Banking on Reciprocity: Deposit Insurance and Insolvency *

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Abstract

There is an empirical connection between deposit insurance, risk-taking, and insolvency. We argue that if banks maximize profit this amounts to a puzzle (even taking into account that deposit insurance decreases incentives for customers to monitor banks). However, we show that the empirical regularities can be well captured if bankers are motivated by reciprocity towards their customer base.

KEYWORDS: Deposit Insurance, Reciprocity, Banking, Insolvency, Moral Hazard

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1 Introduction

Two oft-proposed reasons for banking crises are runs and insolvency; see Calomiris (2008). On the former account banks get in liquidity trouble if all depositors withdraw funds (Diamond and Dybvig, 1983). The latter one may be linked to moral hazard; for example, government legislation may create incentives for excessive risk-taking, something Calomiris (2009) forcefully argues is particularly relevant for understanding the 2008+ US financial crisis.

Deposit insurance (DI) is a policy tool that speaks to both crisis reasons. Diamond and Dybvig show theoretically how DI can help avoid bank runs, while Calomiris (1990, 2008) interprets historical records to indicate that DI often caused insolvency by inviting excessive risk-taking. Indeed, numerous studies found evidence suggesting a link between DI and bank risk taking.[1] Our paper is concerned with this latter phenomenon. We argue that from the viewpoint of traditional economic thought, the DI-causes-insolvency pattern is a puzzle. DI affects depositors' payoffs, not bankers', so no direct link connects DI to the behavior of a profit-maximizing banker.

It has been argued that DI reduces customers' incentives to monitor their bank's behavior, and thus invites excessive risk taking.[2] In order to accept this explanation, it is first necessary to accept that depositors have the ability to observe and understand bank risk, which is not at all obvious. As a testament to the opaqueness of the banking sector in general, Morgan (2002) provides evidence that professional credit-rating agencies disagree more often when it comes to banks, than they do for firms in other industries. Moreover, in a

[1] See, e.g., Grossman (1992); Demirgüç-Kunt and Detragiache (2002); Ioannidou and Penas (2010).

[2] See, e.g., Calomiris (1999), Cooper and Ross (2002); Gropp and Vesala (2004), Demirgüç-Kunt and Kane (2002), Demirgüç-Kunt and Detragiache, Demirgüç-Kunt and Huizinga (2004).

recent article in *The Atlantic*, Frank Partnoy and Jesse Eisinger (2013) speak to the challenges of understanding bank risk portfolios:

> The financial crisis had many causes – too much borrowing, foolish investments, misguided regulation – but at its core, the panic resulted from a lack of transparency. The reason no one wanted to lend to or trade with the banks during the fall of 2008, when Lehman Brothers collapsed, was that no one could understand the banks' risks. It was impossible to tell, from looking at a particular bank's disclosures, whether it might suddenly implode.

Even if one believes that customers could acquire and understand this information to some degree, arguably the banking experts at the FDIC could acquire more accurate information at a lower cost. Just as any insurance provider has an incentive to monitor the behavior of their customers, the FDIC would have the incentive to monitor the level of risk undertaken by the bank. The introduction of deposit insurance would shift the monitoring role from the customers to the insurer, and in this paper our working assumption is that the FDIC is at least as adept at this task as the customers. Hence, if so, the bank would be more heavily monitored with DI than without. This constitutes our puzzle. Classical theory is hard-pressed providing a reasonable explanation for the observed link between DI and risk taking.

We identify a novel reason why DI may cause insolvency. If the monitoring account is deemed wanting, our perspective provides an alternative; if the monitoring account makes sense after all (say because the market is better informed than the regulator, or if the regulator is corrupt), then we offer a complementing argument.

Our key train of thought is this: A banker's payoff is that of a residual claimant; he gets what is left after depositors' demandable debt is serviced. His leveraged position invites heavier risk-taking than would benefit depositors, enough to make insolvency loom. But bankers owe their livelihood to their customers. Without deposits bankers would not be in business. Is it not plausible that this makes them somewhat protective of their customer base, and disinclined to hurt them? Without DI there is an obvious way to do that: hold back on risk taking. With DI, by contrast, there is no need to hold back. Even if a banker is grateful, risk-taking won't hurt depositors, so the banker throws caution to the wind. In other words, if bankers are motivated by reciprocity – so that they avoid hurting those that helped them – the empirical link between DI and insolvency can be explained.

Our goal is to tell this story precisely. In a model of depositor-banker-insurer interaction, we incorporate preferences for reciprocation using the approach of Dufwenberg and Kirchsteiger (2004) (henceforth, D&K), which in turn owes its intellectual foundation to the pioneering work by Rabin (1993); but the D&K approach is needed to treat games with a non-trivial dynamic structure. We explore properties, including variations that concern the degree of DI coverage, whether a bank's risk-taking is observable, and how fragmented is its depositor community.

Reciprocal bankers do not have the objective of maximizing profit. Does that really make sense? Recent experimental evidence provided by Cohn et al. (2014) suggest that bankers appear to have non-monetary motivations. The authors explore the honesty of bankers compared to people in other professions. Subjects were given strong monetary incentives to be dishonest, and while the degree of dishonesty among bankers appeared to increase when they were reminded of their profession, they nevertheless did not maximize profit; a finding inconsistent with bankers as the purely selfish "economic man".[3] To boot, much experimental and empirical evidence suggests that many people are motivated by reciprocity.[4] We attribute such motivation to bankers and explore what this implies.

Section 2 introduces the game form on which our analysis builds. Section 3 introduces reciprocity and derives main results. Section 4 considers variations. Section 5 revisits and expounds on the issue of monitoring (by depositors or the FDIC). Section 6 concludes.

2 Setting the stage

Diamond and Dybvig's classic model of bank runs trivializes bankers' choice of risk; given \$1 of deposits there is a sure-fire way of investing, which yields return $R > 1$ for sure, with a delay. The interesting part of their analysis instead concerns coordination intricacies that occur when a collective of depositors consider withdrawing deposited funds. We shift focus, abstracting away from bank run coordination while making bankers' choice of risk non-trivial. We attempt to formulate the simplest structure rich enough to highlight key economic insights that emerge. The benchmark case has just one depositor, and a banker with some freedom to control the riskiness of investment.[5]

Consider a customer and a bank who engage in a three-stage game. The

[3] In the experiment, subjects privately tossed a coin 10 times and self-reported the results to the experimenter. Subjects were informed prior to reporting their results that particular flips ('heads' or 'tails') that they reported would pay out \$20. The bankers whose identities were made salient reported a 'successful' flip 58% of the time, statistically significantly more than the expected 50% associated with honest reporting, but way less than the 100% they would have chosen had they maximized profit.

[4] For relevant reviews, see e.g. Fehr and Gächter (2000) or Sobel (2005).

[5] An extension in section 4.2 allows for more depositors, but the purpose is to explore how this influences the bankers' incentives and we still abstract away from withdrawal panics.

customer is initially endowed with $\pi < 1$ units of money. In the first stage, the customer faces the decision of whether or not to deposit her endowment in the bank. If the customer chooses not to deposit then the game ends; the payoff to the customer is π, and the payoff to the bank is 0. If the customer chooses to deposit, then in the second stage the bank may invest in a risky asset. There is a continuum, $[0, 1]$, of possible assets available to the bank. If the bank invests the deposit in asset $x \in [0, 1]$, then in the third stage the asset pays 0 (fails) with probability x, and pays $1 + Kx$ (succeeds) with probability $1 - x$ where $K > 0$. Thus, a higher x increases the potential return of the asset, but also increases the likelihood with which the asset fails. For this reason, x may be thought of as the level of risk undertaken by the bank.[6]

If the customer deposits, the bank pays the customer an interest payment of $1 - \pi$; the customers' payoff is then: $\pi + (1 - \pi) = 1$. If the asset fails, the bank becomes insolvent and is unable to meet its obligation to the customer. We assume that it then goes bankrupt, and that the payoff to the bank is zero. The payoff to the customer is $a \in [0, 1]$. The parameter a represents the degree to which the customers' deposit is insured. We will examine both the case where $a = 0$ (no deposit insurance) and the case where $a > 0$ (the deposit is partially or fully insured). If the customer deposits and the asset is successful, the bank keeps the residual earnings, Kx, as profit.

Figure 1 shows the resulting game. We first analyze it under classical assumptions, focusing on sub-game perfect equilibrium. If the bank chooses risk level $x \in [0, 1]$ the probability of success is $1-x$ and its payoff in the event of success is Kx, so that the expected payoff is $(1 - x)Kx$. Thus, the bank

[6] By "risk" we do not mean the variance of the payout of the asset. The payout of the asset choice $x = 1$, for instance, has zero variance since it pays nothing with probability one. Rather, we mean that higher values of x carry a greater chance of insolvency.

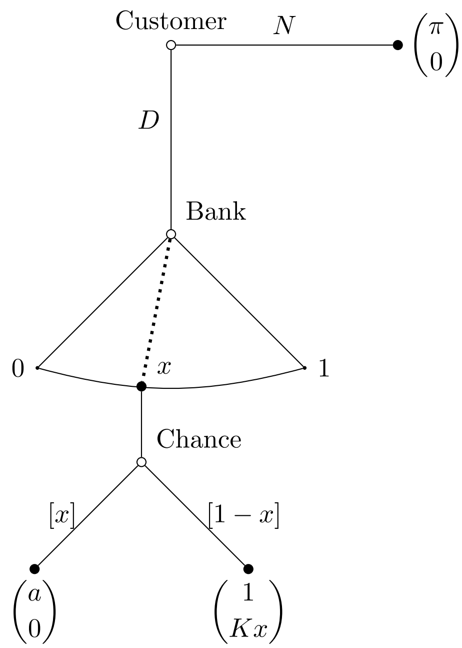

Figure 1: Game Schematic

solves:

$$\max_{x \in [0,1]} (1-x)Kx$$

so the profit-maximizing asset is $x^b = \frac{1}{2}$. Should the customer deposit, her expected payoff would thus be $\frac{1}{2}a + \frac{1}{2} = \frac{a+1}{2}$. Hence, if $\pi > \frac{a+1}{2}$, in equilibrium, the customer does not deposit, whereas if $\pi < \frac{a+1}{2}$ the customer deposits.

Notice that the equilibrium amount of risk taken by the bank does not depend on the degree to which the customers' deposit is insured (i.e. on a). Since a affects only the customers' payoff and not the bank's, in our model, classical theory suggests no connection between the bank's asset choice and the presence or absence of DI.

In Section 3, we instead take a "non-classical" approach. Before proceeding, it will be useful to define a notion of social welfare, which we define to be equal to the total surplus generated. So, if the customer deposits and asset x is chosen, welfare is given by:

$$W(x) = (1 - x)(1 + Kx)$$

Maximizing $W(x)$, we find that the socially optimal asset is $x^s = \max\{\frac{K-1}{2K}, 0\}$. Note that for all K it holds that $x^s < \frac{1}{2}$. Interpreting x as the level of risk undertaken by the bank, it is clear that the bank takes on more risk than is socially optimal. Also note that the customer's payoff is strictly decreasing in x. From his perspective the best choice of x is $x^c = 0$. For any $K > 1$, it holds that $x^s > x^c$. This leads to three distinct benchmark choices: x^c, x^s, and x^b where for all K, $x^c \leq x^s < x^b$ and for $K > 1$ all inequalities are strict.

3 Reciprocity and deposit insurance

We now proceed with our analysis assuming that the bank has a preference for reciprocity. Across sections 3.2-3.4 we explore what happens with three different degrees of DI: none, partial, and full. Before that, in an effort to make the paper self-contained, we provide a brief introduction to D&K's model. We cover formalities only as far as needed to handle our specific games. Readers interested in a more general treatment are referred to D&K.

3.1 D&K's reciprocity model

In this section, as well as in sections 3.2-3.3, we focus on the case of less than full DI, so that $a < \pi$. When $a \geq \pi$, the application of D&K's theory differs in technical details while being similar in spirit, as we explain in section 3.4.

We start by providing a general description of the bank's utility function according to D&K's reciprocity model. Let $s \in \{D, N\}$ denote an action for the customer, where D is deposit, and N is not deposit. Also, let $x \in [0,1]$ denote an asset choice made by the bank, in the event the customer deposits. In classical theory, given s, and x, one could easily calculate the utility level of the bank. However, a key feature of D&K's model is that a reciprocally-motivated player's utility depends, not only on the actions taken in the game, but also on the player's beliefs about the intentions of others.[7]

Should she choose to deposit, the customer's kindness to the bank depends on how much she thinks her decision benefits the bank, which depends on the asset she believes the bank will choose (the customer's "first-order belief"). The bank cannot observe the customer's first-order belief, and therefore, it does not know the customer's "true" kindness. So, the bank forms a (point) belief, denoted $x'' \in [0,1]$, about the customer's belief; this is the bank's "second order belief". When the customer deposits, the bank's utility then depends on both its action, x, as well as its belief, x''; it is defined as follows:

$$U_B(D, x, x'') = m_B(D, x) + Y \cdot \kappa(x) \cdot \lambda(x'')$$

The term, $m_B(D, x)$ is the material payoff earned by the bank, Y is a parameter reflecting the bank's sensitivity to reciprocity, κ is a real-valued function of the bank's asset choice, and it captures the bank's kindness to the customer. λ is a real-valued function of the bank's second-order belief, and it captures the bank's (point) belief about the customer's kindness. $\kappa(x)$ is positive (negative) if the bank is kind (unkind) to the customer. Similarly, $\lambda(x'')$ is positive (negative) if the bank *believes* the customer was kind (unkind)

[7]This reflects how reciprocity theory is formulated within the framework of so-called psychological game theory (cf. Geanakoplos et al., 1989; Battigalli and Dufwenberg, 2009).

to the bank. Reciprocity is captured by the fact that, all else equal, the bank will want to be kind (unkind) to the customer if it believes the customer was kind (unkind).

We now provide definitions for the functions κ and λ. When the customer deposits and the bank chooses the asset, x, $\kappa(x)$ is defined as the difference between the expected material payoff the bank will give the customer by choosing x, and the "equitable payoff" of the customer. The equitable payoff of the customer is a number, defined as the average of the maximum and minimum payoffs the bank can give the customer when the customer deposits. Note, however, that any x greater than the profit-maximizing asset choice of $\frac{1}{2}$ is strictly worse for both the bank and the customer than choosing $x = \frac{1}{2}$. So, when making this calculation we restrict attention to $x \in [0, \frac{1}{2}]$, as any $x > \frac{1}{2}$ is sub-optimal for both parties.[8] Let m_C^e denote the equitable payoff of the customer when depositing. Also, let $m_C(D, x) = xa + (1 - x)$ denote the payoff to the customer when she deposits and the bank chooses x. Then,

$$m_C^e = \frac{1}{2}\left(\max_{x\in[0,\frac{1}{2}]}\{m_C(D, x)\} + \min_{x\in[0,\frac{1}{2}]}\{m_C(D, x)\}\right) \tag{1}$$

Finally, when the customer deposits, and the bank chooses x, the kindness of the bank to the customer, $\kappa(x)$, is defined as follows:[9]

$$\kappa(x) = m_C(D, x) - m_C^e \tag{2}$$

[8]In D&K's reciprocity theory any $x > \frac{1}{2}$ is called "inefficient", which requires a cumbersome definition. We avoid this detail here, but for a discussion of efficient strategies, and their relevance in other contexts, see D&K pp. 275-277

[9]Readers familiar with D&K's theory will know that, in many games, a player's kindness may depend not only on his feasible choices but also on his beliefs about other players' choices. This does not happen in our game (which simplifies our notational task) because no player (except chance) moves after the bank. As will be seen shortly, we will, however, need to consider certain beliefs when we define λ.

Recall that, for a given second-order belief, x'', $\lambda(x'')$ is the bank's (point) belief about the customer's kindness. Before defining this term, it will be instructive to derive the customer's "true" kindness. The customer's kindness depends on the customer's (point) belief about the bank's asset choice. Denote this belief by x'. The customer's kindness is defined as the difference between the material payoff the customer believes she gives the bank when she deposits, and her belief of the equitable payoff of the bank. The customer's belief of the equitable payoff of the bank, denoted $m_B^e(x')$, is the average of the maximum and minimum payoffs the customer believes she could give the bank:

$$m_B^e(x') = \frac{1}{2}\left(\max_{s\in\{D,N\}} \{m_B(s,x')\} + \min_{s\in\{D,N\}} \{m_B(s,x')\} \right)$$

Then, the kindness of the customer when she deposits and believes the bank will choose x' is:

$$m_B(D,x') - m_B^e(x')$$

The bank cannot directly observe the customer's kindness since it does not know the customer's belief, x'. So, the bank forms a (point) belief, x'', about the customer's (point) belief, x'. We let $m_B^e(x'')$ denote the bank's belief of its equitable payoff and define this term:

$$m_B^e(x'') = \frac{1}{2}\left(\max_{s\in\{D,N\}} \{m_B(s,x'')\} + \min_{s\in\{D,N\}} \{m_B(s,x'')\} \right)$$

Finally, $\lambda(x'')$, the bank's belief about the customer's kindness, is defined:

$$\lambda(x'') = m_B(D,x'') - m_B^e(x'')$$

Notice that $\lambda(x'')$ takes an analog mathematical form as the customer's kindness. The former depends on the customer's belief about x, while the latter depends upon the bank's belief about the customer's belief about x.

D&K's equilibrium concept is called sequential-reciprocity equilibrium (SRE). It requires that players maximize utility in each stage, given their beliefs, which are correct. If there are no concerns for reciprocity ($Y = 0$) then SRE coincides with subgame perfection (with an explicit account of beliefs to boot).

3.2 No deposit insurance ($a = 0$)

We first address the case where the customer's deposit is uninsured, $a = 0$. Using the definition in (1), the equitable payoff of the customer is given by:

$$m_C^e = \frac{1}{2}\left[m_C(D,0) + m_C\left(D, \frac{1}{2}\right)\right] = \frac{1}{2}\left(1 + \frac{1}{2}\right) = \frac{3}{4}$$

Using the definition in (2), the kindness of the bank to the customer from choosing x is:

$$\kappa(x) = m_C(D,x) - m_C^e = 1 - x - \frac{3}{4} = \frac{1}{4} - x$$

Next, calculate the bank's belief about the kindness of the customer when she chooses to deposit. Recall, x'' is the bank's second-order belief. Consider the belief held by the bank about its equitable payoff. The customer's least kind choice is to not deposit; this gives the bank a payoff of 0. The customer's kindest choice is to deposit; she believes this gives the bank $Kx'(1 - x')$. The average is the equitable payoff for the bank, equal to $\frac{1}{2}Kx'(1 - x')$. We can define the bank's belief about this number, i.e. the bank's belief about its equitable payoff:

$$m_B^e(x'') = \frac{1}{2}(0 + Kx''(1 - x'')) = \frac{1}{2}Kx''(1 - x'')$$

When the customer deposits, the bank's belief about the material payoff the customer is giving to the bank is $m_B(D, x'') = Kx''(1 - x'')$. The second-order belief held by the bank about the kindness of the customer now is:

$$\lambda(x'') = m_B(D, x'') - m_B^e = Kx''(1 - x'') - \frac{1}{2}Kx''(1 - x'') = \frac{1}{2}Kx''(1 - x'')$$

Given x'', the utility to the bank when choosing x is:

$$U_B(D, x, x'') = m_B(D, x) + Y \cdot \kappa(x) \cdot \lambda(x'') = Kx(1-x) + Y\left(\frac{1}{4} - x\right)\left(\frac{1}{2}Kx''(1-x'')\right)$$

The bank takes its belief, x'', as given and chooses $x \in [0, 1]$ to maximize its utility. $U_B(D, \cdot, x'')$ is strictly concave; hence, the first-order condition is sufficient to characterize the bank's optimal asset choice. It is:

$$1 - 2x^* - Y\frac{1}{2}x''(1 - x'') = 0$$

In any SRE, the second-order belief must be correct, and hence $x'' = x^*$. So, the first-order condition becomes

$$1 - 2x^* - Y\frac{1}{2}x^*(1 - x^*) = 0$$

Solving for x^* we obtain the bank's optimal asset choice:

$$x^* = \frac{4 + Y - \sqrt{16 + Y^2}}{2Y} \tag{3}$$

To provide some intuition, suppose the bank holds second order belief $x'' > x^*$, which is close to the material payoff maximizing choice of $\frac{1}{2}$. Such a choice would be particularly good for the bank (as it provides a high material payoff), but it is bad for the customer. Given this belief, the bank thinks the customer is being very kind; affording the bank a high material payoff when she deposits. As a result, the bank would not make its asset choice equal to x'', but rather take on less risk in order to reciprocate the customer's kindness. This would mean the bank's second-order belief were incorrect; hence, such a belief could not be part of a SRE.

On the other hand, suppose the bank held the second-order belief $x'' < x^*$, which is close to zero. Such an asset would be particularly good for the customer, but give the bank a low material payoff. When the bank holds this belief, a deposit decision is not perceived as particularly kind since the bank thinks the customer is not expecting the bank to earn a high material payoff. The bank would have less reason to be kind to the customer (than in the case where x'' were higher), and so choose a higher level of risk. The equilibrium asset choice balances the bank's belief about the customer's kindness with its desire to reciprocate; when the bank holds the second-order belief, $x'' = x^*$, it chooses optimally and has correct beliefs.

The payoff to the customer, should she deposit, is $1 - x^*$. Hence, the customer will choose to deposit if $1 - x^* > \pi$. Plugging the expression for x^* into this inequality, we find that the customer chooses to deposit if:

$$Y > \frac{2(2\pi - 1)}{\pi(1 - \pi)} \tag{4}$$

This leads to our first observation (all proofs are contained in the appendix):

Observation 1. *In an SRE, the bank's asset choice, given by (3), is strictly* *decreasing in Y, approaches zero as Y becomes large, and approaches the profit-maximizing level as Y approaches zero. The customer deposits if $\pi < \frac{1}{2}$, or if Y is sufficiently large (see (4)).*

To provide intuition for Observation 1, note that when the customer deposits she has done something nice for the bank. She has provided an opportunity to generate profit, something which she would have denied the bank had she not deposited. When the bank has a preference for reciprocity, it will want to reciprocate this kindness. Since the customer's payoff is decreasing in the risk taken by the bank, this preference for reciprocity leads the bank to take on less risk than the profit-maximizing level. As the bank's sensitivity to reciprocity increases, it will wish to be kinder and kinder to the customer when she deposits. This leads the bank to take on less and less risk.

As the bank's sensitivity to reciprocity approaches zero, its reciprocity payoff becomes irrelevant as compared to its material payoff. As a result, the bank's asset choice will approach the profit-maximizing level of $\frac{1}{2}$. On the other hand, as the bank's sensitivity to reciprocity becomes large, its material payoff becomes irrelevant compared to its reciprocity payoff. As a result, the bank's optimal asset choice will approach the asset choice which is best for the customer. Note, however, that an asset choice of $x = 0$ could never be part of an SRE. To understand this, suppose the bank holds the corresponding second-order belief, $x'' = 0$. When the customer deposits the bank believes the customer believes the bank will choose to give itself zero profit. The decision to deposit would therefore not be construed as kind since the bank believes the customer thinks she is giving the bank nothing! The bank would therefore not wish to be so kind and would want to deviate to a higher level of risk.

We now discuss the welfare implications of reciprocity. Recall that when the bank acts as a profit-maximizer, its asset choice is more risky than is socially optimal. Observation 1 demonstrates that a bank motivated by reciprocity takes on less risk than the profit-maximizing level. So long as the bank's preference for reciprocity is not too large, this leads to a welfare improvement as compared to the case where the bank has selfish preferences. Before stating our next observation, suppose $K > 1$ and consider the following bound on the bank's sensitivity to reciprocity:

$$Y < \frac{8K}{K^2 - 1} \tag{5}$$

Observation 2. *If $K < 1$ or if Y is sufficiently small (the precise bound is given by (5)) then equilibrium welfare is increasing in Y.*

Figure 2 shows overall welfare as a function of the bank's risk choice when $K = 2$. The profit-maximizing choice is $x = \frac{1}{2}$ and welfare is maximized at $x = \frac{1}{4}$. Observation 2 says that welfare is increasing in Y so long as Y is sufficiently small. When $K = 2$, this occurs when $Y < \frac{16}{3}$. Examining Figure 2, $Y < \frac{16}{3}$ means $x^* > \frac{1}{4}$. In this case, a small increase in Y moves us closer to the welfare-maximizing level, and increases overall welfare (since x^* is decreasing in Y). Note, however, that in this example welfare is higher than the profit-maximizing level, for any $Y > 0$.

3.3 Partial deposit insurance ($0 < a < \pi$)

Suppose that an outside agency insures part of the customer's deposit: if the customer deposits and the asset fails then the payoff to the customer is $a \in (0, \pi)$. The insurance program is financed entirely by the bank. The observability of x by the insurance agency is a critical determinant in how the bank will be charged for the insurance. In this section it is assumed that

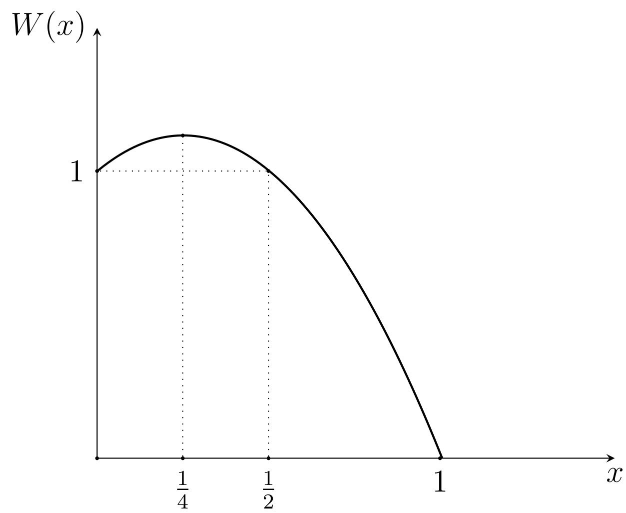

Figure 2: Welfare for $K = 2$. The bank's profit-maximizing asset choice is $x^b = \frac{1}{2}$. The socially optimal asset choice is $x^s = \frac{1}{4}$. For $0 < Y < \frac{16}{3}$, the bank's optimal asset choice satisfies, $\frac{1}{4} < x^* < \frac{1}{2}$.

x is unobservable by the insurance provider; the fee charged to the bank is therefore independent of its asset choice. For simplicity, we take this fee as sunk.[10] One may think of this version of the model in the following way: prior to the interaction between the bank and customer, the bank pays a fixed fee to participate in the insurance program. Thus, at the time of customer-bank interaction, this cost does not affect the incentives of the bank. For ease of analysis, we therefore leave the material payoffs of the bank unchanged from the case with no deposit insurance. In section 4.1 we examine a version of the model in which the bank's asset choice is observable by the insurance provider, and the fee paid by the bank may depend on this choice of asset.

Now, suppose the customer deposits and the bank chooses $x \in [0, \frac{1}{2}]$.[11]

[10] One could envision an alternative formulation in which the bank could choose whether or not to pay F and enter in the first place. That formulation would not change the nature of play following a decision to enter. For simplicity, we abstract away from this consideration.

[11] Recall from section 3.1 that any asset choice greater than $\frac{1}{2}$ is ignored for the purposes

The payoff to the customer is then $m_C(D, x) = ax + 1 - x$. Since $a < \pi < 1$, $m_C(D, \cdot)$ is strictly decreasing. Hence, the equitable payoff of the customer is the average of her payoff when the bank chooses $x = 0$ and her payoff when the bank chooses $x = \frac{1}{2}$. Hence:

$$m_C^e(x) = \frac{1}{2}\left(1 + \frac{1}{2}a + 1 - \frac{1}{2}\right) = \frac{3+a}{4}$$

If the bank chooses $x \in [0, \frac{1}{2}]$ then its kindness to the customer is:

$$\kappa(x) = m_C(x) - m_C^e(x) = ax + 1 - x - \frac{3+a}{4} = \left(\frac{1}{4} - x\right)\left(1 - a\right)$$

Let x'' be the second-order belief held by the bank about its asset choice if the customer deposits. Recall that the material payoffs of the bank are unchanged from the case with no deposit insurance. It therefore follows that the bank's belief about the kindness of the customer should she choose to deposit, $\lambda(x'')$, is unchanged from the section with no deposit insurance:

$$\lambda(x'') = \frac{1}{2}Kx''(1 - x'')$$

Thus, when the customer deposits the bank solves the following problem:

$$\max_{x\in[0,1]} Kx(1-x) + Y\left(\frac{1}{4} - x\right)\left(1 - a\right)\frac{1}{2}Kx''(1 - x'')$$

The maximand above is strictly concave in x; thus, the optimal choice of x is characterized by the first-order condition. Using the fact that in a SRE we must have $x'' = x^*$ it becomes:

of utility calculations.

$$x^* = \frac{4 + Y(1-a) - \sqrt{16 + Y^2(1-a)^2}}{2Y(1-a)} \tag{6}$$

Given such second-stage behavior of the bank, the customer will deposit if:

$$ax^* + 1 - x^* > \pi$$

Substituting 6 into this inequality, we see that the customer deposits if:

$$Y > \frac{2\left[2\pi - (1+a)\right]}{(1-\pi)(\pi - a)} \tag{7}$$

Observation 3. *With $a \in (0, \pi)$, the bank's asset choice, given by (6), is strictly decreasing in Y, approaches zero as Y becomes large, and approaches the profit-maximizing level as Y approaches zero. For fixed Y, the bank's asset choice is strictly increasing in a. Finally, the level of risk taken on by the bank is strictly greater than in the absence of deposit insurance.*

Observation 3 shows that the bank takes on more risk in the presence of DI than when the customer's deposit is not insured. Intuitively, in the absence of DI the bank takes on less risk (than the profit-maximizing level) in order to reciprocate the customer's kind action of depositing; by taking on less risk, the bank decreases the likelihood of insolvency and increases the expected return to the customer. DI protects the customer in the event of insolvency, and reduces the amount of harm the bank will cause the customer when it takes on more risk. This decreases the incentive of the bank to hold back on risk taking as compared to the case where the deposit is uninsured. As a increases, the customer is afforded more protection in the event of insolvency and this leads to additional risk taking by the bank. Still, note that for any $a < \pi$ the amount of risk undertaken by the bank is less than if the bank acted as a profit-maximizer.

Our final observation in this section examines the welfare impact of DI. We assume that the lump-sum fee paid by the bank is a transfer of wealth and does not affect welfare. Similarly the amount, a, paid to the customer by the insurance agency if the asset fails, is a transfer of wealth from the insurance agency to the customer and does not affect welfare.

Observation 4. *If Y is sufficiently small (the precise bound is given by (5)) then equilibrium welfare is strictly decreasing in the degree to which the customer's deposit is insured, a.*

To understand Observation 4 recall the result discussed in Observation 2 with no DI. The bank's preference for reciprocity leads it to take on less risk than in the case where the bank had selfish preferences. For Y sufficiently small, this decrease in risk-taking increases welfare. Introducing DI leads the bank to take on more risk than without DI, and so decreases welfare.

3.4 Fully insured deposit ($a \geq \pi$)

When $a \geq \pi$ the full amount of the customer's initial deposit, π, is insured. Therefore, the customer is weakly better off depositing than not depositing, regardless of the bank's asset choice. Moreover, the bank is always better off when the customer chooses to deposit. Therefore a decision not to deposit seems quite unreasonable when $a \geq \pi$. In essence, the customer faces no trade off between depositing and not depositing. It's better for everyone, no matter what the bank does, when the customer deposits.

Under these circumstances, a decision to deposit by the customer is no longer perceived as a kind (or unkind) action by the bank in the D&K model;[12]

[12] Technically, the decision to not deposit is no longer (what D&K call) an efficient strategy

the kindness of the customers is zero. Since the customer is neither kind nor unkind to the bank when she deposits, the bank will act as if it is profit-maximizing. This leads to our next observation:

Observation 5. *If $a \geq \pi$ then there is a unique SRE in which the customer deposits and the bank chooses the profit-maximizing asset.*

Observation 5 is straightforward, but the implication nevertheless significant. When the customer's initial deposit is fully insured, the insurance program counteracts any incentive provided by reciprocity for the bank to hold back on its risk-taking. While the bank may be motivated by reciprocity, its behavior is no different from that of a profit maximizer. This result may provide a partial explanation for the casual observation that banks maximize profit with little regard for the well-being of their customers.

4 Extensions

We next consider two variations of the model presented above. We first examine an environment in which the insurance provider observes the amount of risk taken on by the bank. We then examine versions of the model with an arbitrary number of customers.

4.1 Observable asset choice

The previous analysis assumes that the risk taken on by the bank is unobservable by the insurance provider. In practice, fees paid by members of the FDIC partially depend upon the amount of risk a member bank undertakes. In this

for the customer. As mentioned in section 3.1 we refer an interested reader to D&K for a thorough treatment of efficient strategies.

section, we assume that x is costlessly observed by the insurance provider. The insurance provider then charges the bank a fee that depends on its asset choice. Let $C(x)$ be the fee paid by the bank when it chooses asset x. It is assumed that the bank only pays this fee in the event that the customer deposits and the asset is successful. If the customer does not deposit then the bank has taken on no risk and therefore is not charged. If the customer does deposit but the asset fails, it's assumed that a limited liability rule applies and the bank is not forced to pay the fee.[13]

The insurance agency wishes to remain budget balanced (in expectation). If the bank chooses x, the expected cost to the agency is ax while the expected payment to the agency is $(1-x)C(x)$. Budget balancedness therefore implies that for all $x : (1-x)C(x) = ax$. Hence, $C(x) = \frac{ax}{1-x}$. In this section, we assume that $K > 1$ and allow for any $a \in [0, 1]$.[14]

The profit maximizing choice of x then solves solves:

$$\max_{x \in [0,1]} (1-x)\left(Kx - \frac{ax}{1-x}\right)$$

It is easily verified that the profit-maximizing choice of x is $\hat{x}^b = \frac{K-a}{2K}$ (which is positive since $K > 1 \geq a$).

Any choice of $x > \hat{x}^b$ gives both the bank and the customer a strictly lower material payoff than $x = \hat{x}^b$. So, for the purposes of utility calculations, we restrict attention to $x \in [0, \hat{x}^b]$.[15] Modifying the definition given in (1), the

[13] This limited liability rule imposed is innocuous. The analysis is unchanged if the bank must pay the fee even in the event of asset failure, provided the fee is actuarially fair.

[14] When x is non observable and $a \geq \pi$ (i.e. section 3.4) a decision not to deposit is inefficient. In this section, this is not true. The reason is that the bank is not *necessarily* better off when the customer deposits. If, for instance, the customer deposits and the bank chooses x close to 1, its payoff would be negative, and it would have been better off if the customer did not deposit.

[15] As defined in D&K, any $x > \hat{x}^b$ is inefficient. See footnote 8.

equitable payoff of the customer is given by:

$$m_C^e \equiv \frac{1}{2}\left(\max_{x\in[0,\hat{x}^b]}\{m_C(D,x)\} + \min_{x\in[0,\hat{x}^b]}\{m_C(D,x)\}\right)$$

Since the customer's payoff is decreasing in x when she deposits, it follows that

$$m_C^e = \frac{1}{2}\left[m_C(D,0) + m_C(D,\hat{x}^b)\right] = \frac{1}{2}\left[1 + ax^b + 1 - \hat{x}^b\right]$$

The kindness of the bank to the customer is then given by:

$$\kappa(x) = ax + 1 - x - \frac{1}{2}\left[1 + a\hat{x}^b + 1 - \hat{x}^b\right]$$

Plugging in for $\hat{x}^b$ and re-arranging it follows that

$$\kappa(x) = (a-1)\left(x - \frac{K-a}{4K}\right)$$

Now, if the bank holds the second-order belief x'', then the material payoff the bank believes the customer believes she is giving the bank when she deposits is $m_B(D,x'') = (1-x'')\left(Kx'' - \frac{ax''}{1-x''}\right)$. By not depositing, the customer gives the bank 0. Hence, the equitable payoff of the bank is $\frac{1}{2}m_B(D,x'')$. So, the bank's belief of the kindness of the customer is $\lambda(x'') = m_B(D,x'') - m_B^e(x'') = \frac{1}{2}m_B(D,x'')$. Thus,

$$\lambda(x'') = m_B(D,x'') - m_B^e(x'') = \frac{1}{2}(1-x'')\left(Kx'' - \frac{ax''}{1-x''}\right)$$

So, the bank solves the following problem:

$$\max_{x\in[0,1]}\ (1-x)\left(Kx-\frac{ax}{1-x}\right)+\frac{1}{2}Y\left[(a-1)\left(x-\frac{K-a}{4K}\right)\right]\left[(1-x'')\left(Kx''-\frac{ax''}{1-x''}\right)\right]$$

Taking the first-order condition and using the fact that in any SRE $x''=x$ we obtain the optimal choice of x:

$$x^*=\frac{4K+Y(1-a)(K-a)-\sqrt{16K^2+Y^2(1-a)^2(K-a)^2}}{2YK(1-a)} \tag{8}$$

Given the second-stage behavior of the bank following a decision to deposit, the customer deposits only if $ax^*+1-x^*\geq\pi$. This leads to our next observation:

Observation 6. *When DI is financed via a variable charge, the bank's equilibrium asset choice (given by 8) is strictly decreasing in Y, approaches zero as Y becomes large, and approaches the profit-maximizing level as Y approaches zero. In the equilibrium, the customer deposits if Y is sufficiently large.*

This observation shows that the comparative statics with respect to the bank's reciprocity sensitivity are consistent with the model where x is unobservable. In contrast, the relationship between the optimal asset choice and the degree to which deposits are insured is less clear in this version of the model.

Observation 7. *When DI is financed via a variable charge, the bank's optimal asset choice may be increasing or decreasing in a. If $Y>4$ then the bank's equilibrium asset choice is strictly increasing in a for a sufficiently small.*

When DI is financed via a variable charge, an increase in a has two competing effects. First, it provides additional protection to the customer and decreases the amount of harm the bank can inflict when she takes on more risk; this leads the bank to desire a higher x. However, an increase in a also increases the material cost of taking on more risk, since, for any x, the fee paid by the bank is increasing in a. Observation 7 shows that when the bank's sensitivity to reciprocity is sufficiently large, the reciprocity effect dominates the material effect for small values of a.

4.2 Multiple customers

In this section, we consider versions of the model with $n \geq 1$ identical customers, each of whom makes their deposit decision simultaneously. We assume that the bank's preference for reciprocity is the same with respect to each of its customers and that the bank's asset choice is unobservable by the insurance provider.

There are two distinct ways in which additional customers may be introduced. First, one could consider a version in which we introduce many customers, each of whom is endowed with π units of money at the start of the game. This version of the model may be thought of as an expansion in the size of the bank; not only do we have more customers, but the bank now has a larger volume of deposits. Under such bank expansion, it can easily be shown that the bank's optimal asset choice is independent of the number of customers. Moreover, our results from sections 3.2 - 3.4 remain completely unchanged. Intuitively, the degree to which the bank would like to reciprocate depends on how kind the bank perceives each customer to be. The bank's belief of the kindness of each customer depends on the additional payoff it thinks each customer has chosen to give the bank by depositing. The "gift" given by each customer, when she chooses to deposit, is unchanged from the case of a single depositor. Hence, the degree to which the bank would like to reciprocate does not change. As a result, the bank's equilibrium asset choice does not depend on the number of customers.

Alternatively, one could consider a version of the model in which our previously single customer, with π units of money to deposit, is fragmentized into many customers while the total amount of money endowed in the economy is unchanged. That is, each of n customers is endowed with $\frac{\pi}{n}$ units of money. We first study the case where $a \in [0, \pi)$; the case where $a \geq \pi$ is similar in spirit but differs in its technical details and will be addressed later in this section. If the bank's asset fails, the payoff to any customer who deposited their endowment is $\frac{a}{n}$. Finally, if the bank's asset is successful then the payoff to the customer is $\frac{1}{n}$. If m customers deposit, and the asset is successful then the profit earned by the bank is $\frac{m}{n}Kx$.

Let $s_i \in \{D, N\}$ denote an action for customer i, and let $\mathbf{D} = (D, \cdots, D)$ denote the strategy profile of the customers corresponding to the case where all customers deposit. Let x_i'' the bank's second-order belief regarding customer i, and let $\mathbf{x}'' = (x_1'', \cdots, x_n'')$ denote the vector of second-order beliefs held by the bank. Let $\kappa_i(x)$ be the kindness of the bank to customer i when the bank chooses asset x, and let $\lambda_i(x_i'')$ be the bank's belief of the kindness of customer i. We begin by analyzing the bank's behavior when all customer's deposit. Following D&K, if all customer's deposit, the bank's utility is:

$$U_B(\mathbf{D}, x, \mathbf{x}'') \equiv m_B(\mathbf{D}, x) + Y \sum_i \kappa_i(x)\lambda_i(x_i'')$$

The functions λ_i and κ_i are defined in a similar manner as in the single customer case. Consider some customer i. If customer i deposits and the bank chooses some $x \in [0, 1]$ then the kindness of the bank to customer i is:

$$\kappa_i(x) \equiv m_i(D, x) - m_i^e$$

Here, $m_i(D, x) = x\frac{a}{n} + (1-x)\frac{1}{n}$ is the material payoff of customer i when the bank chooses x. m_i^e is the equitable payoff of customer i. As in the single customer case, $m_i^e = \frac{1}{2}\left[m_i(D, 0) + m_i\big(D, \frac{1}{2}\big)\right]$. Hence, the kindness of the bank to customer i is:

$$\kappa_i(x) = \frac{1}{n}(ax + 1 - x) - \frac{1}{2n}\left(1 + \frac{a+1}{2}\right) = \frac{1}{n}\left(\frac{1}{4} - x\right)(1-a)$$

Now, suppose that each of the other $n-1$ customers choose to deposit. If customer i does not deposit, then the bank believes i thinks the bank's payoff will be: $(1 - x_i'')\frac{n-1}{n}Kx_i''$. If i deposits, the bank believes i believes the bank's material payoff will be: $(1 - x_i'')Kx_i''$. The equitable payoff of the bank with respect to customer i is the average of these two material payoffs: $\frac{1}{2}\left[(1 - x'')\frac{n-1}{n}Kx_i'' + (1 - x_i'')Kx_i''\right] = \frac{1}{2n}Kx_i''(2n-1)(1-x_i'')$. If all customers deposit the bank's belief of the kindness of each customer i is then:

$$\lambda_i(x_i'') = (1 - x_i'')Kx_i'' - \frac{1}{2n}Kx_i''(2n-1)(1-x_i'') = \frac{1}{2n}Kx_i''(1-x_i'')$$

If each customer deposits then the bank's optimal asset choice solves:

$$\max_{x\in[0,1]}(1-x)xK + \frac{Y}{n^2}\sum_i\left[\left(\frac{1}{4} - x\right)(1-a)\right]\left[\frac{1}{2}Kx_i''(1-x_i'')\right]$$

The maximand above is strictly concave in x. Hence, the optimal asset choice is characterized by the first-order condition. Using the fact that in any

SRE we must have $x_i'' = x^*$ we thus obtain the bank's optimal asset choice:

$$x^* = \frac{4 + (\frac{Y}{n})(1-a) - \sqrt{16 + \left(\frac{Y}{n}\right)^2 (1-a)^2}}{2(\frac{Y}{n})(1-a)} \tag{9}$$

Given the behavior of the bank when each customer deposits, each customer will deposit in an SRE if $x^* \frac{a}{n} + (1-x^*)\frac{1}{n} > \pi$. Substituting our expression for x^* into this inequality we see that the customer deposits if:

$$Y > \frac{2n\left[2\pi - (1+a)\right]}{(1-\pi)(\pi - a)} \tag{10}$$

Observation 8. *For any fixed number of customers $n \geq 1$, the bank's equilibrium asset choice (given by 9) is strictly decreasing in Y, approaches zero as Y becomes large, and approaches the profit-maximizing level as Y approaches zero. For fixed Y, the bank's asset choice is strictly decreasing in a. In equilibrium, the customer deposits if Y is large enough (see (10))*

Observation (8) shows that in this version of the model the comparative statics results with respect to the sensitivity to reciprocity and a remain the same as in the single customer case. We now move on to investigate the impact on the bank's optimal asset choice.

Observation 9. *For fixed Y and a, the bank's equilibrium asset choice is strictly increasing in the number of customers and approaches the profit-maximizing level as the number of customers becomes large.*

Observation 9 demonstrates that as the degree of customer fragmentation increases, the bank takes on more risk. Intuitively, as n increases this decreases the stakes of the game; each customer has less money at risk. This decreases the harm the bank can cause each customer, and leads it to take on more risk. At the same time, however, the bank is inflicting harm on a larger group customers when it takes on risk; all else equal this would lead the bank to take on less risk. It turns out that the first effect always dominates the second. The reason is that the bank's utility is nonlinear with respect to the monetary stakes, but linear in the number of customers. As n increases, the stakes of the game diminish at the rate of $\frac{1}{n^2}$ while the number of customers grows at the rate n. As a result, the bank will take on additional risk as the customer base becomes more fragmentized. In essence, the bank is more comfortable causing a little harm to many customers than causing significant harm to a few customers. Our final observation considers the case where $a \geq \pi$.

Observation 10. *If $a \geq \pi$ then for any $n \geq 1$ there is a unique SRE in which each customer deposits and the bank chooses the profit-maximizing asset.*

As in the single-customer case, note that when $a \geq \pi$, choosing not to deposit is worse than depositing for both the customer and the bank. The logic of Observation 10 then follows exactly as in Observation 5. For this reason, we do not include a proof of this statement.

5 Deposit insurance, market discipline, and moral hazard

We now discuss a leading alternative theory, based on the relationship between DI, market discipline (MD) and moral hazard, and related empirical evidence. The essence of what we will refer to as the "market-discipline hypothesis" (MDH) is that, absent DI, customers have strong incentives to monitor the risk-taking of their banks. Moreover, customers may, through some means, induce their banks to take less risk than they would, otherwise. The introduction of DI protects customers in the event of insolvency, decreases incentives for the market to engage in costly monitoring activities, thereby leading banks to take on additional risk. Cooper and Ross provide a formal account of the MDH, but take for granted the ability of customers to observe/understand bank risk (market monitoring) and their ability to affect the bank's behavior (market influence). These abilities are essential for market discipline to be effective (Bliss and Flannery, 2002), and are therefore necessary conditions for the MDH. So, we begin our discussion by describing some of the relevant literature on MD (both market monitoring and influence). A more in-depth survey of this literature can be found in Demirgüç-Kunt and Kane (2002).

The typical study examines the relationship between proxies of bank risk-taking and either deposit growth, or interest rates (interest rates on deposits, yield spreads on subordinated debt, or spreads on new bond issues). A negative (positive) relationship is consistent with market participants that are at least able to understand measures of bank risk taking. Generally speaking, the evidence on MD appears to be mixed. Focusing on yield spreads on subordinated debt, a number of studies in the 1980s find little-to-no evidence in support of MD (e.g., Avery et al., 1988; Gorton and Santomero, 1990). Yet, also focusing on yield spreads on subordinated debt, evidence in support of MD was found in several studies from the 1990s and early 2000s (e.g., Flannery and Sorescu, 1996; Sironi, 2003).[16] Focusing on spreads of new bond issues, Morgan and Stiroh (2001) find that banks holding riskier portfolios tend to have greater spreads.

[16] Several authors, including Flannery and Sorescu and Sironi attribute the difference in these findings to a changing regulatory environment. In the early to mid 80s, they argue, implicit safety nets that protected holders of bank liabilities, and decreased incentives to monitor; these safety nets vanished in the late 80s and early 90s.

Yet at the heart of the MDH is whether bank managers actually *change* their behavior in response to, say, stock or bond prices. Bliss and Flannery specifically address this question and find no support, writing (p. 361): "Day-to-day market influence remains, for the moment, more a matter of faith than of empirical evidence." More recently, Berger and Turk-Ariss (2014), focusing on deposit growth, find a negative relationship between measures of risk and deposits leading up to the recent crisis, but no relationship during the crash.[17]

In addition to the ability of depositors to discipline their banks, the MDH also requires that MD weakens after the introduction of DI. In the affirmative, Demirgüç-Kunt and Huizinga study the connection between DI, measures of risk-taking, and interest rates on deposits; the authors find that the presence of DI makes interest rates less sensitive to risk. Furthermore, Ioannidou and Penas (2010) examine the riskiness of bank loan profiles before and after the introduction of DI in Bolivia. They show that, prior to the introduction of DI, banks with a high share of large depositors take less risk, but this effect disappears after DI is introduced. The authors explain this by arguing that large depositors have the greatest incentives (and ability) to monitor bank behavior; the introduction of DI then leads to a breakdown in MD, as these large depositors lose the incentive to monitor.[18] Martinez Peria and Schmukler (2001) study the relationship between the volume of deposits, interest rates on deposits, and bank risk taking in Argentina, Chile, and Mexico, and find no evidence that DI decreases MD. The authors point to two particular reasons why. The first reason is related to the credibility of the insurance provider;

[17]The lack of a significant relationship during the crash is attributed to government interventions in the market.

[18]Our results on customer base fragmentization (Section 4.2) also imply that banks with a high share of large depositors take less risk in the absence of DI. Our model predicts that this effect completely disappears if the DI program offers full coverage of deposits.

if the insurance provider lacks credibility, then DI need not lead to less MD. Second, insured depositors may wish to avoid any costly delays in the event their bank becomes insolvent.

Finally, even if depositors can monitor/influence their bank's behavior, and depositor discipline weakens after DI is introduced, the MDH still requires that government regulators do not share this same ability. Otherwise, DI would merely shift the burden of discipline from depositors to government agencies like the FDIC. Demirgüç-Kunt and Kane present evidence consistent with this conjecture. The authors study the relationship between DI and the stability of the banking system (as measured by the likelihood of a banking crisis). The authors find that the presence of DI is associated with more frequent crises, and that a crisis is more likely when the degree of coverage is higher (findings consistent with our results). However, it is also shown that in countries with better established regulatory institutions, the impact of DI is much less pronounced. Also speaking to this issue, Sironi (p. 446) writes, "...the available empirical research on the U.S. banking industry indicates that financial markets participants and bank supervisors both produce value-relevant information about the future soundness of banks and that neither the market nor supervisors possess clearly superior quality information."

All in all, on our reading, the evidence on monitoring is ambiguous enough to justify consideration of our alternative (or complementary) reciprocity-based account.

6 Concluding remarks

Empirically, there appears to be a connection between deposit insurance (DI), risk-taking, and insolvency. From the perspective of classical economic theory, at first glance this seems puzzling. If bankers decide how much risk to take on then DI should not affect their choice, since DI affects the payoffs of depositors and not that of bankers.

A commonly cited hypothesis contends that DI decreases customers' incentives to monitor their banks, and therefore leads to more risky bank behavior. One may, however, be skeptical of this idea because monitoring by the FDIC would seem to be an adequate substitute for depositor monitoring. Also, the empirical support for the monitoring hypothesis is not overwhelming (cf. section 5).

We propose an alternative, or complementary, theory. The observed connection between DI, risk taking, and insolvency can be explained if banks are motivated by reciprocity.

Some economists will find it hard to accept the notion that professional bankers would not have the pure objective to maximize profit. They may look back at recent market turmoil and interpret it in terms of greed & profit rather than quid-pro-quo reasoning. However, we defend our assumption in three ways: First, lots of recent experimental and empirical evidence suggests that many people are motivated by reciprocity (cf. footnote 4), and in this paper we allow ourselves to apply such an assumption to bankers to explore what it implies. Second, this assumption turns out to get the predictions right. Third, *with DI*, if bankers are motivated by reciprocity they do in fact appear to be all about greed & profit. That is, with DI, reciprocal bankers will act *as if* they maximized profit.

Appendix

Proof of Observation 1

Proof. The fact that there exists a unique SRE in which the customer deposits when Y exceeds the threshold in (4) is immediate. Multiplying the numerator and denominator of the expression for x^* by $\left(4+Y+\sqrt{16+Y^2}\right)$, it may easily be checked that we may re-write x^* as

$$x^* = \frac{4}{4+Y+\sqrt{16+Y^2}}$$

Examining this expression, it is clear that the bank's optimal asset choice is strictly decreasing in Y approaching 0 as $Y \to \infty$ and approaching $\frac{1}{2}$ (the profit-maximizing asset choice) as $Y \to 0$. Finally, since $\lim_{Y\to 0} x^* = \frac{1}{2}$ and x^* is strictly decreasing in Y it is clear that $x^* < \frac{1}{2}$ for all $Y > 0$.

□

Proof of Observation 2

Proof. When $K < 1$ welfare is strictly decreasing in x for all $x \in [0, 1]$. Since x^* is strictly decreasing in Y, the result immediately follows. If $K > 1$ then the socially optimal level of risk is $\frac{K-1}{2K} < \frac{1}{2}$. Clearly, welfare is strictly decreasing in x for all $x \in (\frac{K-1}{2K}, \frac{1}{2})$. It is easily verified that when the inequality given by (5) is satisfied, we have $x^* \in (\frac{K-1}{2K}, \frac{1}{2})$. Since x^* is decreasing in Y, the result follows.

□

Proof of Observation 3

Proof. Multiplying the numerator and denominator of $x^*(Y,a)$ by $\Big(4+Y(1-a)+\sqrt{16+Y^2(1-a)^2}\Big)$ we obtain:

$$x^*(Y,a) = \frac{4}{4+Y(1-a)+\sqrt{16+Y^2(1-a)^2}}$$

Since $a<1$ it is clear from this expression that $x^*(Y,a)$ is strictly decreasing in Y, approaching 0 as $Y \to \infty$ and approaching $\frac{1}{2}$, the profit-maximizing asset choice, as $Y \to 0$. It is also easily seen that the denominator in the expression above is strictly decreasing in a which means $x^*(Y,a)$ is strictly increasing in a. Finally, note that $x^*(Y,0)$ is the asset choice in the case where deposits are uninsured. Since $x^*(Y,a)$ is strictly increasing in a, clearly the bank takes on more risk than when the customer's deposit is uninsured. □

Proof of Observation 4

Proof. First note that $x^*(Y,0)$ corresponds to the bank's optimal asset choice when the customer's deposit is uninsured (this is the optimal asset choice from section 3.2). Then recall from the proof of Observation 2 that, for $Y \in (0,Y^*)$ we have $x^*(Y,0) > x^s$, where x^s is the welfare maximizing asset choice. Fix $Y \in (0,Y^*)$ and note that for any $a,a' \in (0,\pi)$ with $a'>a$, Observations 2 and 3 together imply $x^*(Y,a') > x^*(Y,a) > x^*(Y,0) > x^s$. By the strict concavity of $W(\cdot)$ we must have $W(x^*(Y,a)) > W(x^*(Y,a'))$.

□

Proof of Observation 5

Proof. When $a \geq \pi$, both the customer and the bank are weakly better off when the customer deposits for any asset choice $x \in [0, 1]$. Moreover, the bank is strictly better off when the customer deposits for any asset choice $x \in (0, 1)$. Thus, following D&K's definition of efficient strategies, not depositing is no longer an efficient strategy for the customer. It follows that, when the customer deposits, this action is neither perceived as kind nor unkind (so $\lambda(x'') = 0$), since depositing is the only efficient strategy. Therefore, the bank will choose the asset which maximizes its expected material payoff (profit). When the bank chooses the profit-maximizing asset, the customer is strictly better off depositing for any $a \geq \pi$. Hence, there is a unique SRE in which the customer deposits and the bank chooses the profit-maximizing asset.

□

Proof of Observation 6

Proof. Multiplying the numerator and denominator of (8) by

$$4K + Y(1-a)(K-a) + \sqrt{16K^2 + Y^2(1-a)^2(K-a)^2}$$

We obtain the equivalent expression:

$$x^* = \frac{4(K-a)}{4K + Y(1-a)(K-a) + \sqrt{16K^2 + Y^2(1-a)^2(K-a)^2}}$$

Since $a < 1 < K$ it is clear from this expression that x^* is strictly decreasing in Y, approaching 0 as $Y \to \infty$ and approaching $\frac{K-a}{2K}$, the profit-maximizing asset choice, as $Y \to 0$.

□

Proof of Observation 7

Proof. Differentiating $x^*(Y, a, K)$ with respect to a and evaluating at $a = 0$ we obtain:

$$\left.\frac{\partial x^*(Y, a, K)}{\partial a}\right|_{a=0} = \frac{(4K - Y)\sqrt{Y^2 + 16} + (Y^2 - 16K)}{2KY\sqrt{Y^2 + 16}}$$

Clearly $\left.\frac{\partial x^*(Y,a,K)}{\partial a}\right|_{a=0} > 0$ if and only if the numerator of the expression above is positive. Let $\Gamma(Y, K) \equiv (4K - Y)\sqrt{Y^2 + 16} + (Y^2 - 16K)$ (= the numerator in the expression above). It is easily verified that $\Gamma(Y, K)$ is strictly increasing in K for any $Y > 0$. Since $K > 1 \implies \Gamma(Y, K) > \Gamma(Y, 1)$. Finally, note that $\Gamma(Y, 1) > 0$ if and only if:

$$(Y - 4)\left[(Y + 4) - \sqrt{Y^2 + 16}\right] > 0 \iff Y > 4$$

Thus, if $Y > 4$ then for a sufficiently small $\frac{\partial x^*(Y,a,K)}{\partial a} > 0$. □

Proof of Observation 8

Proof. Multiply the numerator and denominator of (9) by

$$4 + \left(\frac{Y}{n}\right)(1 - a) + \sqrt{16 + \left(\frac{Y}{n}\right)^2 (1 - a)^2}$$

The remainder of the proof is analogous to the proofs of Observations 3 and 4.

□

Proof of Observation 9

Proof. Let $x^*(Y,a)$ denote the bank's optimal asset choice in the model examined in section 3.3 with a single customer. Examining our expression for $x_n^*(Y,a)$ it is clear that $x_n^*(Y,a) = x^*\left(\frac{Y}{n}, a\right)$. Letting $\hat{Y} \equiv \frac{Y}{n}$ we have,

$$\frac{\partial x_n^*(Y,a)}{\partial n} = \left(\frac{\partial x^*(\hat{Y},a)}{\partial \hat{Y}}\right)\left(-\frac{Y}{n^2}\right)$$

By observation 3 we know $\frac{\partial x^*(\hat{Y},a)}{\partial \hat{Y}} < 0$ which means $\frac{\partial x_n^*(Y,a)}{\partial n} > 0$. Finally, note that $\lim_{n\to\infty} x_n^*(Y,a) = \lim_{\hat{Y}\to 0} x^*(\hat{Y},a) = \frac{1}{2}$ by Observation 3.

□

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