliefs: $\{\lambda_B = \underline{\lambda}, \lambda_M = \bar{\lambda}\}$ and $\{\lambda_B = \bar{\lambda}, \lambda_M = \underline{\lambda}\}$. In $\{\lambda_B = \underline{\lambda}, \lambda_M = \bar{\lambda}\}$, the manager is more inclined than the bank to favor growth; we compare the corresponding second-best effort allocation with that in $\{\lambda_B = \underline{\lambda}, \lambda_M = \underline{\lambda}\}$, wherein both the bank and the manager are pro-safety. In $\{\lambda_B = \bar{\lambda}, \lambda_M = \underline{\lambda}\}$, the bank is more prone to growth than the manager; we compare the corresponding second-best effort allocation with that in $\{\lambda_B = \bar{\lambda}, \lambda_M = \bar{\lambda}\}$, wherein both the bank and the manager are pro-growth. The comparisons lead to:

Proposition 3 (*Growth versus safety with mismatched beliefs and no investment in culture*). *There is more growth relative to safety when the manager is more prone to growth than the bank, $\{\lambda_B = \underline{\lambda}, \lambda_M = \bar{\lambda}\}$, than when both are pro-safety, $\{\lambda_B = \underline{\lambda}, \lambda_M = \underline{\lambda}\}$, i.e., $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} > e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$, despite a lower pay wedge $\frac{w_X}{w_\varnothing}$ in the former case. The difference $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} - e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ is increasing in the deposit insurance coverage ϕ. There is less growth relative to safety when the bank is more pro-growth than the manager, $\{\lambda_B = \bar{\lambda}, \lambda_M = \underline{\lambda}\}$, than when both are pro-growth, $\{\lambda_B = \bar{\lambda}, \lambda_M = \bar{\lambda}\}$, i.e., $e^{**}_{g\{\bar{\lambda},\underline{\lambda}\}} < e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$, despite a higher pay wedge $\frac{w_X}{w_\varnothing}$ in the former case. The difference $e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}} - e^{**}_{g\{\bar{\lambda},\underline{\lambda}\}}$ is increasing in the deposit insurance coverage ϕ.*

Consider first $\{\lambda_B = \underline{\lambda}, \lambda_M = \bar{\lambda}\}$. In this case, the manager is more optimistic about borrower quality, so she tends to allocate excessive effort to growth from the bank's perspective. To cope with this, the bank lowers $\frac{w_X}{w_\varnothing}$ relative to the matched-beliefs case, $\{\lambda_B = \underline{\lambda}, \lambda_M = \underline{\lambda}\}$. *However, importantly, what prevents the bank from completely undoing the manager's growth tendency is that too low a $\frac{w_X}{w_\varnothing}$ also weakens the manager's incentive to exert effort in the first place.* Thus, there is an incentive-constraint-driven lower bound on $\frac{w_X}{w_\varnothing}$, which explains why excessive effort is allocated to growth (i.e., $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} > e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$) despite the optimal wage contract adjustment. Increasing the (free) deposit insurance coverage ϕ weakens market discipline that forces the bank to (partially) internalize the increased deposit funding cost associated with its growth inclination, thereby exacerbating the problem of excessive growth due to belief mismatch (i.e., $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} - e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ increases).[23] In other words, the multi-tasking agency problem prevents the bank from fully undoing the manager's growth propensity with the wage contract, leaving room for culture to reduce this distortion.

Next, consider $\{\lambda_B = \bar{\lambda}, \lambda_M = \underline{\lambda}\}$, wherein the manager is more pessimistic about borrower quality than the bank and, hence, is prone to underinvest in growth from the bank's perspective. The bank incorporates the manager's excessive-safety tendency into the wage contract by increasing $\frac{w_X}{w_\varnothing}$ relative to the matched-beliefs case, $\{\lambda_B = \bar{\lambda}, \lambda_M = \bar{\lambda}\}$. However, setting $\frac{w_X}{w_\varnothing}$ too high also increases the wage cost. Thus, there exists an endogenous upper bound on $\frac{w_X}{w_\varnothing}$, which explains why $e^{**}_{g\{\bar{\lambda},\underline{\lambda}\}} < e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$, i.e., there is less growth than the bank would like even with the optimal wage contract. As the (free) deposit insurance coverage ϕ increases, the problem of excessive safety becomes more significant for the bank (i.e., $e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}} - e^{**}_{g\{\bar{\lambda},\underline{\lambda}\}}$ increases).[24] Thus, similar to the case $\{\lambda_B = \underline{\lambda}, \lambda_M = \bar{\lambda}\}$, the wage contract is unable to fully undo managerial effort misallocation.

Robustness: The analysis above shows that wage contracts alone cannot induce a bank's preferred effort allocation between growth and safety when beliefs between the bank and the manager are mismatched. While the analysis here is conducted with only two possible values of beliefs, we have verified that the result generalizes to a continuum of

[20] We abstract from the process by which shareholders, with potentially divergent beliefs, select the CEO. See Boot et al. (2006) for a model of the interaction between the beliefs of the CEO and the (possibly different) beliefs of shareholders who are themselves heterogeneous in their beliefs.

[21] We do not explicitly model this belief convergence process. While we expect beliefs among this group to be relatively homogeneous, we acknowledge that in practice there may be disagreement among group members. This raises a host of interesting governance issues that we do not address here.

[22] We can determine $e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ and $e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$ (resp. $e^{*}_{g\{\underline{\lambda},\underline{\lambda}\}}$ and $e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}}$) by replacing λ in (A.2) in the Appendix (resp. (A.1)) with $\underline{\lambda}$ and $\bar{\lambda}$, respectively.

[23] Although both $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}$ and $e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ are increasing in ϕ (a direct consequence of Proposition 2), the former is more sensitive to ϕ due to the manager being more pro-growth in that case.

[24] Both $e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$ and $e^{**}_{g\{\bar{\lambda},\underline{\lambda}\}}$ are increasing in ϕ (which follows from Proposition 2), but the former is more sensitive to ϕ due to the manager being more pro-growth in that case.

possible beliefs for the bank and the manager; that is, the limitation of the wage channel due to the inherent multi-tasking incentive problem in banking contracts extends to a more general setting with a continuum of beliefs.

4.2. Endogenous bank-manager match: culture eases assortative matching

The following intermediate result is useful for our analysis of endogenous bank-manager match.

Lemma 1. *Both types of managers earn bigger rents when hired by a pessimistic bank than when hired by an optimistic bank. If $\frac{\phi}{c}$ is sufficiently high, then a pessimistic bank obtains a higher net profit from hiring a pessimistic manager than from hiring an optimistic manager.*

As explained following (10), a bigger e_g enables the bank to better distinguish among various possibilities that lead to the no-loan state $\{\emptyset\}$. This reduces managerial rent $w_\emptyset$ which she earns even without working. The first part of Lemma 1 then follows from the fact that any manager's effort allocation to growth is higher with an optimistic bank than with a pessimistic bank.

For a pessimistic bank, hiring a pessimistic manager allows it to move closer to its preferred effort allocation, while hiring an optimistic manager lowers its wage cost.[25] The wage cost saving is proportional to the manager's effort cost c (as shown in the Appendix); the value loss due to effort misallocation is increasing in the extent of misallocation, which, in turn, is increasing in the deposit insurance coverage ϕ (see Proposition 3). Thus, as a sufficient condition, if $\frac{\phi}{c}$ is big enough, the pessimistic bank prefers a pessimistic manager.[26] In what follows, we assume this is the case, as our objective is to study how culture reduces effort misallocation through better bank-manager belief matching.[27] The deposit insurance result implies that the value of culture in aligning beliefs is greater for banks with insurance coverage than for non-banks.

4.2.1. Labor market

Let $\bar{n}^{\mathrm{b}}$ and $\underline{n}^{\mathrm{b}}$ (resp. $\bar{n}^{\mathrm{m}}$ and $\underline{n}^{\mathrm{m}}$) denote, respectively, the number of optimistic and pessimistic banks (resp. managers). We assume that: (i) $\bar{n}^{\mathrm{b}} > \bar{n}^{\mathrm{m}}$ and $\underline{n}^{\mathrm{b}} > \underline{n}^{\mathrm{m}}$ to reflect the scarcity of managerial talent of each type, so there is full employment for managers (regardless of type) but some banks will fail to hire a manager; and (ii) $\max\{\bar{n}^{\mathrm{b}}, \underline{n}^{\mathrm{b}}\} < \bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$, so neither type of bank will be able to hire all the managers. The equilibrium concept is *stability*, as proposed by Gale and Shapley (1962). A matching is said to be stable if there exists no pair of bank and manager who were not matched with each other but would both strictly prefer to.[28]

A bank's belief λ_B is common knowledge, but each manager's belief λ_M is her private information. A bank designs the wage contract (as in Section 4.1) *after* it is matched with a manager and decides to hire her.[29] The assumption that the employer's type is known to all is reasonable, since this information will be revealed by past hiring and promotion decisions, observed strategies and wage contracts deployed. By contrast, employers typically invest resources in learning about job applicants to determine their skills as well as whether there is a good "fit" with the firm. Moreover, for managerial positions, firms do not post explicit wage contracts before interviewing applicants. Contractual features are typically advertised vaguely, with details negotiated *after* hiring.

Matching process: We use a modified version of the Gale-Shapley algorithm to reach stable matching. We describe it briefly here. Details are in the Appendix (see proof of Proposition 4).

1. Each manager applies to her preferred bank;[30] a bank may receive multiple or no applications.
2. A bank receiving multiple applications screens applicants; the screening cost is increasing in the number of applications. The bank then hires the applicant (if beliefs match), puts her on a waiting list, or rejects her. No screening is conducted in case of only one or no application; in case of one application, the applicant is simply kept on the bank's waiting list.[31]
3. Each rejected manager removes from her list the bank that rejected her and applies to her preferred bank from the rest.
4. The screening process repeats, with each bank pooling its waiting list with new applicants.
5. After a finite number of steps, the optimistic managers who were rejected by *all* pessimistic banks begin applying to optimistic banks,[32] and the same process repeats. The process stops once $\bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$ banks have received applications; at that final stage, any bank that still keeps a waiting list hires the applicant on the list.

The resulting matching is stable as shown by Gale and Shapley (1962). We now have:

Proposition 4 (*Non-assortative matching absent investment in culture*). *Absent investment in culture, all stable matches are non-assortative, wherein pessimistic banks hire all the pessimistic managers but also some optimistic managers.*

Since assortative matching requires that every bank-manager pair have the same beliefs, some pessimistic banks must remain unmatched, given that $\underline{n}^{\mathrm{b}} > \underline{n}^{\mathrm{m}}$. For such a bank and any manager currently paired with an optimistic bank, both would be strictly better off by deviating – the manager would enjoy a bigger rent when hired by a pessimistic bank (see Lemma 1), and the bank would earn a positive profit when hiring a manager, which exceeds the zero profit with an unfilled position. Thus, the assortative matching is unstable.

Remarks: Proposition 4 implies that in a stable match some optimistic banks cannot hire any manager and have to forgo loan opportunities. One might argue that unmatched banks may bid up wages to attract managers. If we permit such Bertrand competition among banks as part of the matching process, then (i) optimistic banks will outbid pessimistic banks (as they have a higher subjective expectation of loan profitability, and hence bid more aggressively), so all optimistic banks are matched with managers while some pessimistic banks would not, and (ii) all the surplus from lending in a bank-manager pair will be accrued to the manager due to the scarcity of managers relative to

[25] The reason is twofold. First, for any given effort allocation between growth and safety, the optimistic manager believes that it is highly likely that the loan (conditional on being found) will pay off and, hence, she will get paid the high wage w_X. Second, because of her optimistic belief, the manager will allocate more effort toward growth, making it more likely that a loan will be found in the first place. These two effects reinforce each other and *ceteris paribus* result in a higher perceived utility for the optimistic manager for any given wage contract.

[26] For a pessimistic bank, the tradeoff between wage cost saving and misallocation-induced value loss from hiring an optimistic manager exists even with fairly priced deposit insurance fully accounting for loan risk (effectively, $\phi = 0$ in the model with risk-independent insurance). In that case, or $\phi > 0$ but $\frac{\phi}{c}$ is sufficiently low, either effect may dominate depending on other parameters, so it is possible that a pessimistic bank may prefer an optimistic manager. Since our subsequent analysis focuses on the more interesting case wherein a pessimistic bank prefers a pessimistic manager, we make a sufficient (but not necessary) assumption, $\frac{\phi}{c}$ being sufficiently high, to focus on this more interesting case (so we can study the role of culture in facilitating stable assortative matching).

[27] Our objective is not to explore (self-perceived) cost savings due to belief differences.

[28] Gale and Shapley (1962) show that stable matches always exist for two-sided markets (as the one studied here).

[29] This precludes pre-hiring screening of applicants based on beliefs or "belief signaling" by applicants.

[30] Lemma 1 shows that managers all start by applying to a pessimistic bank.

[31] It is optimal for the bank to not conduct screening with only one applicant. If no other applicants show up in future rounds, then the applicant is automatically hired from the waiting list as the algorithm specifies, economizing on the bank's screening cost. If other applicants show up later, screening now (with only one applicant) or later when other applicants show up incurs the same cost to the bank (which only depends on the number of applicants to screen).

[32] Note that neither type of bank can hire all the managers, given that $\max\{\bar{n}^{\mathrm{b}}, \underline{n}^{\mathrm{b}}\} < \bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$.

banks. Our model's setting precludes such possibilities. Our matching model follows the canonical Gale and Shapley (1962) setting with nontransferable utility, wherein the division of the match surplus is exogenously given (all the surplus goes to the bank in *post-match* contracting) and preferences over matches can be expressed in ordinal terms (all managers prefer a pessimistic bank, wherein a pessimistic (resp. optimistic) bank prefers a pessimistic (resp. optimistic) manager). The alternative setting described above belongs to another strand of matching models with perfectly transferable utility, wherein parties being matched can freely transfer payoffs between them. We opt to not use that setting with Bertrand competition because that would render the analysis of bank-manager contracting (Section 3) redundant as all the match surplus goes to the manager. Furthermore, the notion of culture as part of implicit contracting to punish a manager from deviating from bank-preferred benchmark effort allocation (as modeled below) would be redundant too: banks would cut back investment in culture and discipline managers to a lesser extent in order to outbid other banks in hiring managers.

4.2.2. A model of bank culture

We now define our notion of culture. Our view is that culture is developed through reward and punishment linked to employee behavior (see, for example, Lo, 2016, and Thakor, 2016a). If the manager chooses an action that deviates from the bank's culture-dictated preferred behavior, she may suffer implicit (non-pecuniary) punishments such as denial of promotion or interesting/meaningful task assignments, social ostracization and so on. A key is that these implicit rewards and punishments can rely on (noisily) observable signals of performance that are *not* verifiable (by a third party) for contracting purposes. In other words, they cannot be used to write explicit wage contracts, but nonetheless serve as useful indicators for implicit contracting.

Specifically, suppose the manager's effort allocation between growth and safety, $\{e_g, e_s\}$, deviates from a benchmark allocation set by the bank, $\{e_g^B, e_s^B\}$, with $e_g^B + e_s^B = 1$, where the deviation is $|e_g - e_g^B| + |e_s - e_s^B| \in [0, 2]$. A larger e_g^B represents a more growth-oriented culture, and a larger e_s^B represents a more safety-oriented culture. The bank's investment in culture allows it to generate a private signal $d \in \{0, 1\}$ that probabilistically detects such deviation, where $d = 1$ indicates detection and $d = 0$ indicates no detection. Detection only informs that a deviation has occurred but does not reveal the magnitude of the deviation. Assume $\Pr(d = 1) = \alpha(|e_g - e_g^B| + |e_s - e_s^B|)$, where $\alpha \in [0, 1/2]$ measures the strength of culture, with a bigger α corresponding to a stronger culture. The idea is that the stronger is the bank's culture and the larger is the manager's effort-allocation deviation, the more likely it is that the deviation will be detected.[33] The manager suffers a disutility, which is normalized to one without loss of generality, when $d = 1$. Thus, the expected disutility suffered by the manager is:

$$\alpha(|e_g - e_g^B| + |e_s - e_s^B|). \tag{13}$$

We can interpret α as the bank's investment in culture; examples include building an organization with a clear set of rules and procedures that ensure these rules are followed, and fostering an environment that encourages and rewards internal flag-raising and whistleblowing that help detect managerial behaviors that are incompatible with the organization's culture.[34] Such investments are costly; the cost for the bank to develop a culture with strength α is $\frac{1}{2}\beta\alpha^2$, where the marginal cost β may vary in the cross-section of banks.

We view this as a reduced-form, steady-state representation of culture. Typically, such steady-state cultural practices are the result of a dynamic and organic process of evolving norms and practices. For example, it was reported that when James McNerney took over as CEO of 3M, he began a process of transforming the traditionally innovation-focused culture into a more efficiency-focused and safety-oriented culture with initiatives like six-sigma quality. It was reported that this had significantly changed the company by the time he left six years later. Similarly, it is widely reported that the culture of major U.S. investment banks changed away from a more cooperative orientation as a result of moving from a partnership to a public ownership mode. No matter what the trigger for the change in culture, ensuring compliance with culture invariably involves the deployment of organizational mechanisms that seek to align the behavior of employees with that culture (e.g., Group of Thirty, 2015). In that sense, the "culture carriers" of the organization tend to be "monitors." A key difference between the usual monitoring in principal-agent settings and cultural "oversight" is that in the former case compensation contracts are typically conditioned on the verifiable signals from monitoring (e.g., Holmstrom, 1979), whereas in the latter case the signals are non-verifiable for explicit contracting, so their use is in less formal and more subtle ways.

This is also reflected in how the influential (Group of Thirty, 2015) report characterizes the role of bank culture:

> "Most banks should aim for a fundamental shift in the overall mindset on culture... raising the bar for CEO and Executive team leadership, visibility, and appetite to consistently take difficult internal sanctioning decisions (ensuring material consequences in terms of both termination of implicated management and employees, and significant compensation adjustments)... Banks should work to fully embed the desired culture through ongoing monitoring and perseverance..."

Similarly, William Dudley, President of the Federal Reserve Bank of New York, stated:

> "To maintain such a culture, senior leaders must promote effective self-policing... A firm's employees are its best monitors, but this only works well if they feel a shared responsibility to speak up, expect to be heard and their efforts supported by senior management." – Dudley (2014).

Remarks: One might argue that in a multi-period setting the bank may infer managerial effort exertion and allocation after repeatedly observing loan volumes and default rates over time. After many periods, the frequency with which the manager extends a loan and the rate that extended loans do not default should converge to $e_g[\lambda + (1-\lambda)(1-e_s)]$ and $\frac{\lambda}{\lambda + (1-\lambda)(1-e_s)}$, respectively. Therefore, instead of engaging in costly monitoring to detect a one-shot deviation (as modeled above), the bank may invest in culture by setting up long-term compensation systems and condition pay on loan outcomes over many periods. Although theoretically plausible, implementing such a long-term scheme is not without cost in reality. First, although it economizes on the cost of short-term monitoring, the bank has to wait for many periods to detect any deviation. That may be too late because a disaster may strike well before the bank can accumulate sufficient data to detect deviation. Second, the manager may quit or be moved to another unit of the bank before long-term incentives can be implemented. Third, a long-term scheme is most effective in a stationary setting in which the

[33] This specification implies that while it is possible that a deviation will go undetected, the bank will never observe a signal indicating a deviation when there is none.

[34] The Group of Thirty (2015) report refers to this as "escalation." One way to implement this is through peer monitoring. Similar to the "cosigning" notion of peer monitoring in lending in Stiglitz (1990), the bank may assign the manager to a functional group and base each member's compensation on the group performance. This facilitates the generation of the signal d by incentivizing the members of the group to monitor the actions of their peers. The group should be of a moderate size for effective monitoring: groups too small promote collusion, while group too large encourage free-riding. Ramakrishnan and Thakor (1984) develop a theory of financial intermediation in which members of the financial intermediary can monitor each other and optimal incentive contracts are written on *group performance* even though outputs of individual agents are conditionally i.i.d. The case of incentive contracting with correlated outputs of individual agents is considered in Ramakrishnan and Thakor (1991).

borrower pool quality λ does not change over time. If λ changed each period, or if the bank and the manager had (unobservably) different beliefs about λ, then the long-term mechanism may not work because the inference of managerial effort exertion and allocation will be confounded by non-stationarity or lack of knowledge of beliefs. Also, the mechanism relies on the assumption that borrower qualities are identical and independently distributed over periods, so the law of large numbers applies. This may not hold either, as borrower qualities may be correlated over time.

Culture and identity: One may interpret our notion of culture as a source of "identity" for the manager à la (Akerlof and Kranton, 2005). In their paper, the manager suffers a disutility when her action deviates from the firm's desired benchmark as in our model.[35] Acquiring soft information about the manager's effort deviation from the bank's "norms" does not help the bank with writing a more effective wage contract, but it does help it decide whether to impose implicit (non-pecuniary) punishment, such as denial of promotion or interesting/meaningful task assignments, social ostracization and so on, on the manager. We can think of this as the bank shaping the manager's "identity." Such actions are ubiquitous in organizations. When an employee's behavior is consistent with the organization's culture, recognition and rewards like promotions follow; the converse is true when behaviors are inconsistent with the culture. This effect of culture essentially promotes "we thinking" in Akerlof's (2016) terminology.

Culture and assortative matching: To study the role of culture, we assume that a pessimistic bank prefers to *always* be matched with a pessimistic manager, even at the risk of remaining unmatched, given that there are more pessimistic banks ($\underline{n}^{\mathrm{b}}$) than pessimistic managers ($\underline{n}^{\mathrm{m}}$). Culture seeks to dissuade the "wrong" type of manager from applying, so as to reduce costly screening. But the tradeoff is that culture development is also costly. Without investment in culture, the bank is always matched with some manager, but the probability that it is a pessimistic manager is only $\frac{\underline{n}^{\mathrm{m}}}{\underline{n}^{\mathrm{b}}}$ without screening. So, while the bank avoids a culture development cost, it incurs a high screening cost in the matching process due to a flood of applications. Instead, if the bank invests in a strong safety-oriented culture, it ensures that only pessimistic managers apply, which eliminates a screening cost. The reason is as follow. Compared to a pessimistic manager, an optimistic manager's (optimistic-belief-induced) effort allocation deviates more from the pessimistic bank's benchmark allocation with a safety-oriented culture; the optimistic manager is thus more likely than her pessimistic counterpart to suffer a disutility from deviating from the safety-oriented bank's culture. As a result, a sufficiently strong culture developed by the pessimistic bank generates a lower job utility for an optimistic manager than for a pessimistic manager. Since there are more pessimistic banks than pessimistic managers, in this case each pessimistic bank will be able to hire a pessimistic manager (still) w.p. $\frac{\underline{n}^{\mathrm{m}}}{\underline{n}^{\mathrm{b}}}$ but leave its position unfilled w.p. $1-\frac{\underline{n}^{\mathrm{m}}}{\underline{n}^{\mathrm{b}}}$.

The downside of developing a strong culture is the possibility of hiring no one, while the benefit is the saving on the screening cost. If $\underline{n}^{\mathrm{m}}$ is not too small relative to $\underline{n}^{\mathrm{b}}$ or screening is sufficiently costly, then the *net* benefit of developing a strong culture is positive, and pessimistic banks invest in culture to generate a stable match that is *assortative*. Since any stable match absent culture investment is non-assortative (see Proposition 4), our analysis provides an *endogenous rationale* for culture to be deployed as an *assortative matching device* in the bank managerial labor market.

Formally, we show that a pessimistic bank will invest in a safety-oriented culture by setting its benchmark allocation as the corresponding first best, $\left\{e^*_{g\{\underline{\lambda},\underline{\lambda}\}}, e^*_{s\{\underline{\lambda},\underline{\lambda}\}}\right\}$, and choose the strength of the culture denoted by $\underline{\alpha}$, that makes an optimistic manager indifferent between a growth-oriented (optimistic) bank and a safety-oriented (pessimistic) bank. Consequently, all managers are hired by banks that share their beliefs, but some banks are unable to hire anyone.

An optimistic bank matched with an optimistic manager will also invest in culture to move that manager's effort closer to the first best. That is, the optimistic bank also sets the benchmark allocation as the corresponding first-best allocation, $\left\{e^*_{g\{\overline{\lambda},\overline{\lambda}\}}, e^*_{s\{\overline{\lambda},\overline{\lambda}\}}\right\}$, and then chooses its culture strength (denoted by $\overline{\alpha}$). The optimistic bank's culture investment affects an optimistic manager's payoff, which *endogenously* affects a pessimistic bank's investment in culture to make the optimistic manager indifferent between the two bank types.

A bank's choice of culture (i.e., the benchmark allocation: $\{e^*_{g\{\underline{\lambda},\underline{\lambda}\}}, e^*_{s\{\underline{\lambda},\underline{\lambda}\}}\}$ for a pessimistic bank; $\left\{e^*_{g\{\overline{\lambda},\overline{\lambda}\}}, e^*_{s\{\overline{\lambda},\overline{\lambda}\}}\right\}$ for an optimistic bank) and its strength ($\underline{\alpha}$ for a pessimistic bank; $\overline{\alpha}$ for an optimistic bank) are both publicly observable. Firms that develop strong cultures also develop visible reputations for having those cultures become salient to outsiders, due to word-of-mouth dissemination or media accounts. For example, Commerce Bank has a well known culture focused on safety, cost productivity and prudent management of credit risks.

In sum, two points emerge: (i) besides facilitating assortative matching, culture also moves effort choices closer to the first best; and (ii) achieving assortative matching also causes culture investments in different banks ($\underline{\alpha}$ and $\overline{\alpha}$) to be *endogenously correlated*. Formally, we have:

Proposition 5 (*Assortative matching and optimal bank culture*). *Pessimistic banks select the first best* $\{e^*_{g\{\underline{\lambda},\underline{\lambda}\}}, e^*_{s\{\underline{\lambda},\underline{\lambda}\}}\}$ *as the benchmark and develop a sufficiently strong safety-oriented culture by choosing* $\alpha = \underline{\alpha}$ *(determined by (A.22) in the Appendix)that makes an optimistic manager indifferent between an optimistic and a pessimistic bank. The resulting assortative matching, wherein a manager with belief* $\lambda_M \in \{\overline{\lambda}, \underline{\lambda}\}$ *is matched with a bank with the same belief* $\lambda_B = \lambda_M$*, is stable. Optimistic banks matched with optimistic managers select the first best* $\left\{e^*_{g\{\overline{\lambda},\overline{\lambda}\}}, e^*_{s\{\overline{\lambda},\overline{\lambda}\}}\right\}$ *as the benchmark and develops a growth-oriented culture with strength* $\alpha = \overline{\alpha}$ *(determined by (A.19) in the Appendix). Moreover, both* $\underline{\alpha}$ *and* $\overline{\alpha}$ *are decreasing in the deposit insurance coverage* ϕ.

The assortative matching is stable because any pair of bank and manager who are currently unmatched cannot both be made strictly better off by deviating from their current matches and rematching with each other. An optimistic manager currently matched with an optimistic bank cannot do better by leaving her bank and joining a pessimistic bank, given the pessimistic bank's investment in a safety-oriented culture. Similarly, a pessimistic manager currently matched with a pessimistic bank also cannot be strictly better off by rematching with an optimistic bank: given that a pessimistic bank's culture makes an optimistic manager indifferent between optimistic and pessimistic banks, it makes the pessimistic manager strictly prefer the pessimistic bank.

Each bank's investment in culture also moves managerial effort allocation closer to its preferred benchmark (the first best) by reducing excessive growth.[36] But when the (free) deposit insurance coverage ϕ increases, each bank obtains a higher government subsidy in case of loan default and, hence, internalizes less of the cost of excessive growth and invests less in culture ($\underline{\alpha}$ and $\overline{\alpha}$ both decrease).[37]

What kinds of banks will invest more in culture? Our analysis implies that when there is greater homogeneity in beliefs, investment in culture will be lower. So a U.S. community bank that draws its

[35] We may interpret this as an implicit organizational sanction or disapproval of a manager who violates "trust." Relying on trust to enforce desirable behavior can only be sustained if there are suitable sanctions for violating trust. Absent such sanctions, we would need to rely on some emotion like "guilt" for violating trust (e.g., Elster, 1998).

[36] Recall that in the two cases with matched bank-manager beliefs, absent investment in culture the second best always involves excessive growth relative to the first best; see Section 4.1.

[37] Our analysis ignores an important benefit of deposit insurance in insulating the bank's (depository) customers from the bank's credit risk; see Merton and Thakor (2018), who show that deposit insurance can enhance welfare even when there is no threat of bank runs.

employees mainly from the local community or banks in small, relatively homogeneous countries (e.g., Scandinavian countries) are unlikely to need significant investments in culture. By contrast, money-center U.S. banks that draw employees from diverse backgrounds and ethnicities will need larger culture investments. Along the size and complexity dimensions, larger banks – especially those with more organizational complexity and a greater range of activities – will need to invest more in culture to deal with the higher possibility of attracting employees with divergent beliefs.

Business strategy also has an effect. Assortative matching is more important when the bank has distinct strategy choices and the manager can make a choice of effort allocation across growth and safety that cannot be readily monitored. Commercial and investment banks are good examples. It is likely to be less important in brokerage firms where strategic choice has lesser influence.

Finally, while our analysis takes agents' beliefs as given in a static setting, beliefs do change over time. In a richer dynamic setting, a long sequence of favorable loan outcomes (like those prior to the 2007–2009 financial crisis) leads all agents to elevate their beliefs about the borrower pool quality, making banks more growth-oriented. Conversely, after a long string of bad banking outcomes, banks lower their assessments of the borrower pool quality and become more safety-focused.[38] Therefore, bank culture may evolve over business cycles, contributing to busts (see the evidence in Fahlenbrach et al., 2018), followed by safety-oriented bank cultures.

5. Two banks

In this section, we extend the analysis to examine the implications of interbank competition for culture. Same as the analysis in Section 4, we first shut down the culture channel in Sections 5.1 and 5.2 and then enable the channel in Section 5.3.

5.1. Herding in growth: two identical banks with no investment in culture

The analysis here extends the base model into two banks. Section 3 shows that, in the one-bank case, the manager allocates excessive effort to growth relative to safety compared to the first best (see Proposition 2). We now show that with two banks with identical beliefs about the borrower pool quality (λ) and managers also being endowed with the same beliefs as banks, the externality that each bank exerts on the other due to interbank competition causes each bank to tilt *even more* toward growth; this increases the odds that both banks fail together, elevating systemic risk.

Before diving into the algebra, here is the intuition. For bank i, the probability that it locates a loan not only depends on its own growth effort $e_{g[i]}$, but also on bank j's growth effort $e_{g[j]}$: a bigger $e_{g[j]}$ *ceteris paribus* lowers bank i's ability to locate a loan due to competition. Then, bank i will have to elicit a larger $e_{g[i]}$ from its own manager to counteract the effect of competition from bank j. In a symmetric equilibrium, the same happens to bank j. This is the first channel through which the effect of competition is manifested. The second channel, which is more subtle, is that the value of safety to bank i is diminished as bank j's increased growth focus causes bank i to lose more loans to bank j. This is because bank i has fewer loans to apply its safety screening to. That is, the marginal value of safety is diminished in a more competitive growth-oriented environment.[39]

Model: With two banks, there will be competition in finding a loan. Think of both banks searching for the urn with balls at the same time. The bank that finds it first gets to make the loan, and the other bank makes no loan. We label the banks as "bank 1" and "bank 2" and model competition as follows. Consider bank 1, whose probability of finding a loan is $\max(e_{g[1]} - \kappa e_{g[2]}, 0)$, where $\kappa \in (0, 1)$ can be thought of as the degree of competition, with a larger κ corresponding to a more competitive loan market. This simple specification implies that as bank j engages more in growth (i.e., larger $e_{g[j]}$), bank i's ability to locate a loan is lower *ceteris paribus*, with $i \neq j$.

Our model of competition has an alternative interpretation. A borrower who is rejected by bank 2 may still apply for a loan from bank 1 if the rejection is not publicly observable. The stronger is bank 2's investment in safety (i.e., larger $e_{s[2]}$ and, hence, smaller $e_{g[2]}$), the higher is the chance that the borrower will be rejected by bank 2 and, consequently, the higher is the chance that bank 1 will still be able to find this borrower. That is, a smaller $e_{g[2]}$ increases bank 1's ability to locate a loan, consistent with the specification $\max(e_{g[1]} - \kappa e_{g[2]}, 0)$ for bank 1's loan generation probability.

Analysis: Bank 1 chooses wages w_X and $w_\varnothing$ to maximize (bank 2's problem is symmetric):[40]

$$\begin{aligned}\pi_1 = {} & (e_{g[1]} - \kappa e_{g[2]})[\lambda(X - R_1 - E - w_X) + (1-\lambda)e_{s[1]}(-w_\varnothing) \\ & + (1-\lambda)(1 - e_{s[1]})(-E)] \\ & + [1 - (e_{g[1]} - \kappa e_{g[2]})](-w_\varnothing),\end{aligned} \tag{14}$$

where $R_1 = D + \frac{(1-\lambda)(1-e_{s[1]})(D-\phi)}{\lambda}$. The utility derived by the manager of bank 1 from working is:

$$\begin{aligned}u_1 = {} & (e_{g[1]} - \kappa e_{g[2]})[\lambda w_X + (1-\lambda)e_{s[1]} w_\varnothing] \\ & + [1 - (e_{g[1]} - \kappa e_{g[2]})] w_\varnothing - c,\end{aligned} \tag{15}$$

and her IC constraints for effort exertion and allocation are given by (16) and (17), respectively:

$$u_1 \geq w_\varnothing \Rightarrow \lambda \frac{w_X}{w_\varnothing} \geq 1 - (1-\lambda)e_{s[1]} + \frac{c}{(e_{g[1]} - \kappa e_{g[2]})w_\varnothing}, \tag{16}$$

$$\{e_{g[1]}, e_{s[1]}\} \in \underset{\{e_{g[1]}+e_{s[1]}=1\}}{\operatorname{argmax}} \; u_1 \Rightarrow \begin{cases} e_{g[1]} - \dfrac{\kappa}{2} e_{g[2]} = \dfrac{\lambda}{2(1-\lambda)}\left(\dfrac{w_X}{w_\varnothing} - 1\right), \\ e_{s[1]} + \dfrac{\kappa}{2} e_{g[2]} = \dfrac{\lambda}{2(1-\lambda)}\left(\dfrac{2-\lambda}{\lambda} - \dfrac{w_X}{w_\varnothing}\right). \end{cases} \tag{17}$$

Eqs. (14)–(17) can be understood in the same way as for (2), (3), (5) and (6) in the base model, respectively, with e_g there being replaced with $e_{g[1]} - \kappa e_{g[2]}$ here to reflect the effect of interbank competition on the loan generation probability.

Comparing (17) with (6), we see that in a symmetric equilibrium, $e_{g[1]} = e_{g[2]} > e_g$ and $e_{s[1]} = e_{s[2]} < e_s$ for any given $\frac{w_X}{w_\varnothing}$. That is, if we fix $\frac{w_X}{w_\varnothing}$ across the one-bank and two-bank cases, the two-bank case will involve more growth but less safety for each bank. Intuitively, given the same pay wedge $\frac{w_X}{w_\varnothing}$, each manager in the two-bank case needs to allocate more effort to growth to counteract competition from the other bank: to get the high wage w_X, the manager would have to generate a loan and have it not taken away by the competitor in the first place.

It turns out that $\frac{w_X}{w_\varnothing}$ must also be higher in the two-bank case. To see this informally, substitute (17) into (16), and note that $e_{g[1]} = e_{g[2]}$ in a symmetric equilibrium, so we can rewrite (16) as $\frac{w_X}{w_\varnothing} \geq 1 + \left(\frac{2-\kappa}{1-\kappa}\right)^2 \frac{1-\lambda}{\lambda^2} \frac{c}{w_X - w_\varnothing}$. Comparing it with (7) in the one-bank case

[38] See Gennaioli et al. (2015) for a model of (non-Bayesian) belief formation in which this happens. Thakor (2016b) develops a model in which such belief revision dynamics occur even with Bayesian rationality.

[39] There may be another (unmodeled) channel, which is even more subtle. As bank i focuses more on growth and less on safety, it is more likely to fail; bank j then fears less about its own failure, because if both banks fail altogether, the government will be more likely to rescue both. This is a "too-many-to-fail" problem: more banks failing makes it more likely for the government to intervene. This third channel reinforces each bank's growth incentive, and increases the odds that both banks fail altogether; systemic risk (if it can be simply defined as such) then goes up.

[40] Since $e_{g[1]} = e_{g[2]}$ in a symmetric equilibrium, $\max(e_{g[1]} - \kappa e_{g[2]}, 0) = e_{g[1]} - \kappa e_{g[2]}$.

(both constraints are binding), we see that the term $\left(\frac{2-\kappa}{1-\kappa}\right)^2 > 4$ shows that $\frac{w_X}{w_\varnothing}$ should be bigger here with two competing banks. Formally, we have:

Proposition 6 (*Interbank competition-induced excessive growth: homogeneous banks with no investment in culture*). *Compared to the one-bank case, in a symmetric equilibrium each bank in the two-bank case (with both banks and managers having the same beliefs): (i) allocates more effort toward growth and less toward safety, i.e., $e^{**}_{g[1]} = e^{**}_{g[2]} > e^{**}_g$ and $e^{**}_{s[1]} = e^{**}_{s[2]} < e^{**}_s$; and (ii) uses a steeper pay-for-performance contract, i.e., larger $\frac{w_X}{w_\varnothing}$. These differences become bigger when the deposit insurance coverage ϕ and/or the degree of competition κ increases. As a result, the banking system is more likely to suffer systemic risk wherein both banks fail together, and this risk becomes higher with a higher deposit insurance coverage and/or a more competitive loan market.*

This proposition shows that the interbank competition externality has two consequences. First, it causes each bank to engage more in growth but less in safety ("herding on growth") to counteract the effect of competition from the other bank(s). This leads to higher systemic risk. This result is reminiscent of Marcus (1984) who shows that greater competition reduces the value of bank charters and, hence, intensifies the bank's risk-taking incentives.[41] Second, managerial compensation will exhibit higher performance-based pay in the two-bank case to induce mangers to compete more aggressively for growth. These consequences are intensified when competition becomes stronger. This is related to the fact that prior to the 2007–2009 crisis, U.S. depository institutions faced increasingly competitive pressure from shadow banks, which may have induced these depository institutions to develop more aggressive growth-oriented strategies and engage in more risk-taking (e.g., reaching for yield as documented by Becker and Ivashina, 2015).[42] Proposition 6 also shows that (risk-independent) deposit insurance, by weakening market discipline (which forces each bank to partially internalize its own growth-induced loan risk), exacerbates the competition externality. Thus, the degree of excessive growth in an economy with strong competition but low insurance coverage may be the same as that in an economy with low competition but high insurance coverage.

5.2. Herding with two different types of banks and no investment in culture

Consider two banks endowed with different beliefs about the borrower pool quality: bank 1 is optimistic ($\lambda_{B[1]} = \overline{\lambda}$) and bank 2 is pessimistic ($\lambda_{B[2]} = \underline{\lambda}$). Managers have either the optimistic or pessimistic beliefs. Suppose neither bank invests in culture, and each bank hires a manager endowed with the same belief as the bank, i.e., $\{\lambda_{B[1]} = \overline{\lambda}, \lambda_{M[1]} = \overline{\lambda}\}$ and $\{\lambda_{B[2]} = \underline{\lambda}, \lambda_{M[2]} = \underline{\lambda}\}$. We examine how competition affects effort allocation in this case with two different types of banks. Each banks' contracting problem can be similarly stated as the one in Section 5.1 (with λ there being replaced with $\overline{\lambda}$ for bank 1 and $\underline{\lambda}$ for bank 2), so we relegate details to the Appendix.

[41] More recently, Rud et al. (2018) provide experimental evidence that competition leads intermediaries to not protect the interests of their clients as much as a monopolist would. This is because intermediaries earn revenues only when they recommend that their clients proceed with the transaction. This is similar to our model in which banks pursue growth more aggressively when faced with greater competition.

[42] Competition from non-banks that forced banking deregulation and intensified risk-taking behavior was apparent decades before 2007, but the effect was perhaps more prominent during the most recent crisis. In his letter to JPMorgan Chase shareholders in 2013, Jamie Dimon described shadow banks as one main source of competition. He wrote: "We really should not call them 'shadow' banks – they do not operate in shadows. They are non-bank financial competitors, and there is a wide set of them. They range from money-market funds and asset managers, mortgage real-estate investment trusts and mortgage servicers and middle-market lending funds to PayPal and clearing houses. Many of these institutions are smart and sophisticated... Non-bank financial competitors will look at every product we price, and if they can do it cheaper with their set of capital providers, they will."

Proposition 7 (*Interbank competition-induced excessive growth: heterogeneous banks with no investment in culture*). *Compared to the one-bank case wherein the bank and its manager are both optimistic, in the two-bank case with one bank and its manager being optimistic and the other bank and its manager being pessimistic: (i) the optimistic bank always allocates more effort toward growth; and (ii) if the interbank competition is sufficiently strong (i.e., κ being larger than a cutoff value κ_g), then the pessimistic bank also allocates more effort toward growth. Moreover, κ_g is decreasing in the deposit insurance coverage ϕ.*

This is similar to Proposition 6 (where two banks are identical), but it shows that a correlated emphasis on growth does *not* require banks to have homogeneous (optimistic) beliefs; instead, it can arise from interbank competition. What is surprising about this result is that, in the two-bank case with sufficiently strong competition (i.e., $\kappa > \kappa_g$) and no investment in culture by either bank, even the bank with the pessimistic belief may have its pessimistic manager allocate more effort to growth than the optimistic bank does (with an optimistic manager) in the single-bank case. Thus, in the multi-bank case, what drives the greater growth emphasis is *competition*, not correlated optimism among banks. The intuition is again related to the diminished value of safety for bank *i* when bank *j* pursues growth more aggressively. Moreoever, the result that κ_g is decreasing in ϕ shows again (as in Proposition 6) that (free) deposit insurance exacerbates the effect of competition on growth herding. Thus, competition-induced excessive growth is more prominent for depositories than for non-financials.

5.3. Two different types of banks with investment in culture: how culture can reduce herding

We now introduce culture in the two-bank case with heterogeneous types. To make the analysis here comparable to that in Section 5.2, we continue to assume that each bank hires a manager with the same belief as the bank (as in Section 5.2). Our goal is to show that a strong safety culture developed by (pessimistic) bank 2 reduces bank 2's effort allocation to growth, which, in turn, reduces the competition externality exerted on (optimistic) bank 1. Bank 1 then also reduces its effort allocation to growth, which, in turn, reduces the competition externality exerted on bank 2. This feedback effect will be stronger if bank 1 also invests in culture to move its manager's effort allocation closer to its corresponding first-best allocation. Consequently, each bank allocates less effort to growth than in the case without investment in culture (as in Proposition 7), and systemic risk is lowered. Bank culture is thus contagious – a safety-oriented culture in one bank can affect other banks by attenuating to some extent the competition-induced externality among banks.

The analysis is similar as in Section 5.2, except that: (i) each manager's IC constraints of effort exertion and allocation need to modified to reflect the effect of culture on managerial incentives; and (ii) each bank's investment in culture need to be determined, taking into account the cost of culture investment and the effect of the culture on the interbank competition externality exerted on the other bank. We relegate details to the Appendix, and present the main result here.

Proposition 8 (*Mediating role of culture*). *In the two-bank case with bank 1 and its manager being optimistic and bank 2 and its manager being pessimistic, if both banks invest in culture, then: (i) both select their respective first-best allocations as the benchmark, $\left\{e^*_{g\{\overline{\lambda},\overline{\lambda}\}}, e^*_{s\{\overline{\lambda},\overline{\lambda}\}}\right\}$ for bank 1 and $\{e^*_{g\{\underline{\lambda},\underline{\lambda}\}}, e^*_{s\{\underline{\lambda},\underline{\lambda}\}}\}$ for bank 2, and the strength of culture is $\overline{\alpha}(\kappa)$ for bank 1 (determined by (A.41) in the Appendix)and $\underline{\alpha}(\kappa)$ for bank 2 (determined by (A.43) in the Appendix); (ii) both banks allocate less effort to growth, compared to the case wherein neither bank invests in culture; and (iii) when the deposit insurance coverage ϕ and/or the degree of competition κ increases, $\overline{\alpha}(\kappa)$ and $\underline{\alpha}(\kappa)$ both decrease, which increases both banks' effort allocations to growth.*

This proposition can be understood as follows.

Transmission of safety culture: Bank 2 is pessimistic so its benchmark effort allocation tilts more toward safety than (optimistic) bank 1's benchmark (i.e., $e^*_{s\{\underline{\lambda},\underline{\lambda}\}} > e^*_{s\{\overline{\lambda},\overline{\lambda}\}}$); bank 2's culture is thus more safety-oriented. Bank 2's safety culture attenuates the competition-induced growth externality, thereby reducing the effort allocation to growth by bank 1. As a result, bank 1 also invests in culture, moving its effort allocation closer to its own first-best benchmark. The consequent reduced growth propensity of bank 1, in turn, weakens the competition externality on bank 2, further inducing more effort allocation to safety by bank 2. Each bank thus allocates less effort to growth and more to safety, compared to the case in Section 5.2 where neither bank invests in culture (see Proposition 7). This contagion effect of a safety culture lowers systemic risk.

Deposit insurance and interbank competition impede this safety culture transmission. An increase in the (free) deposit insurance coverage ϕ induces bank 2 to reduce its investment in safety culture by lowering $\underline{\alpha}(\kappa)$, which moves its effort allocation away from its first-best benchmark. The consequent increase in bank 2's growth focus increases the competition externality that it exerts on bank 1, which, together with the direct effect of higher deposit insurance coverage on bank 1, causes bank 1 to also lower its investment in culture ($\overline{\alpha}(\kappa)$ decreases) and increase its growth focus. This increases the competition externality that bank 1 exerts on bank 2 and feeds back to further increase bank 2's shift to growth. When interbank competition becomes stronger (κ increases), outcompeting the opponent becomes relatively more important than controlling its own risk for each bank, so each bank shifts effort away from safety and toward growth. In sum, when ϕ and/or κ increases, each bank scales back its investment in culture, so safety culture transmission is impeded, and effort allocations by both banks involve greater focus on growth.

Transmission of growth culture: Bank 1 is optimistic so its benchmark effort allocation involves more growth than bank 2 (i.e., $e^*_{g\{\overline{\lambda},\overline{\lambda}\}} > e^*_{g\{\underline{\lambda},\underline{\lambda}\}}$); hence, bank 1's culture is more growth-oriented. Such a growth culture can be contagious as well (as implied by Proposition 7). That is, the fact that bank 1 allocates more effort to growth exerts competition externality on bank 2, causing bank 2 to allocate more effort to growth relative to the case in which bank 1 is absent. Deposit insurance that is not fairly priced and interbank competition facilitate the transmission of a growth culture from bank 1 to bank 2, for the same reason that it impedes the transmission of a safety culture from bank 2 to bank 1.

This infectious nature of the growth culture may lead to overlending by the entire banking system, thereby causing asset price bubbles. For example, if a few prominent large banks adopt aggressive risk-taking and growth-oriented culture (say, due to too-big-to-fail guarantees), then other banks may well follow suit, and a growth culture dominates the financial system.

Influencing culture transmission: When $\kappa = 0$, i.e., absent interbank competition, the results in Proposition 8 are the same as those in Proposition 5. There, the two banks do not compete for loans, so bank 1's growth-oriented culture does not influence bank 2. Each bank allocates more effort to safety than when interbank competition exists. This is related to Acharya et al. (2016), who show that managerial mobility across firms as a result of competition for managerial talent delays the revelation of managers' true quality, which may result in low-quality managers being assigned to handle projects that are too risky for them, thereby enhancing systemic risk in the industry. Their policy implication is that discouraging managerial mobility may be optimal for curbing systemic risk. Similarly, our analysis implies that it may be optimal to discourage interbank competition so as to restrict the competition-induced transmission of growth culture. Of course, a comprehensive policy analysis needs to also account for the benefit of competition. But the message here is that restricting interbank competition is beneficial at least in occasions wherein such competition may spread contagious growth culture to the entire banking system.

When κ becomes very big, each bank lowers its investment in culture, and the results in Proposition 8 move closer to those characterized in Proposition 7, in which no bank invests in culture to counteract the competition-induced externality, causing even (pessimistic) bank 2 to engage in more growth than a stand-alone optimistic bank in case of strong competition.

Within the model, transmission of safety culture should be encouraged while transmission of growth culture should be discouraged. When the fraction of optimistic banks increases (i.e., more banks like bank 1 than bank 2), as what occurred before the 2007–09 financial crisis due to beliefs for more banks being elevated following a long sequence of favorable investment outcomes, transmission of growth culture is more likely to dominate safety culture. By contrast, after the crisis, more banks' beliefs are dampened by the bad outcomes; the fraction of pessimistic banks increases and, therefore, safety culture is more likely to get transmitted.

5.4. Role of collateral

One issue that we have not considered is the role of collateral. The role of collateral in loan contracting has been analyzed from many perspectives in the literature (e.g., Besanko and Thakor, 1987; Inderst and Mueller, 2007). With collateral, higher interbank competition may lead to an increase in the supply of credit, which then increases the value of the collateral that the credit is used to purchase (e.g., houses), which can increase the safety of the bank's loan, and induce more banks to enter. In such a circumstance, higher safety and higher growth may be possible simultaneously for banks. While this is an interesting possibility, higher value of collateral could also induce banks to devote less resources to screening borrowers, leading to riskier lending. Analyzing these issues requires far more structure than our present model has, including endogenizing the interaction of credit supply and collateral values, and is beyond the scope of our analysis.

6. Empirical predictions and regulatory implications

Empirical predictions: The analysis has three testable predictions. First, there should be stronger safety-oriented bank cultures in countries with weaker safety nets (deposit insurance, too-big-to-fail guarantees, etc.), higher capital requirements and lower interbank competition. This prediction can be tested using international data, with culture proxies such as those in Fiordelisi et al. (2016), for example. Some evidence for this already exists. For example, Demirguc-Kunt and Detragiache (2002) document that explicit deposit insurance encourages risk taking and makes banking crises more likely. Countries with the highest coverage limits are five times more fragile than countries with the lowest coverage limits in their sample.

Second, there should be a higher correlation in cultural orientation (growth versus safety) across banks when they are competing rather than across banks that are not competing with each other. That is, greater competition increases cultural herding.[43]

Third, a positive (exogenous) shock to a bank's loan pool quality should lead to a shift away from safety and toward a growth-oriented culture; the opposite cultural shift should be observed following a negative shock.

Regulatory implications: There are three regulatory policy implications of the analysis. First, if regulators would like banks to have stronger safety-oriented culture, then they should increase capital requirements and/or reduce safety nets (both explicit protections like deposit insurance and implicit guarantees such as bailing out distressed

[43] While increased competition in our model leads banks to focus more on growth, the implication that this will lead to greater risk should be interpreted with caution. Our analysis does not include the *sorting effect* of competition that can result in weak (and possibly more risky) banks being replaced by stronger banks, which could reduce risk, as documented by Goetz (2018).

banks).[44] This means that familiar regulatory tools can be used to influence bank culture, without worrying about how to measure bank culture. Second, our analysis implies a tradeoff in the bank's choice of culture. In choosing a safety-oriented culture, the bank sacrifices growth. This is something for regulators to note. Third, Proposition 8 highlights the contagious nature of culture. This means that regulators need not seek to monitor culture at all banks. Rather, attention can be focused on a subset of highly visible banks. These will typically be the largest banks. In contrast to current policy – especially that related to TBTF – this will mean a lowering of the bailout probability for these banks. It will also mean higher capital requirements for these banks.

7. Conclusion

The issue of bank culture is now front and center in the minds of regulators, but a theoretical economics framework for analyzing bank culture is not available to think about bank culture in a systematic manner. This paper has attempted to fill that void.

We have developed as simple a model as we could think of, while still capturing two essential ideas. One is that in a banking context, growth versus safety is a fundamental choice that shapes the bank's strategy as well as culture. The other is that the competitive environment and the safety-net protection offered to banks should play prominent roles in examining both the bank's relative emphasis on growth versus safety and the mediating role of culture in this choice.

Although simple, the model has yielded a rich harvest of results, and we hope it proves to be useful in future research. The key results are as follows. First, whenever there is a multi-tasking problem in a bank, it will tilt in favor of growth over safety. Second, competition among banks exacerbates this excessive focus on growth, and this leads to a competition-induced propensity to "herd" on growth. Third, bank culture can play two roles, one of which is a matching role, helping match employees with banks that share their beliefs, even when the beliefs of employees are unobservable. The second role is to possibly enhance the bank's focus on safety. A strong safety culture can temper the bank's competition-induced excessive growth focus. Fourth, culture is contagious – when one bank chooses a strong safety culture, it induces competing banks to focus more on safety, including banks that do not themselves have a safety culture. Finally, higher bank capital increases the focus of the culture on safety, whereas stronger safety nets (e.g., higher deposit insurance coverage or bailout probability) decreases the focus of the culture on safety.

Our analysis has also generated regulatory policy implications. It shows how familiar regulatory tools like capital requirements, deposit insurance and bank bailout policy can be used to influence bank culture, allowing regulators to sidestep thorny culture measurement issues, at least initially. An open question raised by our research is whether the importance of bank culture lessens or increases the need for regulatory supervision. On the one hand, if a sufficiently large number of banks develop strong safety cultures, bank supervisors and regulators will have less to worry about. On the other hand, the evidence seems to suggest that replacing trust with control can produce better outcomes (see Bengtsson and Engström, 2014), suggesting that a strong bank culture should be viewed more as a *complement* to regulatory supervision, rather than a substitute for it.[45]

An interesting implication of our result that greater competition will strengthen banks' incentives to adopt growth-oriented culture is that greater competition from *non-banks* like shadow banks and P2P lending platforms will potentially push banks to focus more on growth. This means an increase in bank risk, with obvious prudential regulation implications, but this time coming from the *culture* channel.

We have scratched only the surface of this important topic. Many interesting issues remain for future research. For example, what is the effect of organizational form/ownership structure on culture? Many claim that U.S. investment banks were far more prudent in their risk-taking behaviors when they were partnerships than they were after going public. This raises an interesting question about how public ownership influences corporate culture. One possibility is that public companies face greater shareholder pressure and hence become more aggressive in pursuit of growth. Another important question is about how "subcultures" develop in organizations with multiple business units and how they affect the overall culture of the organization. For example, a universal bank has units engaging in commercial banking, investment banking, trading and market making, and insurance. Each unit may have its own subculture. One tentative implication of our analysis is that if the opportunities that these units can pursue are substitutes – that is, resources are constrained and any resource allocated to support the pursuit of growth by one unit is not available to another – then there will be a competition-induced externality in the subculture choices. This can be explored more deeply. Finally, we have not analyzed the potentially interesting intertemporal dynamics of how culture evolves. For example, a small bank may start out with a safety-focused culture because the government bailout probability in the event of failure is low. But when it is larger and anticipates a higher bailout probability, it may switch to a growth-focused culture. A dynamic treatment would also permit an exploration of how culture interacts with relationship lending and the optimal duration of bank-borrower relationships.[46]

Appendix.

Proof of Proposition 1. The first-best allocation in (9) follows from the first-order condition (FOC) to the bank's problem in (8) (after substituting (1) into (8)):

$$f_1(e_g^*) \equiv \lambda(X - I) - 2(1 - \lambda)(E + D - \phi)e_g^* = 0. \tag{A.1}$$

Suppose the bank only observes managerial effort exertion but not allocation. We know from the manager's IC constraint of effort allocation (6) that $\frac{w_X}{w_\varnothing} = 1 + \frac{2(1-\lambda)}{\lambda}e_g^*$ to induce the first-best allocation. Substituting this into the manager's binding IR constraint (4) yields the wages $w_\varnothing^*$ and w_X^*. □

Proof of Proposition 2. The second-best effort e_g^{**} is given by the FOC to the bank's problem in (12):

$$f_2(e_g^{**}) \equiv \lambda(X - I) - 2(1 - \lambda)(E + D - \phi)e_g^{**} + \frac{2c}{1 - \lambda}(e_g^{**})^{-3} = 0. \tag{A.2}$$

[44] Regulators may wish to consider using risk-based deposit insurance premia along with risk-based capital requirements in order to diminish the procyclical effects of the latter. See Pennacchi (2005).

[45] Bengtsson and Engström (2014) report the results of a randomized policy experiment in which replacing a trust-based contract with an increased level of monitoring by the principal led to lower costs and fewer financial irregularities. Fiordelisi et al. (2016) document that regulatory enforcement actions in the U.S. between 2006 and 2013 influenced bank behavior in both sanctioned and non-sanctioned banks and corporate culture played an important role in moderating this relationship.

[46] López-Espinosa et al. (2017) provide empirical evidence that the benefits of relationship lending to firms do not kick in right away, but take some time, consistent with Boot and Thakor's (1994) theory of multi-period relationship banking contracting. This means that growth-oriented and safety-oriented banks will have different incentives to invest in relationship lending in the Boot and Thakor (2000) sense.

Comparing (A.2) with the first-best FOC in (A.1), we note that $f_1' < 0$, $f_2' < 0$, and $f_1(z) < f_2(z)$ for $\forall z$. Thus, clearly we have $e_g^{**} > e_g^*$ (hence $e_s^{**} < e_s^*$). Next, we know from (6) that $\frac{w_X}{w_\varnothing} = 1 + \frac{2(1-\lambda)}{\lambda} e_g$, which leads to $\frac{w_X^{**}}{w_\varnothing^{**}} > \frac{w_X^*}{w_\varnothing^*}$ given that $e_g^{**} > e_g^*$. Finally, suppose ϕ increases to ϕ'. Both $f_1(z)$ and $f_2(z)$ increase for $\forall z$ and, thus, both e_g^* and e_g^{**} increase (say, to $e_g^{*'}$ and $e_g^{**'}$, respectively) given that $f_1' < 0$ and $f_2' < 0$. To show $e_g^{**'} - e_g^{*'} > e_g^{**} - e_g^*$, note that $f_2\left(e_g^{**} + \left(e_g^{*'} - e_g^*\right); \phi'\right) - f_2\left(e_g^{**} + \left(e_g^{*'} - e_g^*\right); \phi\right) > f_1\left(e_g^{*'}; \phi'\right) - f_1\left(e_g^{*'}; \phi\right)$, so $e_g^{**'} > e_g^{**} + \left(e_g^{*'} - e_g^*\right)$. The result that $\frac{w_X^{**}}{w_\varnothing^{**}} - \frac{w_X^*}{w_\varnothing^*}$ increases as ϕ increases follows immediately. □

Proof of Proposition 3. The bank's problem with generic beliefs $\{\lambda_B, \lambda_M\}$ is as follows:

$$\max_{\{w_X, w_\varnothing\}} \quad e_g[\lambda_B(X-R-E-w_X) - (1-\lambda_B)e_s w_\varnothing - (1-\lambda_B)(1-e_s)E] - (1-e_g)w_\varnothing, \tag{A.3}$$

$$\text{subject to} \quad u_{\{\lambda_M\}} \geq w_\varnothing \Rightarrow \lambda_M \frac{w_X}{w_\varnothing} \geq 1 - (1-\lambda_M)e_s + \frac{c}{e_g w_\varnothing}, \tag{A.4}$$

$$\{e_g, e_s\} \in \underset{\{e_g+e_s=1\}}{\operatorname{argmax}} u_{\{\lambda_M\}} \Rightarrow e_g = \frac{\lambda_M}{2(1-\lambda_M)}\left(\frac{w_X}{w_\varnothing} - 1\right) \text{ and } e_s = \frac{\lambda_M}{2(1-\lambda_M)}\left(\frac{2-\lambda_M}{\lambda_M} - \frac{w_X}{w_\varnothing}\right), \tag{A.5}$$

where $u_{\{\lambda_M\}} = e_g[\lambda_M w_X + (1-\lambda_M)e_s w_\varnothing] + (1-e_g)w_\varnothing - c$ and $R = D + \frac{(1-\lambda_B)(1-e_s)(D-\phi)}{\lambda_B}$. Combining (A.4) and (A.5) yields:[47]

$$w_\varnothing = \frac{c}{(1-\lambda_M)e_g^2}. \tag{A.6}$$

We analyze the case $\{\lambda_B = \underline{\lambda}, \lambda_M = \bar{\lambda}\}$.[48] The bank's expected wage cost (using its own belief $\lambda_B = \underline{\lambda}$) is $e_g[\underline{\lambda} w_X + (1-\underline{\lambda})e_s w_\varnothing] + (1-e_g)w_\varnothing$. Comparing it with the binding IC constraint (A.4) (using the manager's belief $\lambda_M = \bar{\lambda}$), $e_g[\bar{\lambda} w_X + (1-\bar{\lambda})e_s w_\varnothing] + (1-e_g)w_\varnothing = w_\varnothing + c$, we can rewrite the bank's wage cost as:

$$w_\varnothing + c - e_g(\bar{\lambda} - \underline{\lambda})(w_X - e_s w_\varnothing). \tag{A.7}$$

Combining (A.5) and (A.6), we can rewrite the last term in (A.7) as $e_g(\bar{\lambda} - \underline{\lambda})(w_X - e_s w_\varnothing) = \frac{c(\bar{\lambda}-\underline{\lambda})(2-\bar{\lambda})}{\bar{\lambda}(1-\bar{\lambda})}$. Thus, the bank's problem in (A.3) can be rewritten as (with $\lambda_B = \underline{\lambda}$):

$$\max_{\{e_g+e_s=1\}} \quad e_g[\underline{\lambda}(X-R-E) - (1-\underline{\lambda})(1-e_s)E] - \frac{c}{(1-\bar{\lambda})e_g^2} - c + \frac{c(\bar{\lambda}-\underline{\lambda})(2-\bar{\lambda})}{\bar{\lambda}(1-\bar{\lambda})}. \tag{A.8}$$

The FOC to the problem in (A.8) is:

$$f_{\{\underline{\lambda},\bar{\lambda}\}}\left(e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}\right) \equiv \underline{\lambda}(X-I) - 2(1-\underline{\lambda})(E+D-\phi)e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} + \frac{2c}{1-\bar{\lambda}}\left(e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}\right)^{-3} = 0. \tag{A.9}$$

Replacing λ in (A.2) with $\underline{\lambda}$, we can write the FOC in the case with matched beliefs $\{\lambda_B = \underline{\lambda}, \lambda_M = \underline{\lambda}\}$ as:

$$f_{\{\underline{\lambda},\underline{\lambda}\}}\left(e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}\right) \equiv \underline{\lambda}(X-I) - 2(1-\underline{\lambda})(E+D-\phi)e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}} + \frac{2c}{1-\underline{\lambda}}\left(e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}\right)^{-3} = 0. \tag{A.10}$$

The difference between the two FOCs lies in the coefficient in the last term: it is $\frac{2c}{1-\bar{\lambda}}$ in $f_{\{\underline{\lambda},\bar{\lambda}\}}$, while $\frac{2c}{1-\underline{\lambda}}$ in $f_{\{\underline{\lambda},\underline{\lambda}\}}$. Since $f'_{\{\underline{\lambda},\bar{\lambda}\}} < 0$, $f'_{\{\underline{\lambda},\underline{\lambda}\}} < 0$, and $f_{\{\underline{\lambda},\bar{\lambda}\}}(z) > f_{\{\underline{\lambda},\underline{\lambda}\}}(z)$ for $\forall z$, we must have $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} > e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ (hence $e^{**}_{s\{\underline{\lambda},\bar{\lambda}\}} < e^{**}_{s\{\underline{\lambda},\underline{\lambda}\}}$). The result that $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} - e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ is increasing in ϕ can be proved in a similar way as the proof for the result that $e_g^{**} - e_g^*$ is increasing in ϕ (see the proof of Proposition 2) and, hence, is omitted.

Note $\frac{w_X}{w_\varnothing} = 1 + \frac{2(1-\bar{\lambda})}{\bar{\lambda}} e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}$ with mismatched beliefs, and $\frac{w_X}{w_\varnothing} = 1 + \frac{2(1-\underline{\lambda})}{\underline{\lambda}} e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ with matched beliefs. Thus, to show that $\frac{w_X}{w_\varnothing}$ is lower in the former case, we only need to show $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} < \frac{\bar{\lambda}}{1-\bar{\lambda}}\frac{1-\underline{\lambda}}{\underline{\lambda}} e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$.[49] For this, it is sufficient to show $f_{\{\underline{\lambda},\bar{\lambda}\}}\left(\frac{\bar{\lambda}}{1-\bar{\lambda}}\frac{1-\underline{\lambda}}{\underline{\lambda}} z\right) < f_{\{\underline{\lambda},\underline{\lambda}\}}(z)$ for $\forall z$. This is obvious:

[47] Note that (A.3), (A.4), (A.5) and (A.6) correspond to (2), (5), (6) and (10) in the base model, respectively.

[48] The analysis for the other case $\{\lambda_B = \bar{\lambda}, \lambda_M = \underline{\lambda}\}$ is similar and, therefore, is omitted.

[49] Note $\frac{\bar{\lambda}}{1-\bar{\lambda}}\frac{1-\underline{\lambda}}{\underline{\lambda}} > 1$, so the inequality does not conflict with $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} > e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$.

$$\begin{aligned}
f_{\{\underline{\lambda},\bar{\lambda}\}}\left(\frac{\bar{\lambda}}{1-\bar{\lambda}}\frac{1-\underline{\lambda}}{\underline{\lambda}}z\right) &= \underline{\lambda}(X-I)-2(1-\underline{\lambda})(I-\phi)\left(\frac{\bar{\lambda}}{1-\bar{\lambda}}\frac{1-\underline{\lambda}}{\underline{\lambda}}\right)z \\
&\quad +\frac{2c}{1-\bar{\lambda}}\left(\frac{\underline{\lambda}}{1-\underline{\lambda}}\frac{1-\bar{\lambda}}{\bar{\lambda}}\right)^3 z^{-3} \\
&< \underline{\lambda}(X-I)-2(1-\underline{\lambda})(I-\phi)z \\
&\quad +\frac{2c}{1-\bar{\lambda}}\left(\frac{\underline{\lambda}}{1-\underline{\lambda}}\frac{1-\bar{\lambda}}{\bar{\lambda}}\right)^3 z^{-3} \\
&< \underline{\lambda}(X-I)-2(1-\underline{\lambda})(I-\phi)z+\frac{2c}{1-\underline{\lambda}}z^{-3} \\
&= f_{\{\underline{\lambda},\underline{\lambda}\}}(z),
\end{aligned} \tag{A.11}$$

where the second inequality follows from the fact that $\frac{1}{1-\bar{\lambda}}\left(\frac{\underline{\lambda}}{1-\underline{\lambda}}\frac{1-\bar{\lambda}}{\bar{\lambda}}\right)^3 < \frac{1}{1-\underline{\lambda}}$.[50] □

Proof of Lemma 1. We know from (10) that the rent enjoyed by a manager with belief λ_M is $w_{\emptyset} = \frac{c}{(1-\lambda_M)\left(e^{**}_{g\{\lambda_B,\lambda_M\}}\right)^2}$, where $e^{**}_{g\{\lambda_B,\lambda_M\}}$ is the second-best growth effort when the manager is hired by a bank with belief λ_B. The first part of the lemma follows directly from the fact $e^{**}_{g\{\bar{\lambda},\lambda_M\}} > e^{**}_{g\{\underline{\lambda},\lambda_M\}}$, $\forall\ \lambda_M \in \{\bar{\lambda}, \underline{\lambda}\}$, the proof of which is similar as that of Proposition 3. To prove the second part, denote a bank's (with belief λ_B) net profit from hiring a manager with belief λ_M as $\pi_{\{\lambda_B,\lambda_M\}}$. We know from (A.8) that:

$$\begin{aligned}
\pi_{\{\underline{\lambda},\underline{\lambda}\}} &= e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}\left[\underline{\lambda}(X-I)-(1-\underline{\lambda})e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}(I-\phi)\right] \\
&\quad -\frac{c}{(1-\underline{\lambda})(e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}})^2}-c \\
&> e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}\left[\underline{\lambda}(X-I)-(1-\underline{\lambda})e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}(I-\phi)\right] \\
&\quad -\frac{c}{(1-\underline{\lambda})\left(e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}\right)^2}-c \\
&> e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}\left[\underline{\lambda}(X-I)-(1-\underline{\lambda})e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}(I-\phi)\right] \\
&\quad -\frac{c}{(1-\bar{\lambda})\left(e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}\right)^2}-c \\
&= \pi_{\{\underline{\lambda},\bar{\lambda}\}}-\frac{c(\bar{\lambda}-\underline{\lambda})(2-\bar{\lambda})}{\bar{\lambda}(1-\bar{\lambda})},
\end{aligned} \tag{A.12}$$

where the first inequality follows from $e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$ being the (second-best) optimal allocation for a bank with belief $\lambda_B = \underline{\lambda}$ hiring a manager with belief $\lambda_M = \underline{\lambda}$, the second inequality directly follows from $\bar{\lambda} > \underline{\lambda}$, and $\frac{c(\bar{\lambda}-\underline{\lambda})(2-\bar{\lambda})}{\bar{\lambda}(1-\bar{\lambda})}$ in the last equality is the perceived reduction in the wage cost when a manager with belief $\lambda_M = \bar{\lambda}$ is hired (see (A.7)). Note $\pi_{\{\underline{\lambda},\underline{\lambda}\}} - \left[\pi_{\{\underline{\lambda},\bar{\lambda}\}} - \frac{c(\bar{\lambda}-\underline{\lambda})(2-\bar{\lambda})}{\bar{\lambda}(1-\bar{\lambda})}\right]$ is increasing in $e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}} - e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}}$ (following from the concavity of the objective function and $e^{**}_{g\{\underline{\lambda},\bar{\lambda}\}} > e^{**}_{g\{\underline{\lambda},\underline{\lambda}\}}$), which is itself increasing in ϕ (see Proposition 3). Since $\frac{c(\bar{\lambda}-\underline{\lambda})(2-\bar{\lambda})}{\bar{\lambda}(1-\bar{\lambda})}$ is a constant, we have $\pi_{\{\underline{\lambda},\underline{\lambda}\}} - \pi_{\{\underline{\lambda},\bar{\lambda}\}} > 0$ when $\frac{\phi}{c}$ is sufficiently big. □

Proof of Proposition 4. We first describe *details of the matching process* (sketched in the text):

1 Each manager applies to her preferred bank (which is a pessimistic bank; see Lemma 1). There must be some pessimistic bank receiving multiple applications (given that $\underline{n}^{\mathrm{b}} < \bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$), but it is also possible that some pessimistic bank receives no application at first.
2 Each pessimistic bank receiving multiple applications screens the applicants one by one; screening each applicant costs the bank η.[51] Once screening reveals a pessimistic manager, the bank hires the manager (given its preference for a pessimistic manager; see Lemma 1), rejects the rest, and closes its position. If screening shows that all the applicants are optimistic, the bank randomly picks one applicant, keeps her on a waiting list, and rejects the rest; the bank does not hire the optimistic manager yet to allow for the possibility that some pessimistic manager may apply later. If a bank receives only one application, it does not screen the applicant but simply keeps her on its waiting list. Banks receiving no application do nothing.
3 Each rejected manager removes the bank that ever rejected her from her list, and then applies to her preferred bank among those remaining.
4 Repeat the procedure in the same manner, except that from now on the manager on a bank's waiting list (if any) shall be pooled together with any new applicants for the bank to consider.
5 Given that neither type of bank can hire all the managers, after finite steps some optimistic managers, after being rejected by *all* the pessimistic banks, start to apply to optimistic banks; note that each pessimistic manager will eventually be hired by some pessimistic bank after finite steps of applying and interviewing and, hence, will not apply to an optimistic bank. Thus, an optimistic bank understands that anyone applying to its position must be an optimistic manager and, hence, hires the applicant immediately. The procedure stops once $\bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$ banks have been applied to. At that final stage, any bank that has not closed its position yet but maintains a waiting list hires the manager on the list.

[50] Note $\frac{1}{1-\bar{\lambda}}\left(\frac{\underline{\lambda}}{1-\underline{\lambda}}\frac{1-\bar{\lambda}}{\bar{\lambda}}\right)^3 < \frac{1}{1-\underline{\lambda}} \Leftrightarrow \left(\frac{\underline{\lambda}}{\bar{\lambda}}\right)^3 < \left(\frac{1-\underline{\lambda}}{1-\bar{\lambda}}\right)^2$, which is obvious since $\frac{\underline{\lambda}}{\bar{\lambda}} < 1$ while $\frac{1-\underline{\lambda}}{1-\bar{\lambda}} > 1$.

[51] Clearly, η cannot be too high, say $\eta < \bar{\eta}$, for the mechanism to be viable (otherwise, a bank's expected gain from hiring a manager of the same type does not justify its screening cost). As a bank's expected total screening cost is proportional to the number of managers $\bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$, the upper bound $\bar{\eta}$ becomes tighter as $\bar{n}^{\mathrm{m}} + \underline{n}^{\mathrm{m}}$ increases; we are, however, unable to pinpoint $\bar{\eta}$ analytically.

We now prove the proposition by contradiction. In an assortative matching, all managers with $\lambda_M = \bar{\lambda}$ are matched with banks with $\lambda_B = \bar{\lambda}$, so some banks with $\lambda_B = \underline{\lambda}$ remain unmatched given that $\underline{n}^{\mathrm{b}} > \underline{n}^{\mathrm{m}}$. For any such unmatched bank and any manager currently matched with a bank with $\lambda_B = \bar{\lambda}$, both would be strictly better off if they form a pair: the manager enjoys a bigger rent when matched with a bank with $\lambda_B = \underline{\lambda}$ (see Lemma 1), and the bank is better off because its net profit is zero if it remains unmatched. □

Proof of Proposition 5. For a given wage contract (w_X and $w_\varnothing$), a manager's utility from working is:

$$u_{\{\lambda_M\}} - \alpha(|e_g - e_g^{\mathrm{B}}| + |e_s - e_s^{\mathrm{B}}|), \tag{A.13}$$

where $u_{\{\lambda_M\}} = e_g[\lambda_M w_X + (1-\lambda_M)e_s w_\varnothing] + (1-e_g)w_\varnothing - c$ is her expected wage compensation (net the effort cost c), and $\alpha(|e_g - e_g^{\mathrm{B}}| + |e_s - e_s^{\mathrm{B}}|)$ is the culture-induced disutility component (given by (13)). Suppose the matching is assortative; we will show later how assortative matching can be achieved by culture investment.

We first analyze an optimistic bank's ($\lambda_B = \bar{\lambda}$) investment in culture $\bar{\alpha}$, which is matched with an optimistic manager ($\lambda_M = \bar{\lambda}$). The IC constraint for the manager to exert effort is:[52]

$$\begin{aligned} u_{\{\bar{\lambda}\}} - 2\alpha|e_g - e_g^{\mathrm{B}}| \ \geq \ w_\varnothing - 2\alpha \Rightarrow \bar{\lambda}\frac{w_X}{w_\varnothing} \geq 1 - (1-\bar{\lambda})e_s + \frac{c}{e_g w_\varnothing} \\ - 2\alpha\frac{1 - |e_g - e_g^{\mathrm{B}}|}{e_g w_\varnothing}. \end{aligned} \tag{A.14}$$

The IC constraint for the manager's effort allocation is:[53]

$$\begin{aligned} \{e_g, e_s\} \ &\in \ \underset{\{e_g+e_s=1\}}{\operatorname{argmax}} u_{\{\bar{\lambda}\}} - 2\alpha|e_g - e_g^{\mathrm{B}}| \Rightarrow \\ e_g \ &= \ \frac{\bar{\lambda}}{2(1-\bar{\lambda})}\left(\frac{w_X}{w_\varnothing} - 1\right) - \frac{\alpha \times 1_{\{e_g > e_g^{\mathrm{B}}\}}}{(1-\bar{\lambda})w_\varnothing}, \\ e_s \ &= \ \frac{\bar{\lambda}}{2(1-\bar{\lambda})}\left(\frac{2-\bar{\lambda}}{\bar{\lambda}} - \frac{w_X}{w_\varnothing}\right) + \frac{\alpha \times 1_{\{e_g > e_g^{\mathrm{B}}\}}}{(1-\bar{\lambda})w_\varnothing}. \end{aligned} \tag{A.15}$$

It is clear from (A.15) that choosing the first-best allocation as the benchmark is more likely to pull managerial effort toward the first best and, therefore, $e_g^{\mathrm{B}} = e^*_{g\{\bar{\lambda},\bar{\lambda}\}}$ and $e_s^{\mathrm{B}} = e^*_{s\{\bar{\lambda},\bar{\lambda}\}}$. Combining (A.14) and (A.15) yields:

$$w_\varnothing = \frac{c - 2\alpha\left(1 + e^*_{g\{\bar{\lambda},\bar{\lambda}\}} \times 1_{\left\{e_g > e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right\}}\right)}{(1-\bar{\lambda})e_g^2}. \tag{A.16}$$

The bank's expected compensation to the manager is $e_g[\bar{\lambda}w_X + (1-\bar{\lambda})e_s w_\varnothing] + (1-e_g)w_\varnothing = u_{\{\bar{\lambda}\}} + c = w_\varnothing + c + 2\alpha\left|e_g - e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right| - 2\alpha$. Thus, for a given α, the bank's contracting problem can be written as:

$$\begin{aligned} \max_{\{e_g+e_s=1\}} \quad & e_g[\bar{\lambda}(X-I) - (1-\bar{\lambda})(1-e_s)(I-\phi)] \\ & - \frac{c - 2\alpha\left(1 + e^*_{g\{\bar{\lambda},\bar{\lambda}\}} \times 1_{\left\{e_g > e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right\}}\right)}{(1-\bar{\lambda})e_g^2} - c - 2\alpha\left|e_g - e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right| \\ & + 2\alpha - \frac{1}{2}\beta\alpha^2. \end{aligned} \tag{A.17}$$

The FOC (w.r.t. e_g) is:

$$\begin{aligned} \bar{\lambda}(X-I) \ - \ 2(1-\bar{\lambda})(I-\phi)e_g + \frac{2c}{1-\bar{\lambda}}(e_g)^{-3} \\ - \alpha\left[3 + \frac{4\left(1 + e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right)}{1-\bar{\lambda}}(e_g)^{-3}\right] = 0. \end{aligned} \tag{A.18}$$

The first-best effort allocation to growth, $e^*_{g\{\bar{\lambda},\bar{\lambda}\}}$, is given by $\bar{\lambda}(X-I) - 2(1-\bar{\lambda})(I-\phi)e^*_{g\{\bar{\lambda},\bar{\lambda}\}} = 0$ (replacing λ in (A.1) with $\bar{\lambda}$). The second-best effort allocation to growth absent culture investment, $e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$, is given by $\bar{\lambda}(X-I) - 2(1-\bar{\lambda})(I-\phi)e^*_{g\{\bar{\lambda},\bar{\lambda}\}} + \frac{2c}{1-\bar{\lambda}}\left(e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}\right)^{-3} = 0$ (replacing λ in (A.2) with $\bar{\lambda}$). It follows from (A.18) that the optimal solution with culture investment $e_g \in \left(e^*_{g\{\bar{\lambda},\bar{\lambda}\}}, e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}\right)$.[54]

[52] To understand (A.14), note that if the manager shirks, $\Pr(d=1) = 2\alpha$, so her culture-induced disutility is 2α; if she works (i.e., choosing $e_g + e_s = 1$), her culture-induced disutility is $\alpha(|e_g - e_g^{\mathrm{B}}| + |e_s - e_s^{\mathrm{B}}|) = 2\alpha|e_g - e_g^{\mathrm{B}}| \leq 2\alpha$, where the equality follows from the fact $e_g + e_s = e_g^{\mathrm{B}} + e_s^{\mathrm{B}} = 1$.

[53] The indicator function $1_{\{e_g > e_g^{\mathrm{B}}\}}$ equals 1 if $e_g > e_g^{\mathrm{B}}$, 0 if $e_g = e_g^{\mathrm{B}}$, or -1 if $e_g < e_g^{\mathrm{B}}$.

[54] Suppose $\alpha = 0$, in which case it is clear that $e_g = e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$ ((A.18) is identical to (A.2), replacing λ in the latter with $\bar{\lambda}$). As α increases, the LHS in (A.18) decreases, so e_g has to fall to maintain the equality. If α is extremely big, then the LHS in (A.18) will fall below $\bar{\lambda}(X-I) - 2(1-\bar{\lambda})(I-\phi)e_g$ (for $\forall e_g$), in which case $e_g < e^*_{g\{\bar{\lambda},\bar{\lambda}\}}$. But this is not optimal: given that the objective function is concave in e_g, some $e_g' > e^*_{g\{\bar{\lambda},\bar{\lambda}\}}$ will lead to the same payoff (as $e_g < e^*_{g\{\bar{\lambda},\bar{\lambda}\}}$) but can be induced with a smaller α. Therefore, α cannot be so big such that e_g falls below $e^*_{g\{\bar{\lambda},\bar{\lambda}\}}$.

The bank chooses α to maxmize $\pi(\alpha) - \frac{1}{2}\beta\alpha^2$, where $\pi(\alpha) = e_g[\bar{\lambda}(X-I) - (1-\bar{\lambda})(I-\phi)e_g] - \frac{c - 2\alpha\left(1 + e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right)}{(1-\bar{\lambda})e_g^2} - c - 2\alpha\left(e_g - e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right) + 2\alpha$. The solution, $\bar{\alpha}$, is given by:[55]

$$\frac{1 + e^*_{g\{\bar{\lambda},\bar{\lambda}\}}}{(1-\bar{\lambda})e_g^2} + 1 - \left(e_g - e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right) = \beta\bar{\alpha}/2. \tag{A.19}$$

The expected pay to the optimistic manager is:

$$\begin{aligned} w_\varnothing + c + 2\bar{\alpha}\left(e_g - e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right) - 2\bar{\alpha} &= \frac{c - 2\bar{\alpha}\left(1 + e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right)}{(1-\bar{\lambda})e_g^2} + c \\ &+ 2\bar{\alpha}\left(e_g - e^*_{g\{\bar{\lambda},\bar{\lambda}\}}\right) - 2\bar{\alpha}, \end{aligned} \tag{A.20}$$

where e_g and $\bar{\alpha}$ are jointly given by (A.18) and (A.19).

Substituting (A.19) into (A.18), we note that when ϕ increases, the LHS of (A.18) increases, so to maintain equality, e_g must increase as well; this, in turn, lowers the LHS of (A.19), thereby causing $\bar{\alpha}$ to fall.

Next, we examine a pessimistic bank's ($\lambda_B = \underline{\lambda}$) investment in culture $\underline{\alpha}$, which is matched with a pessimistic manager ($\lambda_M = \underline{\lambda}$). Following an analysis similar to the one for the optimistic bank, we can show that $\underline{\alpha}$ and the pessimistic manager's equilibrium effort e_g are jointly given by (details omitted):

$$\begin{aligned} \underline{\lambda}(X-I) \;-\; 2(1-\underline{\lambda})(I-\phi)e_g + \frac{2c}{1-\underline{\lambda}}(e_g)^{-3} \\ -\alpha\left[3 + \frac{4(1 + e^*_{g\{\underline{\lambda},\underline{\lambda}\}})}{1-\underline{\lambda}}(e_g)^{-3}\right] = 0, \end{aligned} \tag{A.21}$$

and

$$\frac{1 + e^*_{g\{\underline{\lambda},\underline{\lambda}\}}}{(1-\underline{\lambda})e_g^2} + 1 - \left(e_g - e^*_{g\{\underline{\lambda},\underline{\lambda}\}}\right) = \beta\underline{\alpha}/2, \tag{A.22}$$

where the first-best effort allocation to growth (also the benchmark), $e^*_{g\{\underline{\lambda},\underline{\lambda}\}}$, is given by $\underline{\lambda}(X-I) - 2(1-\underline{\lambda})(I-\phi)e^*_{g\{\underline{\lambda},\underline{\lambda}\}} = 0$ (replacing λ in (A.1) with $\underline{\lambda}$). The result that $\underline{\alpha}$ is decreasing in ϕ can be shown similarly as that for the result that $\bar{\alpha}$ is decreasing in ϕ.

Furthermore, the pessimistic bank's choice of α also needs to prevent an optimistic manager from applying. Suppose the pessimistic bank is matched with an optimistic manager. It can be shown that, for a given α, the optimistic manager's equilibrium effort is given by (note the difference between (A.21) and (A.23)):

$$\begin{aligned} \underline{\lambda}(X-I) \;-\; 2(1-\underline{\lambda})(I-\phi)e_g + \frac{2c}{1-\bar{\lambda}}(e_g)^{-3} \\ -\alpha\left[3 + \frac{4(1 + e^*_{g\{\underline{\lambda},\underline{\lambda}\}})}{1-\bar{\lambda}}(e_g)^{-3}\right] = 0. \end{aligned} \tag{A.23}$$

The expected pay to the optimist manager is:

$$\frac{c - 2\alpha(1 + e^*_{g\{\underline{\lambda},\underline{\lambda}\}})}{(1-\bar{\lambda})e_g^2} + c + 2\alpha\left(e_g - e^*_{g\{\underline{\lambda},\underline{\lambda}\}}\right) - 2\alpha. \tag{A.24}$$

To prevent an optimistic manager from applying, the pessimistic bank sets $\alpha \geq \underline{\alpha}'$, where $\underline{\alpha}'$ is such that (A.24) equals (A.20). Thus, $\underline{\alpha}$ equals the maximum of $\underline{\alpha}'$ and the one determined by (A.21) and (A.19). □

Proof of Proposition 6. Combining (16) and (17), we have:

$$w_\varnothing = \frac{c}{(1-\lambda)(e_{g[1]} - \kappa e_{g[2]})^2}. \tag{A.25}$$

Bank 1's problem can be written as:

$$\begin{aligned} \max_{\{e_{g[1]}\}} \quad & (e_{g[1]} - \kappa e_{g[2]})[\lambda(X - R_1 - E) - (1-\lambda)e_{g[1]}E] \\ & - \frac{c}{(1-\lambda)(e_{g[1]} - \kappa e_{g[2]})^2} - c. \end{aligned} \tag{A.26}$$

The FOC w.r.t. $e_{g[1]}$ (and using $e_{g[1]} = e_{g[2]}$ in a symmetric equilibrium) is:

$$\begin{aligned} \hat{f}_2(e^{**}_{g[1]}) \;\equiv\; & \lambda(X-I) - (2-\kappa)(1-\lambda)(E + D - \phi)e^{**}_{g[1]} \\ & + \frac{1}{(1-\kappa)^3}\frac{2c}{1-\lambda}(e^{**}_{g[1]})^{-3} = 0. \end{aligned} \tag{A.27}$$

Comparing it with the FOC that determines e^{**}_g in the one-bank case in (A.2), $f_2(e^{**}_g) = 0$, we note that $f_2' < 0$ and $\hat{f}_2' < 0$. We claim:

[55] The LHS of (A.19), $\pi'(\alpha)$, which is clearly positive, follows from the envelope theorem.

$$e_{g[1]}^{**} > \frac{2}{2-\kappa} e_g^{**} > e_g^{**}. \quad (A.28)$$

To see this, note:

$$\begin{aligned}\hat{f}_2\left(\frac{2}{2-\kappa}z\right) &= \lambda(X-I) - (2-\kappa)(1-\lambda)(I-\phi)\left(\frac{2}{2-\kappa}z\right) \\ &+ \frac{(2-\kappa)^3}{8(1-\kappa)^3}\frac{2c}{1-\lambda}z^{-3} > f_2(z),\end{aligned} \quad (A.29)$$

where the inequality holds, since $\frac{(2-\kappa)^3}{8(1-\kappa)^3} > 1$. Thus, we must have $e_{g[1]}^{**} = e_{g[2]}^{**} > \frac{2}{2-\kappa} e_g^{**} > e_g^{**}$. The result that $e_{g[1]}^{**} - e_g^{**}$ is increasing in κ follows directly from the fact that $\hat{f}_2(z)$ is increasing in κ for $\forall z$.

Next, we know from (17) that:

$$\frac{w_X}{w_\varnothing} = 1 + \frac{(2-\kappa)(1-\lambda)}{\lambda} e_{g[1]}^{**} > 1 + \frac{2(1-\lambda)}{\lambda} e_g^{**}. \quad (A.30)$$

Since $\frac{w_X}{w_\varnothing} = 1 + \frac{2(1-\lambda)}{\lambda} e_g^{**}$ in the one-bank case (see (6)), $\frac{w_X}{w_\varnothing}$ must be bigger in the two-bank case. The result that the difference in $\frac{w_X}{w_\varnothing}$ between the two cases is increasing in κ follows directly from the fact that $\hat{f}_2\left(\frac{2}{2-\kappa}z\right)$ is increasing in κ for $\forall z$.

Finally, suppose ϕ increases. Following a similar proof for the result that $e_g^{**} - e_g^{*}$ is increasing in ϕ (see the proof of Proposition 2), we can show that $e_{g[1]}^{**} - \frac{2}{2-\kappa} e_g^{**}$ increases and, consequently, the difference in $\frac{w_X}{w_\varnothing}$ between the two cases increases as well. Given that $\frac{2}{2-\kappa} > 1$ and e_g^{**} increases as well when ϕ increases (directly following from (A.2)), $e_{g[1]}^{**} - e_g^{**}$ must increase. □

Proof of Proposition 7. We first state the banks' contracting problems. The expected net profit for bank i, $i \in \{1, 2\}$, is (where $j \neq i$, $\lambda_{B[1]} = \bar{\lambda}$, and $\lambda_{B[2]} = \underline{\lambda}$):

$$\begin{aligned}\pi_i &= (e_{g[i]} - \kappa e_{g[j]})[\lambda_{B[i]}(X - R_i - E - w_{X[i]}) - (1-\lambda_{B[i]})e_{s[i]}w_{\varnothing[i]} \\ &-(1-\lambda_{B[i]})(1-e_{s[i]})E] - [1 - (e_{g[i]} - \kappa e_{g[j]})]w_{\varnothing[i]},\end{aligned} \quad (A.31)$$

where $R_i = D + \frac{(1-\lambda_{B[i]})(1-e_{s[i]})(D-\phi)}{\lambda_{B[i]}}$. The manager's utility from working is ($\lambda_{M[1]} = \bar{\lambda}$, $\lambda_{M[2]} = \underline{\lambda}$):

$$\begin{aligned}u_i &= (e_{g[i]} - \kappa e_{g[j]})[\lambda_{M[i]}w_{X[i]} + (1-\lambda_{M[i]})e_{s[i]}w_{\varnothing[i]}] \\ &+ [1 - (e_{g[i]} - \kappa e_{g[j]})]w_{\varnothing[i]} - c.\end{aligned} \quad (A.32)$$

Bank i's problem can be written as:

$$\begin{aligned} &\max_{\{w_{X[i]}, w_{\varnothing[i]}\}} \quad \pi_i, \\ &\text{subject to} \quad u_i \geq w_{\varnothing[i]} \Rightarrow \lambda_{M[i]}\frac{w_{X[i]}}{w_{\varnothing[i]}} \geq 1 - (1-\lambda_{M[i]})e_{s[i]} \\ &\qquad + \frac{c}{(e_{g[i]} - \kappa e_{g[j]})w_{\varnothing[i]}}, \\ &\{e_{g[i]}, e_{s[i]}\} \in \underset{\{e_{g[i]}+e_{s[i]}=1\}}{\operatorname{argmax}} \\ &u_i \Rightarrow \begin{cases} e_{g[i]} - \frac{\kappa}{2}e_{g[j]} = \frac{\lambda_{M[i]}}{2(1-\lambda_{M[i]})}\left(\frac{w_{X[i]}}{w_{\varnothing[i]}} - 1\right), \\ e_{s[i]} + \frac{\kappa}{2}e_{g[j]} = \frac{\lambda_{M[i]}}{2(1-\lambda_{M[i]})}\left(\frac{2-\lambda_{M[i]}}{\lambda_{M[i]}} - \frac{w_{X[i]}}{w_{\varnothing[i]}}\right). \end{cases}\end{aligned} \quad (A.33)$$

Next, we analyze the problems. Denote bank i's optimal effort allocation to growth as $e_{g[i]}^{**}$. Following the same analysis as in the proof of Proposition 6, we can show that the FOCs for bank 1's problem (with the optimistic belief) and bank 2's problem (with the pessimistic belief) can be written as:

$$\begin{aligned}\hat{f}_{\{\bar{\lambda},\bar{\lambda}\}}(e_{g[1]}^{**}) &\equiv \bar{\lambda}(X-I) - (1-\bar{\lambda})(I-\phi)(2e_{g[1]}^{**} - \kappa e_{g[2]}^{**}) \\ &+ \frac{2c}{1-\bar{\lambda}}(e_{g[1]}^{**} - \kappa e_{g[2]}^{**})^{-3} = 0,\end{aligned} \quad (A.34)$$

and

$$\begin{aligned}\hat{f}_{\{\underline{\lambda},\underline{\lambda}\}}(e_{g[2]}^{**}) &\equiv \underline{\lambda}(X-I) - (1-\underline{\lambda})(I-\phi)(2e_{g[2]}^{**} - \kappa e_{g[1]}^{**}) \\ &+ \frac{2c}{1-\underline{\lambda}}(e_{g[2]}^{**} - \kappa e_{g[1]}^{**})^{-3} = 0,\end{aligned} \quad (A.35)$$

respectively. It can be shown that $e_{g[1]}^{**} > e_{g[2]}^{**}$,[56] so we only need to prove the result for bank 2.

We compare (A.35) with the FOC that determines the bank's effort allocation to growth, $e_{g\{\bar{\lambda},\bar{\lambda}\}}^{**}$, in the one-bank case with both the bank and its manager being optimistic (replacing λ in (A.2) with $\bar{\lambda}$):

[56] If $e_{g[1]}^{**} \leq e_{g[2]}^{**}$, then $\hat{f}_{\{\bar{\lambda},\bar{\lambda}\}}\left(e_{g[1]}^{**}\right) > \hat{f}_{\{\underline{\lambda},\underline{\lambda}\}}\left(e_{g[2]}^{**}\right)$, so the equalities in (A.34) and (A.35) cannot hold simultaneously.

$$f_{\{\bar{\lambda},\bar{\lambda}\}}\left(e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}\right) \equiv \bar{\lambda}(X-I) - 2(1-\bar{\lambda})(I-\phi)e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}} + \frac{2c}{1-\bar{\lambda}}\left(e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}\right)^{-3} = 0. \tag{A.36}$$

Note that $\widehat{f}_{\{\underline{\lambda},\underline{\lambda}\}}(e^{**}_{g[2]})$ is increasing in $e^{**}_{g[1]}$. So, to establish the possibility of $e^{**}_{g[2]} > e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$, it is sufficient to examine the hypothetical case wherein $e^{**}_{g[1]} = e^{**}_{g[2]}$. If that were the case, we could rewrite (A.35) as:

$$\widehat{\widehat{f}}_{\{\underline{\lambda},\underline{\lambda}\}}(e^{**}_{g[2]}) \equiv \underline{\lambda}(X-I) - (2-\kappa)(1-\underline{\lambda})(I-\phi)e^{**}_{g[2]} + \frac{1}{(1-\kappa)^3}\frac{2c}{1-\underline{\lambda}}(e^{**}_{g[2]})^{-3} = 0. \tag{A.37}$$

Note that: (i) $\widehat{\widehat{f}}'_{\{\underline{\lambda},\underline{\lambda}\}} < 0$ and $f'_{\{\bar{\lambda},\bar{\lambda}\}} < 0$; and (ii) $\widehat{\widehat{f}}_{\{\underline{\lambda},\underline{\lambda}\}}(z) > f_{\{\bar{\lambda},\bar{\lambda}\}}(z)$ for $\forall z$, when κ is sufficiently large, in which case we have $e^{**}_{g[2]} > e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$. By a continuity argument, there must exist a cutoff κ_g such that when $e^{**}_{g[2]}$ and $e^{**}_{g[1]}$ are indeed jointly determined by (A.34) and (A.35), $e^{**}_{g[2]} > e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$ when $\kappa > \kappa_g$. Moreover, since $\widehat{\widehat{f}}_{\{\underline{\lambda},\underline{\lambda}\}}(z)$ is increasing in ϕ for $\forall z$, it is more likely that $e^{**}_{g[2]} > e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$ will hold, i.e., κ_g decreases as ϕ increases. Finally, the result that $e^{**}_{g[1]} > e^{**}_{g\{\bar{\lambda},\bar{\lambda}\}}$ is obvious (follows directly from Proposition 6); hence, its proof is omitted. □

Proof of Proposition 8. The proof is based on the proof of Proposition 5 and the proof of Proposition 7 by adding competition to the former and culture investment to the latter (so some intermediate steps are omitted). We first analyze bank 1's problem. It can be shown that:

$$w_{\varnothing[1]} = \frac{c - 2\alpha\left(1 + e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}} - \kappa e_{g[2]}\right)}{(1-\bar{\lambda})(e_{g[1]} - \kappa e_{g[2]})^2}. \tag{A.38}$$

For a given α, bank 1's contracting problem can be written as:

$$\max_{\{e_{g[1]}+e_{s[1]}=1\}} \quad (e_{g[1]} - \kappa e_{g[2]})[\bar{\lambda}(X-I) - (1-\bar{\lambda})(1-e_{s[1]})(I-\phi)] - \frac{c - 2\alpha\left(1 + e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}} - \kappa e_{g[2]}\right)}{(1-\bar{\lambda})(e_{g[1]} - \kappa e_{g[2]})^2} - c - 2\alpha\left(e_{g[1]} - e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}}\right) + 2\alpha - \frac{1}{2}\beta\alpha^2. \tag{A.39}$$

The effort $e_{g[1]}$ is determined by the FOC to the above problem. The bank then chooses α, denoted by $\bar{\alpha}(\kappa)$. In equilibrium, $e_{g[1]}$ and $\bar{\alpha}(\kappa)$ are jointly given by:

$$\bar{\lambda}(X-I) - (1-\bar{\lambda})(I-\phi)(2e_{g[1]} - \kappa e_{g[2]}) + \frac{2c}{1-\bar{\lambda}}(e_{g[1]} - \kappa e_{g[2]})^{-3} - \bar{\alpha}(\kappa)\left[3 + \frac{4\left(1 + e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}} - \kappa e_{g[2]}\right)}{1-\bar{\lambda}}(e_{g[1]} - \kappa e_{g[2]})^{-3}\right] = 0, \tag{A.40}$$

and

$$\frac{1 + e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}} - \kappa e_{g[2]}}{(1-\bar{\lambda})(e_{g[1]} - \kappa e_{g[2]})^2} + 1 - \left(e_{g[1]} - e^{*}_{g\{\bar{\lambda},\bar{\lambda}\}}\right) = \beta\bar{\alpha}(\kappa)/2. \tag{A.41}$$

Bank 2's problem can be analyzed in a similar way. Its manager's effort $e_{g[2]}$ and the bank's investment in culture $\underline{\alpha}(\kappa)$ are jointly determined by:

$$\underline{\lambda}(X-I) - (1-\underline{\lambda})(I-\phi)(2e_{g[2]} - \kappa e_{g[1]}) + \frac{2c}{1-\underline{\lambda}}(e_{g[2]} - \kappa e_{g[1]})^{-3} - \underline{\alpha}(\kappa)\left[3 + \frac{4(1 + e^{*}_{g\{\underline{\lambda},\underline{\lambda}\}} - \kappa e_{g[1]})}{1-\underline{\lambda}}(e_{g[2]} - \kappa e_{g[1]})^{-3}\right] = 0, \tag{A.42}$$

and

$$\frac{1 + e^{*}_{g\{\underline{\lambda},\underline{\lambda}\}} - \kappa e_{g[1]}}{(1-\underline{\lambda})(e_{g[2]} - \kappa e_{g[1]})^2} + 1 - \left(e_{g[2]} - e^{*}_{g\{\underline{\lambda},\underline{\lambda}\}}\right) = \beta\underline{\alpha}(\kappa)/2. \tag{A.43}$$

In the overall equilibrium, $\bar{\alpha}(\kappa)$, $\underline{\alpha}(\kappa)$, $e_{g[1]}$ (hence $e_{s[1]}$), and $e_{g[2]}$ (hence $e_{s[2]}$) are jointly determined by (A.40) – (A.43). Note that the LHSs of (A.40) and (A.42) are decreasing in $\bar{\alpha}(\kappa)$ and $\underline{\alpha}(\kappa)$, respectively; thus, both $e_{g[1]}$ and $e_{g[2]}$ must be smaller than the solutions in the case in which banks do not invest in culture (i.e., by setting $\bar{\alpha}(\kappa) = \underline{\alpha}(\kappa) = 0$); the solutions for that case were given by (A.34) and (A.35).

Substituting (A.41) into (A.40) and (A.43) into (A.42), we note that when ϕ or κ increases, the LHSs of (A.40) and (A.42) increase (all else being equal); thus, $e_{g[1]}$ and $e_{g[2]}$ must increase to maintain equalities. Moreover, an increase in $e_{g[1]}$ ($e_{g[2]}$) further increases the LHS of (A.42) (A.40), causing $e_{g[2]}$ ($e_{g[1]}$) to further increase, so the new equilibrium is settled with higher growth effort for both banks. The LHSs of (A.41) and (A.43) are decreasing in $e_{g[1]}$ and $e_{g[2]}$, respectively, so at the new equilibrium $\bar{\alpha}(\kappa)$ and $\underline{\alpha}(\kappa)$ must be both lower. □

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