Optimal Forbearance of Bank Resolution

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March 26, 2022

Abstract

This paper analyzes a regulator's optimal strategic delay of resolving banks when the regulator's announcement of the intervention delay endogenously affects the depositors' run propensity. Given intervention, the regulator either liquidates the remaining illiquid assets or continues managing the assets (suspension intervention) at a reduced skill level. In either case, I show the depositors may react to more conservative policy by preempting the regulator: the depositors run on the bank more often ex ante if the regulator tolerates fewer withdrawals until intervention. A policy of never intervening can leave the bank more stable than a conservative intervention policy.

Key words: Bank resolution, intervention delay, global games, regulatory forbearance, suspension of convertibility, bank run

JEL Classification: G28,G21,G33, D8, E6

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*Olin School of Business at Washington University in St Louis, lindas@wustl.edu. This paper developed during a stay at the Becker Friedman Institute for Research in Economics at University of Chicago in 2017. The hospitality and support of this institution is gratefully acknowledged. I thank Harald Uhlig, Mikhail Golosov, Andreas Neuhierl, Toni Ahnert, Benjamin Brooks, Edouard Challe, Zhiguo He, Joonhwi Joo, Michael Koetter, Eugen Kovac, Espen Moen, Raghuram Rajan, Philip Schnabl, Peter Sørensen, Jeremy Stein, Philipp Strack, and Ariel Zetlin-Jones for very insightful comments on the paper. This research was supported by a grant of the French National Research Agency (ANR), 'Investissements d'Avenir' (LabEx Ecodec/ANR-11-LABX-0047).

1 Motivation

Banking is a highly regulated industry. Bank runs and regulatory mechanisms for bank-run prevention have been extensively studied in the literature; see, for instance, Diamond and Dybvig (1983), Goldstein and Pauzner (2005) and Ennis and Keister (2009). Regulators not only set deposit insurance levels but also decide when to resolve banks (Martin et al., 2017). Once an institution is perceived as failing, the regulator, through its resolution authority (RA), can intervene, suspend the convertibility of deposits, and resolve the bank.

This paper analyzes how a regulator's intervention delay ("forbearance"), measured in terms of tolerated withdrawals until intervention, affects the depositors' propensity to run on the bank. I study intervention policies that maximize bank stability. Then, I discuss policies that maximize efficiency, that is, policies that maximize the bank's investment value, and how they deviate from stability-maximizing policies.

Studying such questions is important, because in the U.S., the FDIC Improvement Act of 1991 gives the FDIC the authority to close and take into receivership critically undercapitalized banks[1] within 90 days of sending a prompt corrective action (PCA) determination. With Title II of the Dodd-Frank Act, not only depository institutions but also systemically relevant non-depository institutions can be put under FDIC receivership for resolution according to the Orderly Liquidation Authority (OLA). Because bank resolution procedures can be very costly to the public (Granja et al., 2017; White and Yorulmazer, 2014), the FDIC is not obliged to protect uninsured creditors from bearing losses.[2] If debt is demandable, a creditor's anticipation of regulatory action can give the incentive to withdraw before the intervention occurs.

I employ a global-games information structure (Carlsson and Van Damme, 1993; Morris and Shin, 2001) and extend the Goldstein and Pauzner (2005) (GP) model, adding a strategic resolution authority (RA) and partial deposit insurance. Insurance is modeled as partial because unconditional insurance exists neither in the U.S. nor in Europe. Only

[1] A bank is critically undercapitalized if its ratio of tier 1 capital to total assets undercuts 2%. For further details, see Ragalevsky and Ricardi (2009).

[2] Given an intervention, the FDIC is required to apply the least costly resolution method to resolve small banks. Although insured deposits are guaranteed, under receivership, the FDIC is prohibited from protecting uninsured deposits if losses to the insurance fund would increase as a result. The value of uninsured deposits depends on whether the least costly option involves a bidder for the bank's assets who also assumes all or some of the deposits (Purchase and Assumptions Transaction) or whether the cost-minimizing option includes a deposit payoff with a bank liquidation. For large banks, the single point of entry strategy (SPOE) demands that claims of unsecured creditors incur a (partial) bail-in under receivership.

about 59% of U.S. domestic deposits are insured as of 2016; see appendices (FDIC, 2016). The model, however, also considers the limit to full insurance. Likewise, the model applies to the shadow banking sector and can guide regulation of money market mutual funds where debt is uninsured.

In the model, the RA announces and commits to her regulatory forbearance level, which pins down how many withdrawals she tolerates until intervening to resolve the bank. A high forbearance level corresponds to a lax intervention policy whereas a low forbearance level implies a conservative policy that tolerates only few withdrawals until intervention. The depositors perfectly observe the forbearance level, and after observing noisy private signals about the bank's asset quality, decide whether to roll over their deposit or to withdraw. The bank refinances withdrawals by selling assets until the aggregate withdrawals hit the RA's tolerated threshold. If the threshold is reached, the RA intervenes to stop the run, seizes the remaining assets, and imposes a mandatory deposit stay. Only a measure of depositors equal to the tolerated withdrawals may receive the face value of the deposit. Beyond that, all remaining depositors enter the mandatory deposit stay and receive a share of the proceeds that the RA realizes according to the applied resolution procedure. An interpretation for this mechanism is a bank's first-come-first-serve constraint that is interrupted by regulatory intervention. I analyze two distinct resolution procedures. First, I study PCA, where the RA liquidates all of the seized assets at the asset's liquidation value, and second, I study the "suspension intervention" where the RA intervenes to protect assets from liquidation and continues the asset's management until maturity, but at a reduced skill level. Inherent here is the assumption that the bank is an investment expert and that the regulator does not have the same expertise.

My main contribution, is the demonstration that bank resolution policies can backfire. I show that too conservative bank resolution policies cause preemptive depositor behavior. I show that preemptive behavior exists robustly across both resolution procedures and independently of the level of deposit insurance, as long as insurance remains partial. Therefore, some lax regulatory intervention can always improve bank stability in contrast to a laissez-faire policy where the regulator commits to never intervene. But if the regulatory intervention is too conservative, that is, if the RA tolerates too few withdrawals until intervention, the depositors withdraw for a wider signal range, the ex-ante run likelihood increases, and stability drops. That is, the run likelihood is a U-shaped function of the intervention delay. The depositors' preemptive behavior can be interpreted as a probabilistic form of front-running the regulator. Thus, the effectiveness of intervention policies is bounded, and the maximum bank stability is attained at an interior regulatory forbearance level. More conservative intervention can leave a bank less stable than lax intervention policies. In fact, conservative intervention can leave the bank less stable than a policy where the regulator commits to never intervene (laissez faire).

For intuition on the depositors' preemptive behavior, changes in regulatory forbearance have two opposing effects on the depositors' preferences, and these effects are robust across resolution procedures. As in many bank-run settings in the literature, the bank is obliged to liquidate illiquid assets for servicing withdrawals until the RA intervenes. Absent an intervention, higher withdrawals reduce investment and therefore the resources available to depositors who roll over. This payoff externality is standard in the literature (Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005) and gives rise to strategic complementarity in actions and therefore leads to bank runs. If many depositors fear that high withdrawals will occur to reduce the roll-over payoffs, these depositors withdraw, and thus cause a panic bank run. An intervention policy aims to lower the run incentive by bounding the payoff externality. The intervention limits the resources available to early-withdrawing depositors, and thus guarantees minimum resources to the depositors who roll over, thus, bounding their losses. The more regulatory forbearance is imposed, the more lax the intervention bounds the losses. Thus, as the first effect, if the RA pursues a more lax policy and forbears more, the bank is forced to serve more deposits at face value until intervention. Therefore, given an intervention, the RA seizes fewer assets, resources (the "pro-rata shares") to depositors decline under the mandatory stay, and the incentive to run on the bank goes up. I call this effect the "stop-loss effect".[3] One might therefore believe that instant intervention minimizes the run propensity. But it does not, because the intervention gives rise to a second, novel effect that can make the depositors race to the exit more rather than less extreme. The depositors are afraid of an intervention, because both intervention procedures diminish resources either by costly liquidation of assets or by managing assets less skillfully than the bank. I show the costliness of the intervention not only makes depositors who roll over worse off ("unconditional intervention externality," Lemma 4.2), but also does so to an extent that makes these depositors wish they had run on the bank for withdrawing their deposit ("conditional intervention externality," Lemma 4.1). Therefore, the anticipation of an intervention does not prevent but rather increases the incentive to run. That is, the intervention policy backfires,

[3]The stop-loss effect in this setting is similar to a stop-loss order in securities trading, that is, in order to prevent greater losses from occurring, investors or agents seek to liquidate immediately.

which gives rise to the second effect: as the RA forbears more, runs have to be larger to trigger the feared intervenion. Thus, an intervention is believed[4] to occur less frequently, and the incentive to roll over increases. In a nutshell, as the RA pursues a laxer policy and forbears more, the depositors trade off the relaxing effect that a resource-destroying intervention is believed to occur less frequently against the alarming effect that, given an intervention, resources to the depositors under a mandatory stay are smaller because the standard payoff externality is bounded less.

The result that regulatory intervention does not necessarily reduce but can increase the depositor's run propensity is in contrast to Diamond and Dybvig (1983), where regulatory intervention policy can deter runs from happening ex ante. The deterrence of runs is possible there, because the assets are safe and because the regulator manages assets at the same skill level as the bank.

To explain the non-monotonic response to changes in regulatory forbearance, the fear of intervention is strongest under a conservative policy and vanishes under a lax policy. Given an intervention, a conservative policy seizes more assets than a lax policy where the RA intervenes only once the run has progressed further. Therefore, at the margin, the costliness of asset liquidation (PCA) respectively of lower-skilled asset management (suspension intervention) is more severe under a conservative than under a lax policy. Thus, bank stability improves in regulatory forbearance for low forbearance levels, because the fear of intervention dominates the stop-loss effect. By contrast, a very lax policy allows extensive asset liquidation to reduce the roll-over payoffs to the insured level without triggering an intervention. The fear of intervention then vanishes, because once withdrawals increase further to hit the intervention threshold, the intervention does not reduce the depositors' payoffs any further. Only the stop-loss effect remains active, implying bank stability declines in regulatory forbearance for high forbearance levels.

The second contribution of the paper concerns a regulator's trade-off between maximizing bank stability and efficiency (value of bank investment). I show in the case of the PCA intervention, conditional on low levels of deposit insurance, the goal of bank stability maximization and efficiency maximization are perfectly aligned whereas under high levels of insurance, they are at odds. Therefore, given low levels of insurance, overly conservative intervention policies may not be rational. Moreover, due to the existence of

[4]For the marginal depositor, the distribution of possible aggregate withdrawals remains unchanged, and the range of withdrawals for which an intervention occurs becomes larger, so that the ex-ante likelihood of an intervention increases.

preemptive depositor behavior, conservative and lax intervention policies can attain equal levels of both bank stability and efficiency, which further calls into question the usefulness of conservative intervention; see the fork in Figure 7. For intuition, under low levels of deposit insurance, the depositors are anxious about losing a sustantial part of their deposit, and thus run on the bank and enforce asset liquidation too often. To make inefficient runs less likely, efficient policy design corresponds to maximizing stability. That is, the efficient forbearance level is interior and not too conservative. Given a high level of insurance, the depositors face minimal losses and do not withdraw from the bank even for severe solvency shocks. As a consequence, investment in bank assets mostly continues, even though the assets often fail. The latter imposes losses on the deposit-insurance fund, which is financed by the depositors ex ante. Efficient policy design therefore tries to increase the depositors' run propensity to enforce the asset's liquidation more often, and thus limits losses to the insurance fund.

In the case of a suspension policy, the discussion of bank stability maximization versus efficiency is more involved. A PCA intervention always triggers a complete asset liquidation irrespective of the intervention delay. Therefore, a change in the intervention delay affects efficiency solely by steering the depositors' propensity to run on the bank. A suspension intervention, by contrast, protects assets from liquidation. Therefore, a change in the intervention delay affects efficiency in two ways: via the extent of asset liquidation until intervention occurs and via the depositors' run propensity. The RA does not observe the state when commiting to her intervention policy. Policy cannot be made state contingent.[5] Therefore, an efficient policy design requires the regulator to make an educated guess about the average asset quality it protects from liquidation, given the occurrence of a run, while internalizing the impact of its policy on the endogenous likelihood of an intervention. Put differently, the regulator must balance the risk of not protecting high-quality assets against the risk of protecting low-quality assets from liquidation, in addition to considering the impact of its intervention policy on the depositors' run propensity. The details are discussed in section 6.

I demonstrate these results in a setting where the bank's investment and debt structure are fixed. Because the bank is non-strategic, I abstract from moral hazard as a response to the regulator's intervention. All guidance on resolution policies provided in this article is thus conditional on this specific liability and asset structure, and this paper does not describe what would happen if policies could be designed jointly with the bank's debt

[5]The possibility of state-contingent policy would bring new challanges such as equilibrium multiplicity (Angeletos et al., 2006).

structure.

2 Discussion of the Literature

This paper adds to the literature on bank runs and their prevention. Diamond and Dybvig (1983) show suspension policies can deter runs altogether if a regulator stops withdrawals beyond a critical measure. Chari and Jagannathan (1988) discuss how suspension policies help deter panic runs when depositors have asymmetric information. Ennis and Keister (2009) consider ex-post optimal intervention delay when a regulator realizes a run has been happening. Keister and Mitkov (2016) show how the regulator's lack of commitment to bailout policies and a delay in identifying weak institutions give intermediaries the incentive and opportunity to delay bail-ins. Unlike these models, I obtain a unique trigger equilibrium that allows me to analyze feedback effects from the suspension policy into the endogenous run propensity of the depositors. Contrary to Keister and Mitkov (2016), here, the intervention delay is strategic as in Diamond and Dybvig (1983). In a Diamond and Dybvig (1983) setting, Cipriani et al. (2014) explore preemptive depositor runs during which a regulator can impose a suspension of convertibility of deposits. In their model, agent groups are distinctly informed about the fundamental, where the analysis abstracts from miscoordination problems. Here, by contrast, the regulator can vary the intervention point, agents are symmetrically imformed, and the run-propensity is endogenous.

This model features a simultaneous-move game, as in Diamond and Dybvig (1983) and Goldstein and Pauzner (2005), and stays close to the contractual agreement of a classic demand-deposit contract. In a literature strand on suspension policies (Wallace et al., 1988; Chari, 1989; Peck and Shell, 2003; Green and Lin, 2003; Andolfatto et al., 2017), depositors arrive at the bank randomly and sequentially to withdraw, allowing each arrival to obtain a distinct allocation (gradual suspension). Wallace et al. (1988) shows gradual suspension can prevent runs. Chari (1989) argues that under sequential arrival, bank runs can re-occur if depositors observe the current rate at which deposits are redeemed. Peck and Shell (2003) demonstrate, by example, that an optimal suspension contract that satisfies voluntary participation can feature a bank-run equilibrium, as long as the run likelihood is sufficiently low. There, however, the depositors' run propensity is modeled as independent of the suspension policy. Here, the suspension policy endogenously determines the ex-ante run likelihood. Andolfatto, Nosal, and Sultanum (2017) show runs can be prevented under sequential arrival by augmenting the messaging space to allow snitching. A snitch report conveys a depositor's belief that a run is occurring and instantly triggers suspension of convertibility for all later-arriving depositors who report being impatient. By carefully designing the payoffs to snitching, iterated elimination of strictly dominated strategies deters the run equilibrium. Here, by contrast, snitching is not possible, and a suspension is not triggered by a report but by aggregate withdrawals breaching a critical level. In Green and Lin (2003), runs can be precluded from happening if the depositors have an awareness about their arrival time ("clock time") so that the panic element may vanish. He and Manela (2016) study dynamic rumor-based bank runs with endogenous information acquisition. In the context of mutual funds, Zeng (2017) studies runs in a dynamic model, where unlike with debt, share values are soft claims. In his paper, fund managers can rebuild cash buffers after redemption by selling illiquid assets, which reduces future share value and can thus cause runs. That scenario is related to the standard bank run externality (Diamond and Dybvig, 1983) in which the possibility of high volume asset liquidation caused by early withdrawals reduces the future deposit value and causes panic runs. This paper studies optimal intervention during runs and shows the allowance of more liquidation during a run not always increases but can also lower the run incentive. That is, I demonstrate the existence of an additional effect that runs counter to the standard effect.

Unlike the majority of the models mentioned above, risk-sharing is not the focus of this paper. Therefore, this model only features risk-neutral and "patient" depositor types who value consumption in either period.[6] Risk-neutral depositors have been employed in Calomiris and Kahn (1991) to discipline bankers, or in Diamond and Rajan (1999), where the bank's run-prone asset and liability structure acts as a commitment device for the bank to employ its expert skills on behalf of her lenders.

To obtain an equilibrium selection, this paper uses a global-games information environment (Carlsson and Van Damme, 1993; Morris and Shin, 2001). Concerning my model, Goldstein and Pauzner (2005) is most closely related. They analyze the optimality of risk-sharing via demand deposit contracts in a global-games bank-run model. I add to their model a strategic resolution authority that can intervene to protect a deposit-insurance fund. Rochet and Vives (2004) analyze solvency versus liquidity risk, Eisenbach (2017) analyzes efficient asset liquidation through creditor runs, and Dávila and Goldstein (2016) study optimal deposit insurance. Schilling (2022) shows preemptive depositor behavior can also arise under general intervention mechanisms and that "interval intervention" can fix threshold intervention mechanisms such as PCA and the

[6]The incorporation of "impatient" types who instantly need to consume is straightforward.

suspension intervention so that preemptive depositor behavior does not arise. In a later contribution, Matta and Perotti (2021) analyze the impact of intervention delay on the bank-run likelihood in a Golstein-Pauzner (2005) global-games framework where given an intervention the regulator may liquidate liquid and illiquid assets. Like the current paper, they find the run likelihood to be non-montone in the intervention delay, and contribute by studying lack of commitment, whereas here, the regulator is fully committed to its policy.

3 Model

The model builds on Goldstein and Pauzner (2005) but additionally allows for a strategic resolution authority (RA), that has the right to intervene during runs and also provides partial deposit insurance. I start with outlining the GP model and then highlight deviations as the model progresses.

The model has three time periods, $t = 0, 1, 2$, and no discounting. A bank finances a risky, illiquid asset by raising deposits. Returns to scale are constant. The initial bank investment is normalized to one unit. Entry is free, such that the bank is in perfect competition with other banks and makes zero profit. A continuum of bank depositors $i \in [0, 1]$ exist. At time zero, depositors are symmetric, and each is endowed with one unit to invest. As opposed to Goldstein and Pauzner (2005), all depositors are risk neutral and enjoy consumption at $t = 1$ and $t = 2$.[7]

Asset For each unit invested at $t = 0$, the asset pays off $H > 2$ at $t = 2$ with probability θ, and 0 otherwise, where $\theta \sim U[0, 1]$ is the unobservable, random state of the economy.[8] At $t = 1$, the asset yields no cash flow but has an exogenous liquidation value $L \in (0, 1)$. Partial asset liquidation is possible. Following the GP model, I assume

[7]Beginning with the seminal contribution of Diamond and Dybvig (1983), a large literature characterizes demand-deposit contracts as a means to enable risk-sharing among two types of depositors: impatient and patient ones. A crucial step in this literature is the analysis of the incentives of the patient consumers to withdraw early, whereas the analysis of the impatient consumers amounts to little more than stating their withdrawal at period 1. Therefore, I abstract from impatient types. Incorporating them in the analysis is straightforward.

[8]Although GP assume the same state distribution, they additionally allow for a strictly increasing scaling function $p(\theta)$, which gives more flexibility in determining the success likelihood of the asset. Because $p(\cdot)$ is strictly increasing, incorporating the same function in our model is straightforward and will yield the same results. The function $p(\theta) = \theta/\overline{\theta}$ achieves continuity at the boundary to the dominance region $\overline{\theta}$. For simplicity, I suppress the constant and work with $p(\theta) = \theta$ directly, implying the limit case $\overline{\theta} \to 1$.

a boundary state $\overline{\theta} \in (0,1)$ exists such that for state realizations above $\overline{\theta}$, the asset pays off the high return with certainty, and already at $t = 1$. The existence of such a state plays a role in establishing the global-game equilibrium selection argument.

Contract In $t = 0$, the bank offers a demand-deposit contract $(Z_1, Z_2(n))$ to raise funds for investment in the risky asset. All depositors invest their endowment in the contract with the bank. At $t = 1$, a depositor needs to decide on her *action*. She either "withdraws" her deposit and thus opts for the short-term coupon Z_1, or she "rolls over" her deposit until $t = 2$. I assume $Z_1 \in (L, H)$. Let $n \in [0,1]$ denote the endogenous share of depositors who withdraw in $t = 1$ (aggregate withdrawals). If a depositor rolls over, she has a claim to a share of the bank's return on investment in $t = 2$, receiving the withdrawal-contingent pro rata share,

$$Z_2(n) = \frac{H(1 - Z_1 n/L)}{(1-n)}, \text{ with likelihood } p = \theta, \tag{1}$$

if the asset pays off. If the asset fails to pay, agents who roll over receive zero in the GP model.

Signals Before depositors choose actions in $t = 1$, they observe noisy, private signals about the state θ,

$$\theta_i = \theta + \varepsilon_i. \tag{2}$$

The idiosyncratic noise term ε_i is independent of the state θ and is distributed iid according to the uniform distribution $\varepsilon_i \sim U[-\varepsilon, +\varepsilon]$. Because signals are correlated, they additionally transmit information about the other agents' signals. A depositor's strategy maps her private signal θ_i to an action in {withdraw, roll over}.

Illiquidity and Payoff Externality By the maturity mismatch of the bank's balance sheet and because the bank finances withdrawals by liquidating illiquid assets, withdrawing depositors impose a negative externality on depositors who roll over: the pro rata share $Z_2(n)$ to roll over strictly declines as more agents withdraw early because the bank is required to sell more assets at the low liquidation value and foregoes the return H per liquidated unit. As long as the aggregate withdrawals are sufficiently low, $n \leq L/Z_1$, the bank can finance all withdrawals by selling assets, and paying the face value Z_1 to withdrawing depositors. Moreover, the pro rata share Z_2 is positive if the asset pays off. But for a high volume of withdrawals, $n > L/Z_1$, the asset's liquidation value undercuts the value of all claimed deposits, and the bank can no longer pay the face value Z_1 to all depositors requesting withdrawal. The bank in the GP model therefore becomes illiquid

(‘’bank run”) in $t = 1$, and all depositors who roll over receive zero.

In this paper, I therefore introduce a regulator to the GP model who can intervene to deter withdrawals before the bank becomes illiquid. The intervention limits the payoff externality and can therefore guarantee a minimum pro rata share to depositors who roll over.

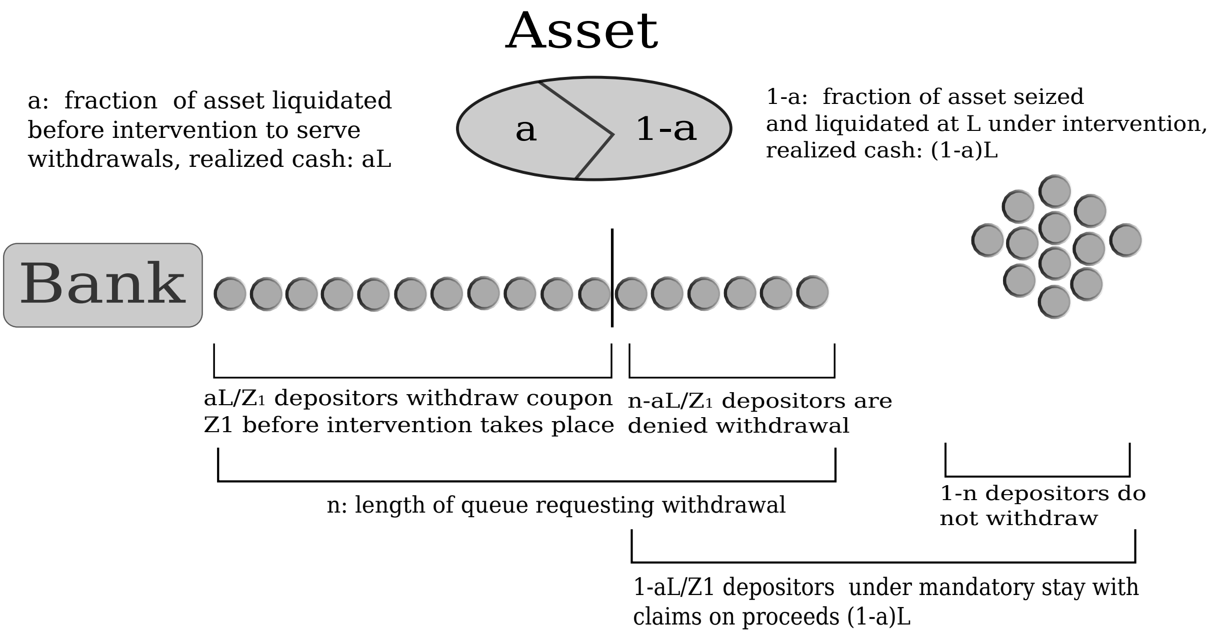


Figure 1: Forbearance determines the maximum deposit outflow until intervention and pro-rata shares under the mandatory stay.

3.1 Resolution Authority and Deposit Insurance

The strategic RA picks two policy parameters $\gamma \in [0, 1)$ and $a \in (\underline{a}, 1]$, $\underline{a} > 0$ at date $t = 0$. The parameter γ characterizes deposit insurance: the RA guarantees a payoff of at least γZ_1 to all depositors. The parameter a characterizes the regulatory *forbearance (policy)* and denotes the maximum share of the bank’s assets that can be liquidated during a run before the RA steps in; see Figure 1. The RA obeys a forbearance minimum $\underline{a} > 0$, because she observes the withdrawals with a delay.[9] An alternative interpretion

[9] I require a minimum forbearance level because; otherwise, a single depositor becomes pivotal, which would change the game structure. The bound $\underline{a}$ can be arbitrarily close to but must be bounded away from zero. The imposition of a minimum forbearance level also has legal reasons. In the U.S., the FDIC has to obey a forbearance minimum. The asset-to-debt ratio has to be below a critical threshold; otherwise, intervention is not legally justified. As a recent example from Europe, in September 2017, bondholders

of the RA's forbearance policy is in terms of "avoidable preference." Under the Orderly Liquidation Authority Provision of the Dodd-Frank Act, the FDIC has the right to claw back payments made to creditors within a specific time period before taking a financial institution into receivership.[10] Although withdrawal decisions are made simultaneously here, the clawback period can be defined in terms of withdrawal volume. A forbearance policy would then pin down the measure of withdrawals that are secure against clawback. As an additional interpretation, irrespective of deposit insurance, the forbearance policy enforces a minimum reserve ratio equal to the pro rata share.[11]

The timing unfolds as follows:

- In $t = 0$, the RA sets and fully commits to her policy (a, γ) *before* depositors decide whether to roll over and before the state θ realizes in $t = 0$. The policy therefore conveys no information on the state and is common knowledge among all agents. To finance deposit insurance, the RA levies symmetric lump-sum taxes $\tau \in (0, 1)$ on all depositors. The tax is set such that the insurance fund runs a balanced budget, taking into account the fund's expected exposure to claims by depositors and the depositors' endogenous run propensity; see section 7.[12] Because the deposit-insurance fund is financed by the depositors, future insurance payments should not be interpreted as a bailout. The depositors invest the after-tax endowment $1 - \tau$ in the contract with the bank. Then, the state θ realizes unobservably to all agents.

- In $t = 1$, all depositors observe the policy (a, γ) and their private signal θ_i. Then, they decide whether to request withdrawal. The RA observes the aggregate withdrawal requests n. Depending on their realized volume, the RA either intervenes to resolve the bank or abstains.

of failed Banco Popular filed an appeal against Spain's banking bailout fund, which followed European authorities (Single Resolution Board) and wiped out equity and junior bondholders before selling the bank to Banco Santander; see Bloomberg (2017) and Reuters (2017).

[10]Under the OLA, the recouped payments are used to reduce losses when the bank liquidation proceeds are insufficient to repay the Treasury. An equivalent clawback clause, however, exists in the U.S. Bankruptcy Code, where the bankruptcy trustee has the right to take back payments made to creditors within 90 days prior to filing for bankruptcy. The recovered payments become part of the bankruptcy estate available to repay remaining creditors; see also Zhong (2018).

[11]When observing the withdrawal requests, the RA intervenes to resolve the bank as soon as the liquidation value of the remaining assets per remaining depositors $L(1 - Z_1 n/L)/(1 - n)$ has fallen to the minimum tolerated level $L(1 - a)/(1 - aL/Z_1)$, that is, the pro rata share.

[12]Because the tax is levied symmetrically on all depositors, it does not alter the equilibrium behavior of the depositors. Therefore, the tax plays no role in the main analysis. I revisit the financing of the insurance fund in section 7.

Case 1: Intervention and bank resolution If the requested withdrawals nZ_1 exceed the cutoff aL, the RA intervenes:

$$nZ_1 \geq aL \qquad \Leftrightarrow \qquad \{\text{Bank resolution}\}. \tag{3}$$

Upon intervention, the bank randomly chooses a measure aL/Z_1 out of the measure of n agents requesting withdrawal to whom she serves the short-term coupon Z_1.[13] Then, the RA takes control, seizing and protecting the remaining asset share $1 - a$ by suspending convertibility and imposing a mandatory deposit stay. Conditional on the occurrence of a resolution, a depositor who requests withdrawal, therefore, has a aL/nZ_1 chance of receiving the face value of her deposit. Depositors of measure $n - aL/Z_1$ are denied the withdrawal and are subject to the mandatory stay jointly with those depositors who rolled over; see Figure 1. After imposing the deposit stay, the RA starts the resolution proceedings. The depositors who are subject to the mandatory deposit stay receive payoffs that are dependent on the resolution procedure. I consider two alternative procedures. I start with PCA as the benchmark case and discuss the suspension intervention in section 5.

Resolution procedure benchmark: Prompt corrective action (PCA) In a PCA resolution, the RA liquidates the seized assets $(1 - a)$ at the liquidation value L and evenly distributes the proceeds among all the depositors who are subject to the mandatory stay; see Figure 1. The depositors under the mandatory stay consist of depositors who rolled over their deposit and depositors who were denied a withdrawal, totalling a measure $1 - aL/Z_1$ of depositors. The PCA pro rata share to depositors under a mandatory stay therefore equals

$$s_\gamma(a) = \max\left(\gamma Z_1, \frac{(1-a)L}{1 - aL/Z_1}\right), \tag{4}$$

where deposit insurance γZ_1 provides a lower bound to the payoff. By choosing $a < 1$, the RA intervenes to seize a share of the asset before the bank becomes illiquid, thus limiting the negative externality imposed by withdrawing depositors.

[13] The random selection of measure aL/Z_1 out of n withdrawing depositors can be interpreted as a bank's *sequential service constraint*. Depositors queue in front of the bank to withdraw, positions in the queue are random, and the bank sequentially serves depositors. The RA monitors the queue and shuts down withdrawals once the measure of served depositors reaches aL/Z_1.

This model nests the GP model, which obtains for the case of no intervention ($a = 1$, laissez-faire policy) and no deposit insurance ($\gamma = 0$). Given a PCA intervention, the game ends in $t = 1$.

Case 2: No intervention If the withdrawal requests remain below the intervention threshold, $n \leq aL/Z_1$, the RA does not intervene, the bank serves all the depositors' withdrawal requests by liquidating assets, and the game proceeds to $t = 2$.

- In $t = 2$, the asset either pays or fails to pay. With likelihood $1 - \theta$, the asset fails to pay, the bank defaults, and the deposit-insurance fund becomes liable, paying γZ_1 to all agents who rolled over. With likelihood θ, the asset pays off and the depositors who roll over receive the pro rata share $Z_2(n)$. If this share is below the insured level of the deposit γZ_1, the deposit-insurance fund becomes liable and tops up the difference, additionally paying $\gamma Z_1 - Z_2(n)$.[14]

The payoffs per unit invested in the demand-deposit contract are

Event/ Action	Withdraw	Roll-Over
No resolution $n \in [0, aL/Z_1]$	Z_1	$\begin{cases} \max\left(Z_2(n), \gamma Z_1\right) & , p = \theta \\ \gamma Z_1 & , p = 1 - \theta \end{cases}$
Bank resolution $n \in (aL/Z_1, 1]$	$\frac{aL}{nZ_1} \cdot Z_1 + (1 - \frac{aL}{nZ_1}) s_\gamma(a)$	$s_\gamma(a)$

To summarize, forbearance determines two things: on the one hand, it affects both the pro rata share to depositors under a mandatory stay, $s_\gamma(a)$, and, given no intervention, the minimum payoff the depositors receive when rolling over their deposit:

$$Z_2(n) \geq \frac{H(1-a)}{1 - aL/Z_1}, \qquad \text{for all } n \in [0, aL/Z_1],\ p = \theta. \tag{5}$$

Therefore, forbearance may serve as a strategic tool to limit losses to both the depositors and the insurance fund at a given insurance level $\gamma \in (0, 1)$. On the other hand, forbearance sets the tolerated measure of withdrawals before triggering an intervention.

The equilibrium concept is perfect Bayes Nash. All proofs can be found in the appendix.

[14] When deviating from the assumption that depositors finance the insurance fund ex ante, an alternative interpretation of this top-up feature is that the depositors receive a (partial) bailout that is financed from outside of the model.

4 Equilibrium Coordination Game: PCA

I start the analysis in $t = 1$. The depositors take the RA's policy (a, γ) as given, observe their private signals, and then decide whether to roll over their deposit. Following Goldstein and Pauzner (2005),

Proposition 4.1 (Existence and Uniqueness)
For every policy (a, γ) with $\gamma < 1$: For vanishing noise $\varepsilon \to 0$, the game played by the depositors has a unique equilibrium and takes the form of a trigger equilibrium. A unique trigger signal $\theta^*(a, \gamma) \in [\underline{\theta}, \overline{\theta}]$ exists at which a depositor is indifferent in her action. For signal realizations below $\theta^*(a, \gamma)$, a depositor optimally withdraws. For signal realizations above the trigger, roll over is optimal.

I derive and provide an explicit closed-form solution for the PCA trigger signal $\theta^*(a, \gamma)$ in the appendix in Lemma 9.1. The lower the trigger, the lower the depositors' ex-ante propensity to run on the bank. I spend much of the following analysis determining how the depositors' run propensity θ^* reacts to changes in the RA's regulatory forbearance a. But to understand how the equilibrium changes in forbearance, first gaining intuition on the depositors' equilibrium behavior at a given forbearance level is helpful.

Fix regulatory forbearance a. Consider the common-knowledge game in which all depositors observe the state perfectly. If the state realizes at the extremes $[0, \underline{\theta}) \cup (\overline{\theta}, 1]$, a depositor has a dominant action. For state realizations $\theta \in [0, \underline{\theta})$ (lower dominance region) below the boundary,

$$\underline{\theta} = \frac{Z_1(1-\gamma)}{H - \gamma Z_1} \in (0, 1), \tag{6}$$

"withdraw" is dominant because the asset pays off with too low a likelihood and because deposit insurance compensates only partially for losses. For high state realizations $\theta \in (\overline{\theta}, 1]$ (upper dominance region), the asset pays off the high return for sure and already in period one. Therefore, the payoff to roll over exceeds the face value with certainty, the aggregate risk and the maturity mismatch between the bank's asset and liabilities dissolves, and "roll-over" is dominant.

For state realizations in a medium range $[\underline{\theta}, \overline{\theta}]$, the withdrawal game has two pure Nash equilibria. For all these states, the payoff likelihood is sufficiently high for 'roll-over' to be optimal, as long as withdrawals are low. Withdrawals cause two different externalities. First, as withdrawals increase, the necessary asset liquidation for servicing withdrawals reduces the pro rata share $Z_2(n)$. Therefore, a strategic complementarity in actions arises:

high and unrestricted withdrawals would eventually cause the $t = 2$ roll-over payoff to fall short of the face value Z_1 of the deposit (see Figure 2 for lax intervention), and withdrawal is optimal for high-volume withdrawals. Second, with a regulatory intervention mechanism, early withdrawals impose a payoff externality on depositors who roll over, because these withdrawals trigger an intervention and an instantaneous liquidation of all of the remaining assets once the withdrawals hit the intervention threshold. The first externality is the standard payoff externality and is already present in the GP and Diamond and Dybvig (1983) models. The second intervention externality is new to this paper.

Lemma 4.1 (Conditional Intervention Externality)**.** *Assume withdrawals trigger a bank resolution. The PCA pro rata share undercuts the deposit's face value,* $s_\gamma(a) < Z_1$*, irrespective of the regulatory forbearance level and the level of partial deposit insurance, that is, for all* (a, γ), $a \in (\underline{a}, 1]$, $\gamma \in (0, 1)$.

The proof is straightforward, using simple algebra. The PCA intervention is effective with regard to bounding the first, standard payoff externality because the pro rata share receivable under a mandatory stay $s_\gamma(a)$ declines in forbearance. However, no level of regulatory forbearance renders the PCA intervention sufficiently effective to deter a run when an intervention is anticipated. Lemma 4.1 shows that, even under instant intervention $a = \underline{a}$, the intervention implicitly imposes a bail-in because asset liquidation is costly. Given a resolution, a depositor can never receive a payoff as high under a mandatory stay as she could by running on the bank. Irrespective of the regulatory forbearance level, all depositors optimally run to withdraw their deposit whenever they believe the aggregate withdrawals are high enough to trigger an intervention. Put differently, due to the conditional intervention externality, an intervention cannot put the standard payoff externality to zero. This feature is visible in Figure 2, because the roll-over payoff is below the withdraw payoff for all aggregate withdrawal levels that trigger an intervention, that is, for all withdrawals above threshold La/Z_1, irrespective of the intervention regime. Likewise, the feature can be seen in Figure 3, because for all withdrawal levels that trigger an intervention, the relative payoff Δ to roll-over versus withdraw is negative, regardless of the intervention regime.

In Diamond and Dybvig (1983), by contrast, the anticipation of a suspension intervention, can deter runs ex ante. In section 5, however, I show that a suspension intervention can also cause adverse depositor behavior once aggregate asset risk is introduced and when assuming the regulator has lower asset-management skills than the bank. Because the PCA intervention does not provide for a special case of adverse depositor behavior, I

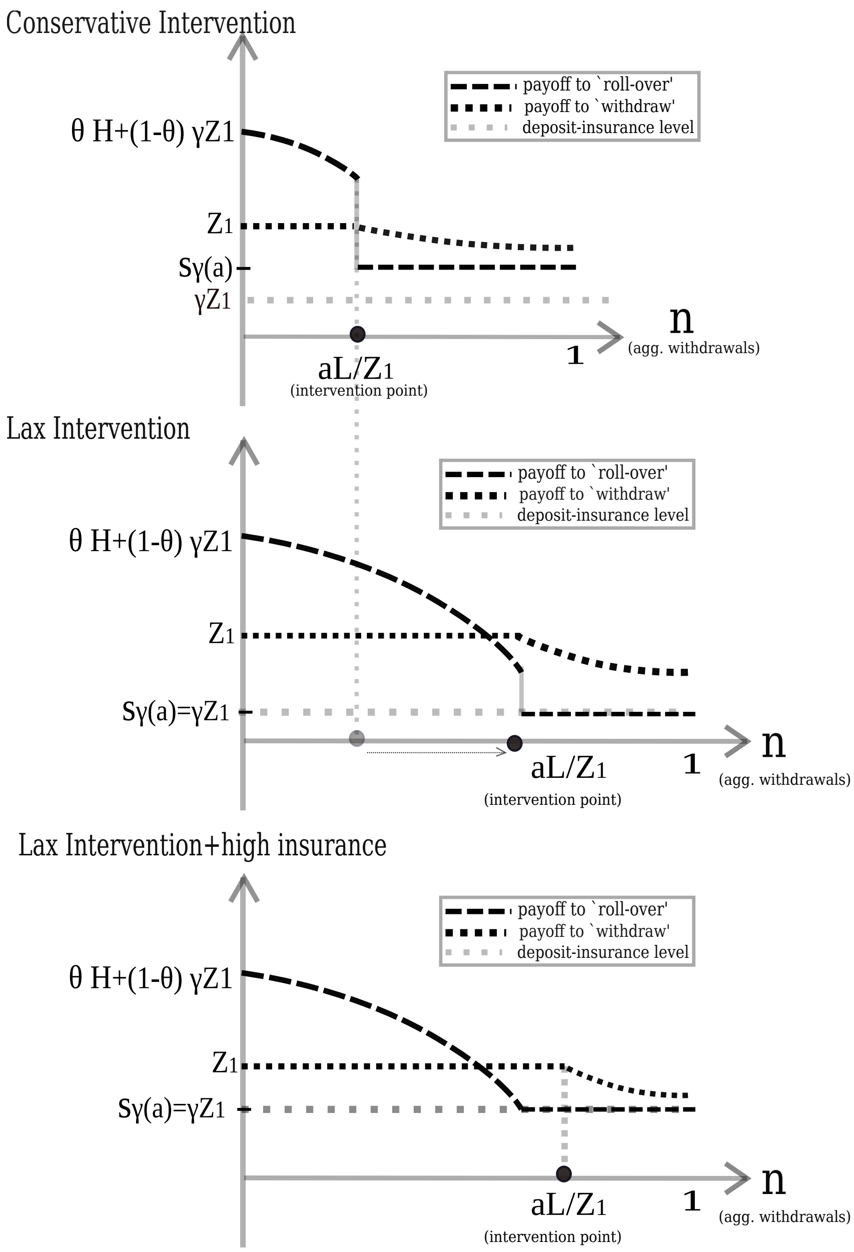


Figure 2: Payoffs to roll-over versus withdraw as a function of the aggregate withdrawals n for states $\theta \in [\underline{\theta}, \overline{\theta}]$. As long as withdrawals are low, roll-over is optimal because the associated payoffs exceed the face value Z_1. For high-volume withdrawals the pay off to roll-over drops below the face value and withdraw becomes optimal (standard payoff externality), irrespective of the intervention regime. Top: Conservative PCA intervention guarantees a high pro rata share $s_\gamma(a)$ above the insured level γZ_1. The intervention causes the payoff to roll-over to drop down to the pro rata share $s_\gamma(a)$ below Z_1, causing a fear of intervention (Lemmata 4.1. and 4.2.). That is, an intervention can *cause* a depositor's optimal response to switch from roll-over to withdraw since PCA liquidates illiquid assets (origin of preemptive behavior). Middle+ Bottom: Under lax intervention, the standard payoff externality is not sufficiently bounded. The payoff to roll-over can drop below the face value (middle) and down to the insured deposit value (bottom) before withdrawals are high enough to trigger an intervention. In either case, intervention no longer alters a depositor's optimal response. Top+Middle: Payoff to roll-over drops by intervention, causing depositors to fear the intervention. Bottom: Under high insurance provision, the intervention leaves the payoff to roll-over constant (payoff- smoothing via high insurance) so that the depositor's fear of intervention vanishes.

continue with analyzing PCA as the benchmark resolution method.

The strategic complementarity in actions in the range $[\underline{\theta}, \overline{\theta}]$ causes a coordination problem. If a depositor anticipates withdrawals will be high, she withdraws. A self-fulfilling bank resolution occurs if many depositors anticipate withdrawals will be high and withdraw, thus *causing* the bank's resolution and justifying their actions ex post. To attain an equilibrium selection, I employ a global-game information structure (Carlson and Van Damme, 1993), similar to Goldstein and Pauzner (2005). The depositors observe private, correlated, and noisy signals that serve as a coordination device to infer information not only about the state but also about the other depositors' actions. Given that all other depositors play a trigger strategy around signal θ^*, a trigger equilibrium exists if a single depositor finds it optimal to follow the same strategy. She optimally withdraws for signals below θ^*, optimally rolls over for signals above θ^*, and is indifferent between either action when observing the trigger signal. Proposition 4.1 establishes the

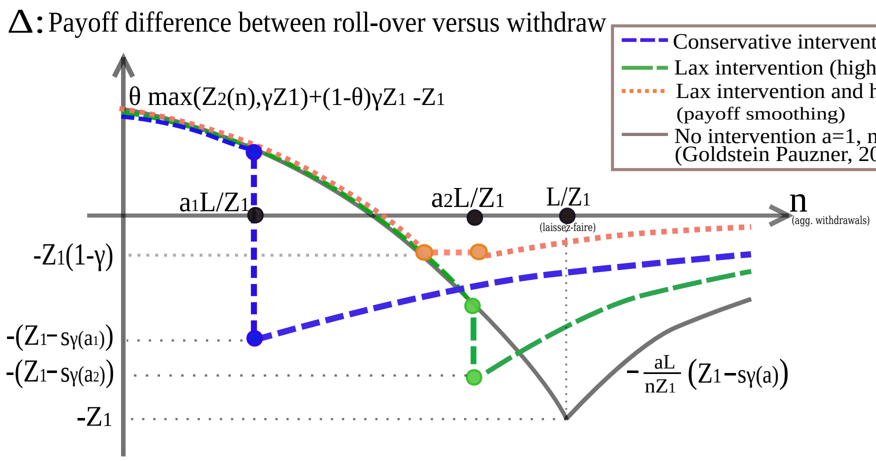


Figure 3: Optimal response for different intervention regimes as a function of aggregate withdrawals n. Roll-over is optimal at a given n iff the payoff difference Δ is positive. Intervention can cause the optimal response to switch from roll-over to withdraw when causing a jump from a positive- to negative-valued Δ at the intervention threshold $n = aL/Z_1$ (see blue, conservative intervention). Withdrawal levels in $[a_1L/Z_1, a_2L/Z_1]$ exist for which roll-over is optimal under a lax regime (positive $\Delta(n)$) but withdrawal is optimal under a conservative regime (negative $\Delta(n)$), meaning more conservative regulatory forbearance can strengthen the run incentives of depositors. Under lax intervention, the local change in the depositors' incentives becomes less extreme (smaller jump) than under a conservative regime. Jumps at the intervention threshold are responsible for preemptive depositor behavior; see Schilling (2022). Deposit insurance can smooth out such jumps (orange line). Absent intervention, jumps do not exist (GP model).

existence and uniqueness of the trigger equilibrium. The proof relies on a version of the proof given in Goldstein and Pauzner (2005). For intuition, consider the state-contingent payoff difference between roll-over versus withdraw.

$$\Delta(n,\theta) = \begin{cases} \theta \max\left(Z_2(n), \gamma Z_1\right) + (1-\theta)\gamma Z_1 - Z_1, & n \in [0, aL/Z_1] \\ -\frac{aL}{nZ_1}\left(Z_1 - s_\gamma(a)\right), & n \in (aL/Z_1, 1]. \end{cases} \tag{7}$$

This difference, $\Delta(n,\theta)$, is monotonically increasing in the state. Moreover, for states in $(\underline{\theta}, \overline{\theta})$, by the strategic complementarity in actions, $\Delta(\theta, n)$ is positive for low-volume withdrawals n, crosses zero at a single withdrawal level, and is negative for high withdrawals; see Figure 3.[15] If the depositors follow a trigger strategy around θ^*, the aggregate withdrawals equal the measure of depositors who observe signals below the trigger. Because depositors are small, the aggregate withdrawals are described by a deterministic function $n(\theta, \theta^*)$ of the state and the equilibrium trigger; see equation (28). The marginal depositor who observes the trigger signal $\theta_i = \theta^*$ holds a uniform Laplacian belief on the aggregate withdrawals; see Morris and Shin (2001). By (7), her expected payoff difference between roll-over and withdraw equals

$$\begin{aligned} F(\theta^*, a) \equiv & \int_0^{aL/Z_1} \underbrace{\left[\theta(n,\theta^*) \max\left(Z_2(n) - \gamma Z_1, 0\right) - Z_1(1-\gamma)\right]}_{\Delta^s(n)} dn \\ & + \int_{aL/Z_1}^{1} \underbrace{\left(-\frac{aL}{nZ_1}\right)\left(Z_1 - s_\gamma(a)\right)}_{\Delta^r(n,a)<0} dn, \end{aligned} \tag{8}$$

where Δ^s and Δ^r are the payoff differences absent and conditional on a resolution, respectively. A signal is a trigger signal θ^* if the depositors are indifferent between withdrawal and roll-over when observing the trigger, requiring the payoff-indifference equation to satisfy $F(\theta^*, a) = 0$. As the trigger θ^* played by all depositors increases, the state $\theta(n, \theta^*)$, which is consistent with a given measure of withdrawals n, necessarily has to rise, thus increasing the expected payoff difference (8). For vanishing noise $\varepsilon \to 0$, the signals become sufficiently precise such that a depositor can infer from her signal whether the state is located in either of the dominance regions; see equation (6). By exploiting the monotonicity of Δ and the existence of an upper and lower dominance region, a unique trigger signal $\theta^*(a)$ exists that satisfies the payoff-indifference equation $F(\theta^*, a) = 0$. Given that all

[15] To see single-crossing, recall that the payoff to roll-over strictly declines in the withdrawals, and at the intervention threshold, the payoff to roll-over discontinuously drops because intervention instantly liquidates all of the remaining assets.

other depositors play a trigger around θ^*, a depositor optimally follows the same strategy, because higher signals imply a higher posterior belief on the fundamental, θ. Goldstein and Pauzner (2005) further show that every equilibrium has to be a threshold equilibrium.

The RA resolves the bank if the aggregate withdrawals exceed the critical value aL/Z_1. Therefore, given the trigger signal θ^*, a unique *critical state* $\theta_b \in [\underline{\theta}, \overline{\theta}]$ exists at which the aggregate withdrawals push the bank to the edge of a resolution:

$$n(\theta_b, \theta^*) = aL/Z_1. \tag{9}$$

Intuitively, the critical state is a cut-off state: for a given trigger signal, state realizations below θ_b imply lower signal realizations and thus higher aggregate withdrawals. If and only if $\theta < \theta_b$, sufficiently many agents receive a signal below the trigger θ^* such that an intervention occurs. Because the private signals are linear functions of the state and noise ε, the trigger signal and the critical state move in lockstep. As noise vanishes, $\varepsilon \to 0$, the critical state and the trigger coincide, as do their comparative statics. Because the state is uniformly distributed, the ex-ante probability of a bank resolution equals θ_b, which motivates the following definition:

Definition 4.1 (Bank stability)**.** *Bank stability increases if the ex-ante probability of the bank's resolution θ_b declines.*

4.1 Comparative Statics under PCA Resolution

This section contains my first main result and shows the depositors preempt the regulator if the forbearance policy is set too conservatively. That is, the ex-ante run likelihood can decline in regulatory forbearance. The next proposition formalizes this result for the PCA intervention.

Proposition 4.2 (Depositors preempt the RA under PCA intervention)
Fix (H, L, Z_1, γ) with arbitrary $H > Z_1 > L$, $\gamma \in [0, 1)$. Bank stability is hump-shaped (the trigger signal is U-shaped) in regulatory forbearance, a, and is maximized at an interior forbearance level $a^* \in (0, 1)$: bank stability increases in regulatory forbearance for low forbearance levels but declines in forbearance for high forbearance levels.

To put Proposition 4.2 in perspective, a regulatory intervention at the forbearance level $a^* \in (0, 1)$ changes the depositors' withdrawal incentives such that the ex-ante run likelihood[16] is reduced relative to a higher threshold, including a laissez-faire policy, $a = 1$, where the regulator commits to never intervene. But if the RA sets a more conservative intervention threshold $a < a^*$, the effect reverts. Instead of further reducing the run propensity, the depositors react to the tougher intervention regime by preempting: they now run to withdraw from the bank for a greater signal range, and the run likelihood increases again ex-ante. This gives rise to a trigger function that is U-shaped in regulatory forbearance; see Figure 5.[17] That is, intervention can improve ex-ante bank stability only to a certain degree. Its effectiveness is bounded. Because regulatory forbearance affects bank stability non-monotonically, forbearance as a policy instrument should be used with caution: the shape of the trigger-curve implies the existence of numerous "stability mirrors," that is, pairs of distinct forbearance levels (a_1, a_2), $a_1 \neq a_2$ that attain the same level of bank stability $\theta^*(a_1, \gamma) = \theta^*(a_2, \gamma)$ but imply different intervention thresholds and thus different degrees of conservativeness of policy. In addition, the U-shape of the trigger implies a conservative PCA intervention can leave the bank less stable ex-ante than a lax intervention regime. In fact, conservative intervention can make the bank less stable ex-ante than a regulatory regime that commits to never intervene during a run, that is, sets a laissez faire policy $(a = 1)$; see Figures 5b and 5f.

Recall that intervention occurs with a minimum delay, $\underline{a} \in (0, 1)$. If the minimum delay is severe, the stability maximizer might undercut the minimum delay, $a^* < \underline{a}$. In that case, bank stability increases in forbearance over the entire range of feasible forbearance levels $(\underline{a}, 1]$.

The case in which depositors are fully insured is excluded from Proposition 4.2, because the depositors then no longer react to their signals in terms of an altered propensity to withdraw. Instead, they roll-over for every signal, irrespective of regulatory forbearance; see Lemma 10.4 in the appendix.

Intuition The depositors' non-monotonic response to a tougher regulator is due to a change in regulatory forbearance having two opposing effects on the depositors' preferences. On the one hand, a PCA intervention guarantees a minimum payoff, the pro rata share $s_\gamma(a)$, to a depositor who is subject to a mandatory deposit stay. The pro rata share reduces the downside risk to roll-over, that is, the intervention bounds the standard

[16] As noise vanishes, $\varepsilon \to 0$, the run likelihood θ_b and the trigger become indistinguishable.

[17] In a later contribution and a slightly different model, Matta and Perotti (2021) arrive at a similar result as shown here and already shown in Schilling (2019a)'s Proposition 7.3.. That is, the run probability is minimized at an interior intervention delay level. In their model, if intervention prevents liquidating illiquid assets, the run probability is monotonically decreasing as in Schilling (2017).

payoff externality with bank runs. I call this the "stop-loss effect" of intervention. The share declines as the RA shows more regulatory forbearance because the bank is forced to serve more withdrawals at face value until a resolution is triggered. Therefore, the depositors' incentive to roll over declines with regulatory forbearance. The smallest possible forbearance level $a = \underline{a}$ would minimize the depositors' losses under a mandatory stay, and thus appears to minimize the run incentive.

Yet, by Lemma 4.1, given an intervention, the incentive to run for withdrawing the deposit persists also for the most conservative regulatory forbearance levels (conditional intervention externality) because the costliness of the intervention pushes pro rata shares below the face value of the deposit. One might nevertheless believe the intervention created value by protecting the depositors who roll-over. That is, one might think that, *unconditionally*, the incentive to roll over is largest under instantaneous intervention. The next result, however, shows that it is not.

Lemma 4.2 (Unconditional intervention externality)**.** *Let deposit insurance $\gamma \in [0, 1)$ be partial, and consider any forbearance level $a \in (\underline{a}, 1]$. Assume the state realizes such that withdrawal is not dominant, $\theta \in [\underline{\theta}(\gamma), 1]$. Then, the payoff to depositors who roll-over either drops discontinuously or stays constant at the intervention threshold $n = aL/Z_1$:*

$$\underbrace{\theta \max\left(Z_2(n), \gamma Z_1\right) + (1-\theta)\gamma Z_1}_{\substack{\textit{deposit continuation value} \\ \textit{absent resolution}}} \geq \underbrace{s_\gamma(a)}_{\textit{value under intervention}}, \quad \textit{for all } n \in [0, aL/Z_1]. \tag{10}$$

When running on the bank is not dominant, the PCA intervention does not protect but harms depositors who roll-over by (weakly) reducing value. Intuitively, the result holds because for high states, the PCA intervention is costly and reduces resources. The proof of this result is non-trivial because the asset is risky, so asset liquidation is efficient for some low states of the world. The proof, however, shows that whenever the PCA intervention increases value, withdrawing from the bank is already dominant, so the depositors enforced the asset's liquidation also without a regulatory mechanism in place. Because the intervention instantaneously liquidates assets despite a high state, the intervention can cause an extreme, local change in the depositors' incentives at the intervention threshold, meaning the payoff-difference function Δ jumps down; see Figure 3.[18]

[18]The payoff to withdraw remains continuous at Z_1 at the intervention threshold. Therefore, changes in relative payoffs are due to changes in the payoff to roll-over.

The costliness of intervention gives rise to preemptive depositors' behavior caused by fear of intervention: considering Lemma 4.2 jointly with Lemma 4.1, because a PCA intervention reduces the deposit value, agents who roll over fear the intervention even though it guarantees a minimum pro rata share, should an intervention occur. This finding holds because the intervention lowers the roll-over payoffs to an extent that running on the bank to secure the deposit is optimal. That is, the intervention fuels the panic and makes the race for the exit more severe because it punishes the agent group that contributes to bank stability by rolling over and rewards the withdrawing agent group that contributes to the occurrence of intervention.[19]

Consequently, and as the second effect, under a more conservative forbearance policy already lower-volume withdrawals trigger a costly intervention. Therefore, a depositor believes a value-reducing intervention occurs more frequently,[20], and her relative incentive to withdraw to secure the deposit increases.

In summary, as the RA shows less regulatory forbearance, the depositors trade off the calming effect that, given an intervention, the guaranteed pro rata shares under a mandatory stay are higher against the alarming effect whereby a value-reducing intervention is believed to occur more frequently. Figure 4 depicts this trade-off.

The U-shape of the trigger reveals that for conservative forbearance levels, the fear of intervention dominates the stop-loss effect such that the intervention makes the depositors' race for the exit more instead of less extreme. Only for lax regulatory forbearance, the stop-loss effect dominates, and intervention reduces the bank-run likelihood ex-ante. The more lax the intervention regime is, the weaker the fear of intervention. This finding holds because under conservative regulatory forbearance, the intervention causes much instantaneous asset liquidation and a larger reduction in deposit value, in comparison to a more lax intervention regime in which the RA seizes fewer assets, such that the intervention causes less additional liquidation. Therefore, the local change in the depositors' incentives at the intervention threshold is weaker under lax than under conservative intervention, that is, the downward jump of the payoff-difference function is less extreme.

[19] A regulatory change toward a more conservative policy can *cause* a depositor's optimal response to switch from roll-over to withdraw at a given withdrawal level. Thus, withdrawal levels exist for which the payoff difference Δ is positive under lax or absent of intervention (green and gray line) but is negative under conservative intervention (blue line), see Figure 3. For interventions at low forbearance levels, the relative payoff of roll-over versus withdrawal drops from positive to negative at the intervention threshold; see point 2 in Figure 3.

[20] From the perspective of the marginal depositor, the distribution of aggregate withdrawals is the uniform distribution. Under less forbearance, the RA intervenes for a wider range of withdrawal realizations, which increases the marginal depositors' belief that a run occurs.

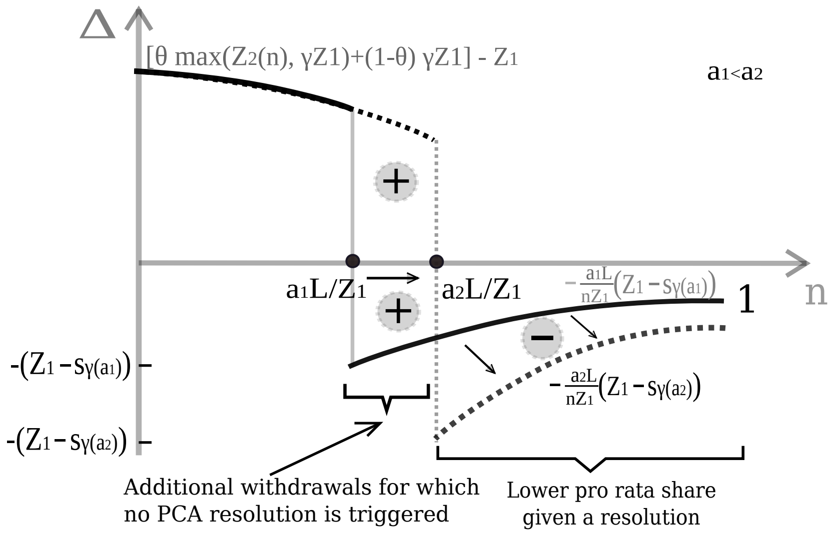
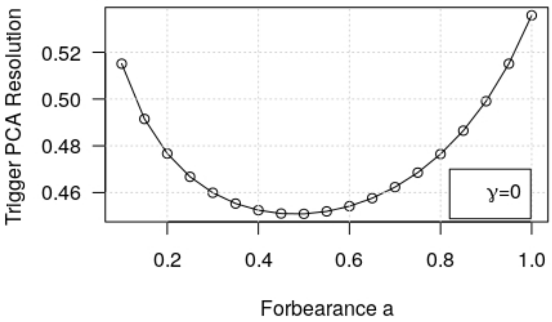


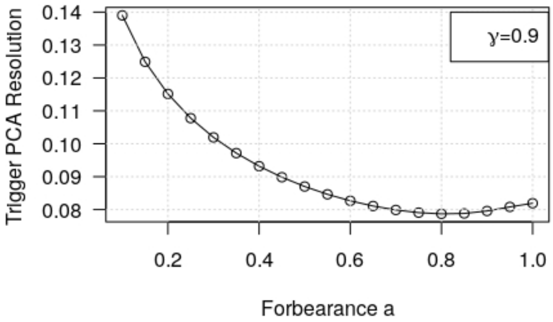
Figure 4: Two-fold change in the expected payoff difference to roll-over versus withdraw as regulatory forbearance increases from a_1 to a_2 under a PCA intervention. As the intervention threshold shifts upward, $a_1L/Z_1 \to a_2L/Z_1$, aggregate withdrawals have to be larger to trigger an intervention. Therefore, a value-reducing PCA intervention is believed to occur less frequently, and the expected payoff to roll-over increases ('+'). On the other hand, given an intervention, the RA seizes fewer assets $(1-a)$, such that the guaranteed pro rata shares $s_\gamma(a)$ under a mandatory stay are lower. Therefore, given an intervention, the payoff-difference curve shifts down, becoming more negative ('-').

The fear of intervention vanishes completely under sufficiently lax intervention such that only the stop-loss effect remains. This finding holds because under lax policy, the intervention no longer reduces the depositors' payoffs. The standard payoff externality is no longer sufficiently bounded; thus, high-volume withdrawals and the correspondingly required asset liquidation push the payoff to roll-over down to the insured value of the deposit even though the withdrawals have not reached the intervention threshold; see the lowest drawing in Figure 2 and the orange line in Figure 3. As the withdrawals reach the intervention threshold, the intervention leaves the payoffs to roll-over constant at the insured level, that is, inequality (10) holds with equality. Because the depositors are no longer afraid of an intervention, a depositor's incentive to preempt the intervention vanishes.[21]

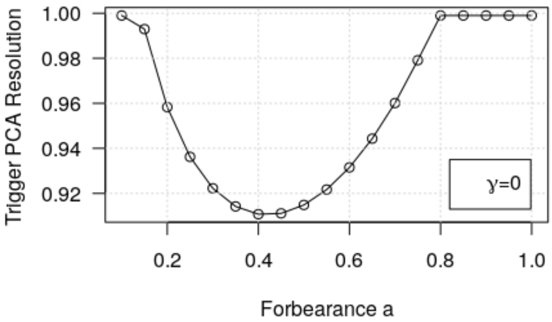
[21] That is, the payoff-difference function has become continuous in forbearance at the intervention threshold, due to deposit-insurance provision. Therefore, marginal changes in forbearance no longer affect the payoff-difference function.



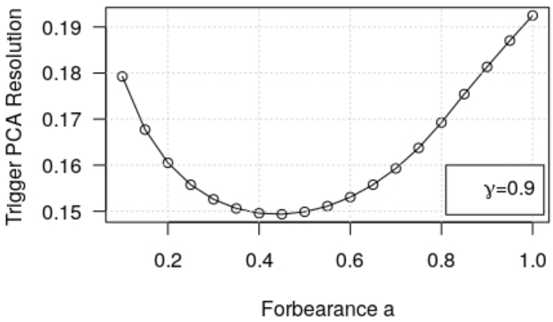
(a) $L = 0.5$



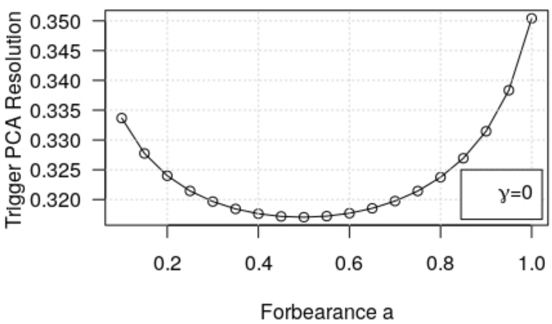
(b) $L = 0.5$



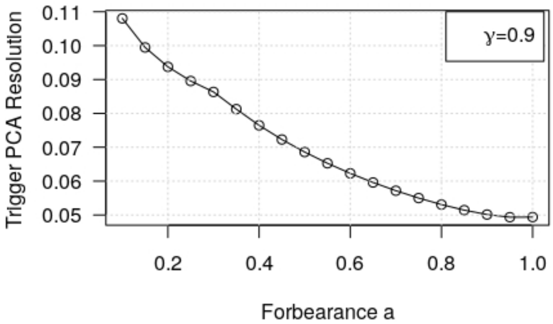
(c) $L = 0.2$



(d) $L = 0.2$



(e) $L = 0.65$



(f) $L = 0.65$

Figure 5: This figure plots the PCA trigger θ^* as a function of regulatory forbearance, a, for $H = 2.5$, $Z_1 = 0.7$. The higher the trigger, the larger the ex-ante likelihood of a PCA intervention. The special case $a = 1$ corresponds to laissez faire, that is, the regulator commits to never intervene during a run. The trigger in the point $a = 0$, and no deposit insurance $\gamma = 0$ (left panel) correponds to the trigger in the Goldstein-Pauzner model. The U-shape reveals the existence of "stability mirrors", i.e. levels of distinct forbearance levels a_1, a_2, $a_1 < a_2$ that attain the same trigger $\theta^*(a_1) = \theta^*(a_2)$, and thus, as noise vanishes, the same stability $\theta_b(a_1) = \theta_b(a_2)$. Therefore, lax intervention at a_2 can be as stable as conservative intervention at a_1.

5 Suspension Resolution

The previous section showed that a PCA resolution can cause preemptive depositor behavior. As a consequence, bank stability can decline in response to a more conservative intervention policy. As I show next, preemptive behavior not only occurs under a PCA intervention, but also persists under a suspension resolution, in which, instead of liquidating assets, the RA holds and continues the management of assets until maturity.[22]

The model changes the following way. As before, the RA intervenes to resolve the bank if the aggregate withdrawal requests exceed the value aL/Z_1. Given an intervention, the RA protects the remaining assets $(1-a)$ from liquidation and holds them until maturity in $t = 2$. Unlike the bank, I impose that the RA is not an investment expert, and therefore realizes a reduced return $r \in (0, H]$ on the remaining investment.[23] Call r the RA's exogenous investment-management skill.

Whereas under a PCA resolution, the liquidation of assets ensures a deterministic but low pro-rata share in $t = 1$ (equation (4)), under a suspension resolution, the asset's riskiness implies a risky, state-contingent pro-rata share under a mandatory deposit stay:[24]

$$s_\gamma(a,\theta) = \gamma Z_1 + \theta \cdot \underbrace{\max\left(\frac{(1-a)r}{1-aL/Z_1} - \gamma Z_1, 0\right)}_{\text{incremental payoff if asset pays}} . \tag{12}$$

More precisely, when the depositors face their withdrawal decision in $t = 1$, the state is not yet revealed, so the pro rata share $s_\gamma(a,\theta)$ is a random variable. Only in $t = 2$, the asset matures, $s_\gamma(a,\theta)$ is revealed, and the realized suspension pro rata share is paid. The state-contingent pro-rata share in (12) replaces the PCA pro-rata share in the payoff

[22] As an example, one may imagine a Purchase and Assumptions Transaction (P &A), under which the FDIC does not liquidate but sells the failing bank's assets to a third institution, potentially including some or all of the bank's deposits. Likewise, given OLA under Title II of the Dodd-Frank Act, the failing bank's assets are not liquidated but transferred to a bridge company for management.

[23] This assumption is in line with Granja et al. (2017), who provide evidence that budget constraints may lead to asset misallocation, such that the highest bidder on the failing bank's assets is not necessarily the institution with the best management capacity.

[24] Equation (12) is the expected pro rata share $s_\gamma(a,\theta)$ conditional on θ. One could also say that under PCA, the return on seized assets equals L whereas under the suspension intervention, the risky return equals θr. With that formulation, the explicit random pro-rata share under the suspension intervention equals

$$s_\gamma(a,\theta) = \left\{ \begin{array}{lll} \frac{(1-a)r}{1-aL/Z_1}, & p=\theta \text{ and } \frac{(1-a)r}{1-aL/Z_1} > \gamma Z_1 \\ \gamma Z_1, & p = 1-\theta \\ \gamma Z_1, & p=\theta \text{ and } \frac{(1-a)r}{1-aL/Z_1} \leq \gamma Z_1 \end{array} \right\}. \tag{11}$$

matrix of the model in section 3.1. To explain the pro rata share (12) further, under a mandatory stay, a depositor receives the insured value γZ_1 for sure and additionally receives the non-negative, incremental payoff if the asset pays off with likelihood θ; see equation (12). The incremental payoff is strictly positive if the RA forbears sufficiently little and if her asset-management skill exceeds the level of deposit-insurance coverage, $r > \gamma Z_1$. Otherwise, the pro-rata share under the mandatory stay is deterministic at γZ_1.

5.1 Equilibrium Existence and Uniqueness

To establish equilibrium existence and uniqueness, I outline next why the game structure has not changed from the previous model that employed a PCA intervention.

If the RA is skillful in managing assets to the extent $r > Z_1$ while also forbearing sufficiently little, a boundary state $\overline{\theta}_r(a) \in (\underline{\theta}, \overline{\theta})$ exists, such that for all higher states $\theta \in (\overline{\theta}_r(a), 1]$, the pro-rata share receivable under an intervention exceeds the face value of the deposit Z_1, and roll-over becomes a depositor's dominant action. The boundary state $\overline{\theta}_r(a)$ is implicitly pinned down via

$$\underbrace{\gamma Z_1 + \overline{\theta}_r(a)\left(\frac{(1-a)r}{1-aL/Z_1} - \gamma Z_1\right)}_{s_\gamma(a,\overline{\theta}_r(a))} = Z_1. \tag{13}$$

Therefore, under a suspension resolution, the bound to the upper dominance region equals $\overline{\theta}_S(a,\gamma) := \min(\overline{\theta}_r(a), \overline{\theta})$, where $\overline{\theta}$ is the bound to the upper dominance region under a PCA intervention. If the RA is not skillful in managing assets, $r < Z_1$, or if she grants too much regulatory forbearance, the boundary $\overline{\theta}_r(a)$ does not exist in $(0,1)$. In that case, the upper dominance regions of a PCA and a suspension intervention coincide. Yet, under the suspension intervention, the RA holds the risky asset until maturity and thus incurs the risk that the asset may not pay off. The RA does not control the asset's return likelihood θ.[25] Therefore, no regulatory forbearance level can guarantee pro rata shares above the deposit's face value. No forbearance level can eliminate a depositor's incentive to run for securing the deposit when the outlook on the asset quality is bad. In Diamond and Dybvig (1983), by contrast, a suspension intervention deters runs ex-ante because the asset pays for sure so that low forbearance levels guarantee a high pro rata share

[25]In a model in which the RA could set her policy state-contingently, a suspension resolution to stabilize the bank does not get simpler. To the contrary, as Angeletos, Hellwig, and Pavan (2006) show, equilibrium multiplicity rearise because the RA's policy then conveys information about the state.

under a mandatory stay. The asset's riskiness makes that mechanism impossible here. Instead, and as a parallel to the case of a PCA intervention, for every forbearance level a range of low state realizations $[0, \underline{\theta})$ exists for which withdraw is dominant because the asset's payoff likelihood is too low and deposit insurance coverage is only partial. These arguments establish the existence of an upper and lower dominance region.

Moreover, for *every* forbearance level $a \in [\underline{a}, 1]$, state realizations exist in a medium range $(\underline{\theta}, \overline{\theta}_S)$ for which a coordination problem with strategic complementarity in actions arises among the depositors. On the one hand, such state realizations imply the expected pro rata share under a resolution undercuts the face value of the deposit:

$$\underbrace{\gamma Z_1 + \theta \left(\frac{(1-a)r}{1 - aL/Z_1} - \gamma Z_1 \right)}_{s_\gamma(a,\theta)} < Z_1, \quad n \geq aL/Z_1 \text{ (intervention).} \tag{14}$$

Therefore, a depositor optimally runs to withdraw from the bank when anticipating a suspension intervention (conditional intervention externality). On the other hand, absent an intervention, such state realizations imply a sufficiently high return likelihood for roll-over to be optimal:

$$Z_1 < \theta Z_2(n) + (1-\theta)\,\gamma Z_1, \quad n < aL/Z_1 \text{ (no intervention)} \tag{15}$$

Because the game structure is identical, the existence and uniqueness result in Proposition 4.1 continues to hold:[26]

Proposition 5.1 (Equilibrium existence and uniqueness: Suspension Intervention)
Fix (H, Z_1, L, r). Assume the RA resolves the bank according to the suspension procedure. For a policy (a, γ), $\gamma < 1$ announced in $t = 0$, under vanishing noise $\varepsilon \to 0$, a unique trigger signal $\theta^*(a, \gamma)$ exists, which makes a depositor indifferent between roll-over and withdraw. Depositors optimally withdraw for signals below the trigger, and otherwise roll over their deposit.

I derive and state the suspension trigger formula in (55) of the appendix.

[26]The pro-rata share in (12) increases in the state. Therefore, state monotonicity of the payoff-difference function is preserved. Further, the pro-rata share is independent of n, which preserves action single-crossing such that the existence and uniqueness proof in Goldstein and Pauzner (2005) goes through.

5.2 Comparative Statics under Suspension Resolution

I next state how the depositors' run propensity changes as the RA varies her regulatory forbearance level with regard to a suspension intervention. This result is a version of my main result in Proposition 4.2 but for the suspension intervention.

Proposition 5.2 (Depositors preempt the RA under suspension intervention)
Fix (H, L, Z_1, γ) with arbitrary $H > Z_1 > L$, $\gamma \in [0, 1)$. Let noise vanish $\varepsilon \to 0$. There exist $\underline{r}, \overline{r} \in [0, H]$, $0 < \underline{r}, \leq \overline{r} < H$, such that
(i) If $r \in [0, \underline{r})$, bank stability is hump-shaped (the trigger is U-shaped) in forbearance and is maximized at an interior forbearance level $a^* \in (0, 1)$: bank stability increases in regulatory forbearance for low forbearance levels and declines in forbearance for high forbearance levels.
(ii) If $r \in [\overline{r}, H]$, bank stability monotonically declines in regulatory forbearance and is maximized at instant intervention $a = \underline{a}$.

To summarize the result, preemptive depositor behavior occurs not only when liquidating assets following a PCA intervention but also if the RA holds assets until maturity but at a lower asset-management skill than the bank $r \in [0, \underline{r})$. Therefore, the effectiveness of a suspension intervention is also bounded. An intervention level that is more conservative, $a < a^*$, may harm stability. Likewise, as with PCA, the U-shape of the trigger implies the existence of stability mirrors (a_1, a_2), $a_1 \neq a_2$, that is, conservative and lax regulatory forbearance levels exist that attain the same level of stability $\theta^*(a_1, \gamma) = \theta^*(a_2, \gamma)$, although they imply distinct levels of asset liquidation during a bank resolution; see Figures 6a and 6b. If and only if the RA's asset-management skill approaches the bank's expert level, regulatory forbearance is a well-behaved, monotonic policy tool. In that case, instant intervention maximizes bank stability; see Figures 6c and 6d.

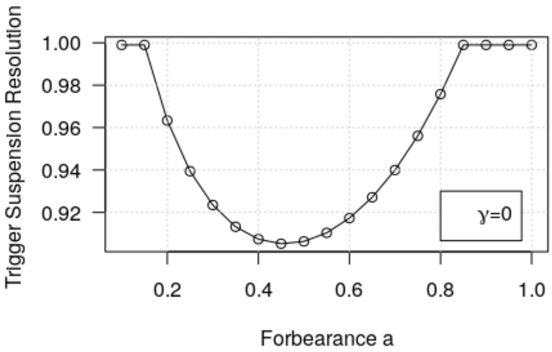
For intuition, as in the case of a PCA intervention, regulatory forbearance has a twofold effect on the depositors' preferences. As the first effect, if the RA intervenes more conservatively, she protects more assets from liquidation, so that at a fixed state, the pro rata shares under a mandatory stay are on average higher (stop-loss effect). As the second effect, the intervention reduces resources to depositors because the asset's management switches from the bank's expert level H to the RA's skill level r (unconditional intervention externality). If and only if the state realizes high in the upper dominance region $[\overline{\theta}, 1]$, the switch of the asset's management from the bank to the RA is not harmful for roll-over incentives, despite the reduced management skill of the RA because the roll-over payoff still exceeds the face value of the deposit. For all state realizations in $[0, \overline{\theta})$, however, the pro rata share under a mandatory stay is below the face value of the deposit. Therefore, analogous to the PCA intervention and Lemma 4.2, the possibility of a suspension intervention causes fear, which increases with the difference $(H - r)$, because the intervention pushes the roll-over-payoffs down to a level below the face value of the deposit. That is, given an intervention, a depositor who rolls over wishes she had withdrawn.[27] Thus, for states in the range $[0, \overline{\theta})$, an effect analogous to the one with a PCA intervention exists: as the RA announces more conservative intervention, smaller runs already trigger the feared resolution. Thus, the intervention and the corresponding drop in the deposit's value are believed to occur more often, and the depositors' incentive to run to secure their deposit increases.

Altogether, as the RA intervenes more conservatively, the marginal depositor trades off the relaxing effect whereby, given an intervention, pro rata shares under a mandatory stay increase against the troubling effect whereby an intervention and the corresponding drop in the deposit's value is believed to occur more often.

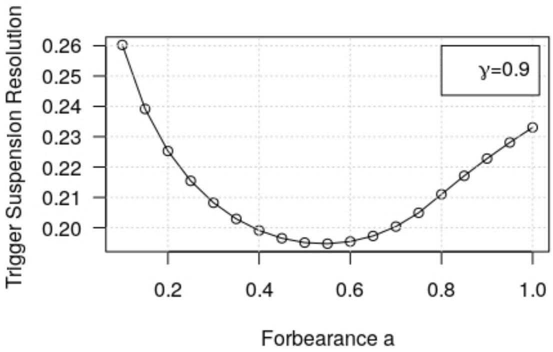
The RA's asset-management skill r has two economic interpretations. On the one hand, as the RA's management skill r approaches the bank's expert skill level H, the switch of the asset's management following an intervention reduces resources less. Therefore, the depositors' fear of an intervention vanishes. In addition, the RA's management skill r also parametrizes the opportunity costs to forbearing because the bank is forced to sell assets at the low liquidation value L until an intervention occurs whereas the RA could have realized the higher return r with likelihood θ when intervening to protect assets from liquidation instead.[28] Conditional on an intervention, the opportunity costs to forbearing increase with the RA's asset-management skill; that is, the pro-rata share under a mandatory stay declines faster in forbearance for larger r, so that the stop-loss effect becomes stronger. Therefore, the trigger is U-shaped only for lower values of r away from H but becomes monotonically increasing in forbearance for r sufficiently close to H; see Figure 6.

[27] Even if the RA manages assets as efficiently as the bank at $r = H$, no forbearance level can deter runs ex-ante with certainty because forbearance does not affect the asset quality (the state).

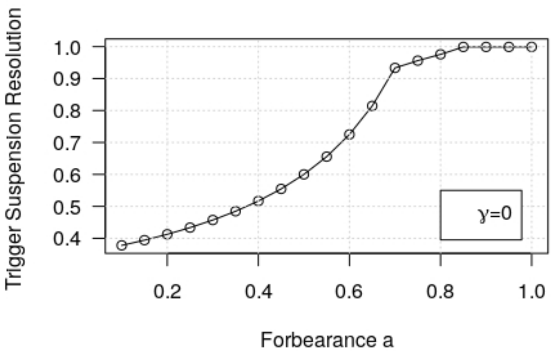
[28] Note, I also allow r to undercut L.



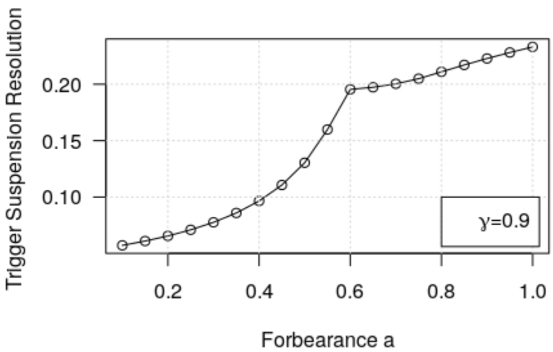
(a) $r = 0.7$



(b) $r = 0.7$



(c) $r = 2$



(d) $r = 2$

Figure 6: This figure plots the suspension trigger θ^* as a function of regulatory forbearance, for $H = 2.5$, $L = 0.2$, $Z_1 = 0.7$. The higher the trigger, the larger the ex-ante likelihood of a suspension intervention. For r small relative to H (top panel), the ex-ante intervention likelihood is U-shaped in regulatory forbearance. As r approaches H (lower panel), the ex-ante intervention likelihood becomes monotonically increasing in the regulatory forbearance. As with PCA, the special case $a = 1$ corresponds to laissez faire, that is, the regulator commits to never intervene during a run. The trigger in the point $a = 0$ and no deposit insurance $\gamma = 0$ (left panel) correponds to the trigger in the Goldstein-Pauzner (2005) model. The U-shape reveals the existence of stability mirrors.

6 Policy Goals: Efficiency versus Bank Stability

The previous sections have shown the maximization of bank stability may require a certain degree of regulatory forbearance. In this section, we shift our attention to an alternate policy goal, namely, the maximization of investment efficiency (value of bank investment), and discuss to what extent a regulator faces a trade-off between bank stability and efficiency maximization.

The maximization of bank stability and efficiency are generically distinct in this framework because the asset is risky. State realizations exist for which the asset's liquidation value exceeds the continuation value of investment. Define the efficiency cut-off

$$\theta_e = \frac{L}{H} \tag{16}$$

as the cut-off state below which the asset's liquidation is efficient.[29] Efficiency is maximized if the regulatory policy enforces a liquidation of the asset for all states in $[0, \theta_e)$, whereas investment continues for all states in $[\theta_e, 1]$. In the economy, the only mechanism that enforces a liquidation of assets is a depositor run with a subsequent PCA intervention. The continuation of investment can only be enforced by absence of runs. Recall that, as noise vanishes, a run with subsequent asset liquidation only occurs for state realizations below the endogenous critical state $\theta_b(a, \gamma)$ (equation (9)), which is the depositors' run propensity that follows the RA's policy. For states above the critical state, investment continues. Note we employ the critical state θ_b here instead of the equilibrium trigger signal θ^* because the benchmark θ_e is a state and not a signal. The trigger signal is, however, a linear function of the critical state, and both as well as their derivatives coincide as noise ε vanishes; see equation (28).

6.1 Efficient PCA Intervention

The depositors' run propensity is responsive to changes in regulatory forbearance and the level of deposit insurance.

Definition 6.1 (Efficient PCA policy)**.** *A PCA resolution policy is efficient if, given the policy announcement (a, γ), the depositors coordinate on a run if and only if asset liquidation is efficient, $\theta_b(a, \gamma) = \theta_e$.*

For maximizing efficiency, the RA would therefore need to design a policy (a, γ) such that the critical state matches the efficiency cut-off as closely as possible. Define the (second-best) efficient forbearance policy at a given level of deposit-insurance coverage

[29] Intuitively, and akin to Allen and Gale (1998), one may think of a low state realization as an economic downturn that occurs naturally in the course of a business cycle.

as[30]

$$a_e(\gamma) \in \arg \min_{a \in (\underline{a},1]} |\theta_b(a,\gamma) - \theta_e| \tag{17}$$

Generically, two types of inefficiencies can arise. If the critical state that follows a policy (a, γ) is located below the efficiency cut-off, $\theta_b < \theta_e$, runs occur inefficiently seldom. More precisely, an interval (θ_b, θ_e) of states exists for which the depositors do not withdraw from the bank and investment continues even though the asset quality is low. Therefore, the asset fails often, resulting in inefficiently high losses to the deposit-insurance fund. By the uniform state distribution, the likelihood of inefficient continuation of investment equals

$$\mathbb{P}(\theta \in (\theta_b(\gamma, a), \theta_e)) = \begin{cases} 0, & \theta_b(a) \geq \theta_e \\ \theta_e - \theta_b(a), & \theta_b(a) < \theta_e. \end{cases} \tag{18}$$

Because the depositors finance the insurance fund ex-ante via taxation, they ultimately pay the bill for a run-propensity that is too low; see also section 7. That is, whenever inefficient continuation of investment arises due to the absence of runs, the goal of maximizing bank stability is at odds with a policy maker's goal to maximize efficiency.

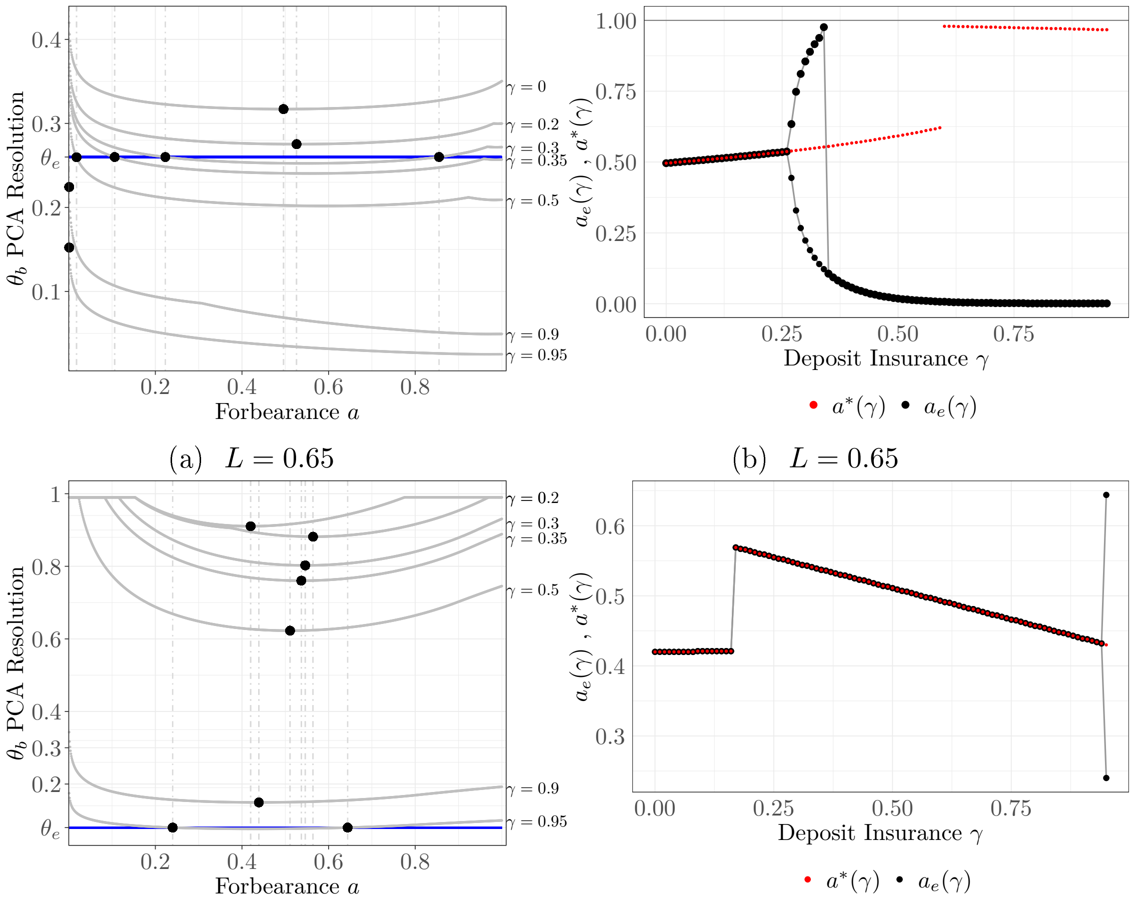
If, on the other hand, the policy (a, γ) implies a critical state that exceeds the efficient liquidation cut-off, $\theta_b > \theta_e$, an interval of states (θ_e, θ_b) exists at which inefficient runs occur. At these states, the depositors run on the bank to trigger an intervention with a subsequent asset liquidation, even though the asset is of high quality. The likelihood of an inefficient run at policy (a, γ) equals

$$\mathbb{P}(\theta \in (\theta_e, \theta_b(\gamma, a))) = \begin{cases} \theta_b(a) - \theta_e, & \theta_b(a) \geq \theta_e \\ 0, & \theta_b(a) < \theta_e. \end{cases} \tag{19}$$

A lower run propensity would increase the value of investment because costly liquidation was prevented more often. Therefore, whenever inefficient runs can occur, no trade-off exists between setting policy to improve efficiency and policy to improve bank stability.

The conflict of inefficient runs versus inefficient continuation of investment depends on the level of deposit insurance.

[30] Note, using the definition of θ_e, one can show that minimizing the objective function given in equation (17) is equivalent to minimizing the objective function $\int_{\theta_e}^{\theta_b(a,\gamma)} (\theta H - L)\, d\theta$ and maximizing the objective function $\int_0^{\theta_b(a,\gamma)} L\, d\theta + \int_{\theta_b(a,\gamma)}^1 \theta H\, d\theta$, as in an earlier version of this paper; see section 4 in Schilling (2017) and Schilling (2019b).



(a) $L = 0.65$

(b) $L = 0.65$

(c) $L = 0.2$

(d) $L = 0.2$

Figure 7: Left panel: Efficient PCA regulatory forbearance for different levels of deposit insurance. Points mark the efficient forbearance level, $a_e(\gamma)$, that is, the forbearance level at which the minimum distance between the U-shaped critical state curve $\theta_b(a, \gamma)$ and the efficiency cut-off state θ_e is attained. As insurance increases, the critical state curve $\theta_b(a, \gamma)$ shifts down, and transitions through the efficiency cut-off, thus intersecting twice for sufficiently high insurance. The double intersection gives rise to the fork (right panel). Right panel: Efficiency- (black) versus stability-maximizing (red) forbearance levels as a function of deposit insurance. For low insurance stability- and efficiency-maximizing forbearance levels coincide, whereas for high insurance levels they diverge. The forks imply that at some interim insurance levels, the efficient forbearance level is simultaneously attained with a lax and a conservative forbearance policy. All plots use $H = 2.5$, $Z_1 = 0.7$, $\theta_e = L/H$.

Corollary 6.1 (Efficient regulatory forbearance under PCA)
Bounds for the levels of deposit insurance provision $\underline{\gamma}, \overline{\gamma} \in [0, 1)$ *with* $0 < \underline{\gamma} < \overline{\gamma} < 1$ *exist such that*
(a) If deposit insurance is low, $\gamma \in [0, \underline{\gamma}]$*, the efficient forbearance level is interior and equal to the maximizer of bank stability,* $a_e = a^* \in (\underline{a}, 1)$*. No regulatory conflict exists between maximizing bank stability and efficiency. The first best outcome is not reached.*
(b) If insurance coverage is intermediate $\gamma \in (\underline{\gamma}, \overline{\gamma}]$*, conservative policy can be as efficient as lax regulatory policy: the first best level of efficiency is simultaneously attained at two distinct, interior forbearance levels,* $a_{e1} < a_{e2}$*,* $\theta^*(a_{e1}) = \theta_e = \theta^*(a_{e2})$*. The efficiency-maximizing forbearance levels differ from the stability-maximizing forbearance level:* $a_{e1} < a^* < a_{e2}$*.*
(c) For high insurance levels, $\gamma \in (\overline{\gamma}, 1)$*, maximizing bank stability is contrary to maximizing efficiency: efficiency of investment is maximized at a forbearance level equal to the global stability minimizer (trigger maximizer). The first best level of efficiency is not reached.*

The proof follows directly from Lemma 10.4 in the appendix and Proposition 4.2.

The results are depicted in Figure 7. The points in Figures 7a and 7c mark the forbearance levels at which, for a given level of deposit insurance, efficiency is maximized. Figures 7c and 7d show the discrepancy between the efficiency- (black) and the bank stability- (red) maximizing forbearance level as a function of deposit insurance. The stability and the efficiency maximizer coincide (lie on top of one another) for low levels of insurance but diverge for high insurance levels. Preemptive depositor behavior and the resulting U-shape of the critical state curve $\theta_b(a)$ give rise to the black fork in 7b, where the first best level of efficiency is simultaneously attained at two distinct forbearance levels, $a_1 < a_2$. These forbearance levels also form stability mirrors, and thus attain not only the same (first-best) efficiency but also stability level, $\theta_b(a_1) = \theta_e = \theta_b(a_2)$. That is, lax intervention at a_2 can attain the same level of stability and efficiency as conservative intervention at a_1, while implying distinct levels of liquidation until intervention. As insurance increases, the fork fans out further because the U-shaped critical state curve is pushed down through the efficiency cut-off; see left panel. Therefore, the spread in regulation intensity across the mirrors becomes more extreme whereas both mirrors attain first best efficiency and the same stability.

The proof is intuitive: recall that the critical state as a function of regulatory forbearance has a U-shape with interior minimizer (i.e., the critical state curve). For low levels of deposit-insurance coverage, the maximization of bank stability and efficiency coincide.

That is, because the critical state curve is entirely located above the efficiency cut-off, that is, the critical state exceeds the efficiency cut-off for every regulatory forbearance level (see Lemma 10.4), such that risk of inefficient runs exists. Because the critical state curve does not intersect with the efficiency cut-off, namely, the blue line in Figures 7a and 7c, the first best efficient outcome is not attained for any regulatory forbearance level. For intuition, under low deposit-insurance coverage, depositors are sensitive to bad news on the asset's fundamental because they potentially face a full loss of their deposit when choosing the "wrong" action. They withdraw too often, such that inefficient runs may occur. To make inefficient runs less likely ex-ante, the RA chooses the forbearance policy that minimizes the depositors' propensity to withdraw. Because the depositors preempt under a PCA intervention, that is, due to the trigger's U-shape, the run propensity is lowest and efficiency is highest at the interior forbearance level a^*; see Proposition 4.2. Therefore, as long as deposit insurance is low, the regulator faces no trade-off between maximizing bank stability and efficiency. In particular, no regulatory incentive exists to intervene more conservatively than at a forbearance level a^*, because such intervention would reduce both bank stability and efficiency.[31]

As deposit-insurance coverage increases, the depositors become more relaxed when observing information on the fundamental. They withdraw less often, implying a downward shift in the critical state curve; see Lemma 10.4. For sufficiently high insurance coverage, the critical state curve therefore runs through the efficiency cut-off and intersects twice, where the double intersection is caused by preemptive depositor behavior. Consequently, two distinct forbearance levels (stability mirrors), $a_{e1} \neq a_{e2}$, $a_{e1} < a_{e2}$ exist that both attain the first best level of efficiency, $\theta^*(a_{e1}, \gamma) = \theta^*(a_{e2}, \gamma) = \theta_e$. Conservative intervention at a_{e1} is just as efficient as more lax intervention at a_{e2}. The mirrors are visible in the plots of Figures 7b and 7d, where the efficient forbearance level forks as deposit insurance becomes sufficiently high. The bank stability level attained at the two efficiency maximizers a_{e1}, a_{e2} is below the global bank stability maximum at a^*. That is, a regulator would face a trade-off between maximizing bank stability and efficiency.

Under high insurance coverage, the critical state curve shifts further down and, given the miminum forbearance level $\underline{a} > 0$, is entirely located below the efficiency cut-off for every level of regulatory forbearance. Intuitively, for high insurance coverage, the depositors face minimal losses given a resolution and are therefore insensitive to bad news

[31] In a special setting of no deposit insurance, and in a related model, Matta and Perotti (2021) find a similar result, that the intervention delay that maximizes welfare can be interior. Here, in contrast, given no deposit insurance $\gamma = 0$, the efficiency maximizer is not only interior but must equal the stability maximum.

about the bank's solvency. They roll over their deposits even for severe solvency shocks on the bank, so that investment in the asset is continued inefficiently often, $\theta_b(a) < \theta_e$, for every forbearance level; see Figure 7a. Therefore, a higher propensity to withdraw is desirable to prevent unnecessary losses to the deposit-insurance fund that would be reflected in high ex-ante taxation. Because the critical state curve is U-shaped in forbearance, the distance to the efficiency cut-off is now minimized when the critical state is maximized (stability is minimized). Depending on the exogenous minimum forbearance level $\underline{a} \in (0, 1)$, the efficient forbearance level can be located at either of the boundaries $\{\underline{a}, 1\}$. A regulator who aims at maximizing bank stability would therefore simultaneously minimize efficiency, and vice versa, so that both goals are at odds with one another.

If the RA can set both the forbearance level and the level of deposit-insurance coverage, she can always attain the first best level of efficiency. The reason is that by Lemma 10.5, the critical state curve can always be arranged to transition through the efficiency cut-off by carefully choosing the deposit-insurance level. The policy that implements the first best level under a PCA intervention is not unique, as the forks in Figures 7b and 7d illustrate. In fact, infinitely many pairs (a, γ) exist that attain the first best outcome. In particular, a laissez-faire policy $a = 1$ can attain the first best outcome when finetuning the extent of deposit-insurance provision, which would make the existence of a regulatory intervention authority redundant. If, on the other hand, the RA sets both forbearance and deposit insurance to maximize bank stability, full deposit insurance reduces the run likelihood to zero for any forbearance level $a \in (\underline{a}, 1]$.

6.2 Efficient Suspension Intervention

The design of an efficient suspension intervention is more intricate than the design of an efficient PCA intervention. As in the case of a PCA intervention, regulatory forbearance with a suspension intervention affects the depositors' run-propensity θ_b. Therefore, changes in forbearance can give rise to inefficient runs or inefficient continuation of investment caused by the absence of runs. But unlike for the PCA intervention, forbearance with a suspension intervention gives rise to an additional source of inefficiency besides the run propensity: it also determines the share of assets that are protected from liquidation. Less regulatory forbearance with a suspension intervention improves efficiency if the true asset quality is high, but lowers efficiency if the asset quality is low, because fewer assets are liquidated. Because the RA commits to her policy without observing the true asset quality,[32], more regulatory forbearance can have a two-sided effect on efficiency, besides affecting the run propensity. Efficiency maximization of a suspension intervention therefore requires the RA to make an educated guess about the average asset quality that triggers a run, $\mathbb{E}[\theta|\theta < \theta_b(a)]$, while internalizing the effect of its own regulatory forbearance on the run propensity $\theta_b(a)$, and thus the chance of both inefficient runs and inefficient continuation of investment by absence of runs. By contrast, forbearance does not have this two-sided effect in the case of the PCA intervention, because there, irrespective of the forbearance level, the entire asset is liquidated.[33]

The decision about how many assets to protect from liquidation by intervention becomes even more intricate if the RA is not as skilled at managing assets as the bank. First, states $\theta \in (\frac{L}{H}, \frac{L}{r})$ exist for which the RA should not intervene during a run for protecting assets even though asset liquidation is inefficient. This finding holds, because for such states, the RA's asset management at skill level r yields an even lower value than liquidation, $r\theta < L < H\theta$. The average asset quality the RA protects given a run should therefore exceed the adjusted efficiency cut-off,

$$\hat{\theta}_e := \frac{L}{r} > \theta_e. \tag{20}$$

Note, $\hat{\theta}_e = \theta_e$ in the special case $r = H$. Otherwise, liquidation via a bank run is more efficient than intervention. The expected gain from a suspension intervention relative to the asset's liquidation in the course of a run equals

$$(1-a)\int_0^{\theta_b(a)} (r\theta - L)\, d\theta = (1-a)r \cdot \mathbb{E}[\theta - \hat{\theta}_e | \theta < \theta_b(a)]. \tag{21}$$

This value is positive, and asset protection increases efficiency, only if the average asset quality given an intervention is sufficiently high, that is, for $\theta_b > 2\hat{\theta}_e$. If instead the average asset quality the RA protects from intervention is low, $\theta_b \leq 2\hat{\theta}_e$, the RA may want to abstain from intervention to allow a complete liquidation of assets. Efficient suspension policy design is further complicated by the fact that for low skill levels $r \in [0, \underline{r})$ the

[32] As in the case of the PCA intervention, the RA does not observe the state and thus cannot finetune her policy to the state realization (asset quality). Instead, the RA commits to her policy, and then the state is drawn. Angeletos et al. (2006) show that if the RA could make state-dependent policy, additional issues would arise because the depositors' coordination behavior fails to have a unique equilibrium.

[33] The share a is liquidated by the bank in the course of a run, while the share $1 - a$ is seized and liquidated by the regulator. Thus, for all $a \in (\underline{a}, 1]$, full liquidation occurs given an intervention.

depositors may preempt the regulator so that bank stability is maximized at an interior forbearance level $a^* \in (0,1)$.

Efficient design of a suspension policy gives rise to a complex objective function. Let $\alpha \in (0,1)$ parametrize the importance of efficient asset protection by suspension intervention, when abstracting from the impact of intervention on the depositors' run propensity. Likewise, let $1-\alpha$ be the relative importance of implementing an efficient depositor run-propensity.

Definition 6.2 (Efficient suspension policy)**.** *Fix $\alpha \in (0,1)$. For a given level of deposit insurance $\gamma \in [0,1)$, define the efficient suspension forbearance policy $a_e(\gamma)$ as the minimizer of the following objective function:*

$$a_e(\gamma) \in \arg\min_{a\in[\underline{a},1]} \left\{ \alpha \times \underbrace{\left(r\,(1-a) \left(\hat{\theta}_e - \frac{\theta_b(a,\gamma)}{2} \right) \right)}_{\substack{\textit{inefficiency by (not)} \\ \textit{protecting low (high) quality assets}}} + (1-\alpha) \times \underbrace{|\theta_b(a,\gamma) - \theta_e|}_{\substack{\textit{inefficiency via} \\ \textit{run-propensity}}} \right\}. \tag{22}$$

Next, I demonstrate that the RA may face a trade-off between, on the one hand, lowering inefficiencies due to the depositors' run propensity, and on the other hand, reducing the risk of either protecting low-quality assets from liquidation or not protecting high-quality assets from liquidation.

Corollary 6.2 (Efficient- vs. stability-maximizing suspension intervention I)
Consider (H, L, Z_1), $\gamma \in [0,1)$, $r \in (\overline{r}, H]$, and let $\alpha \in (0,1)$ be arbitrary.
(i) Assume deposit insurance is high. Then, stability and efficiency maximization are entirely at odds. Efficiency is maximized at $a_e = 1$, stability is maximized at $a^* = \underline{a}$.
(ii) Assume deposit insurance is low. If $\theta_b(\underline{a})/2 \geq \hat{\theta}_e$, stability and efficiency maximization are aligned and are both maximized under instant intervention $a_e = a^* = \underline{a}$. If $\theta_b(\underline{a})/2 < \hat{\theta}_e$, the efficient forbearance level may exceed the stability-maximizing forbearance level, $a_e \geq a^* = \underline{a}$.

Proposition 5.2 shows that if $r \in (\overline{r}, H]$, bank stability declines monotonically in regulatory forbearance for every level of deposit insurance. Stability is maximized by instant intervention. Regarding efficiency, consider a high level of deposit-insurance provision first. Then, by Lemma 10.4, for any regulatory forbearance level, the depositors roll over their deposit even when observing severe shocks to the bank's assets. If a run occurs, the asset quality must be low; that is, the run is efficient. But risk of inefficient continuation of investment exists by the absence of runs, $\theta_b < \theta_e$. To maximize efficiency, the RA would like to enforce the asset's liquidation more often, which requires, first, the maximization of the run propensity, and second, not to intervene to protect assets from liquidation in the course of a run. A laissez-faire policy whereby the RA commits to never intervene attains both goals simultaneously but minimizes stability. That is, under high deposit-insurance provision, stability and efficiency maximization are entirely at odds.

Under lower deposit-insurance provision, the case is less clear cut. Because the depositors are anxious about losing their deposit, they withdraw too often, which gives rise to the risk of inefficient runs, $\theta_b > \theta_e$. The risk of inefficient continuation of investment due to the absence of runs is zero; see Lemma 10.4. To lower the risk of inefficient runs, a minimization of the run-propensity requires instant intervention $a = \underline{a}$. But not all runs are inefficient. If the asset is a lemon, instant intervention following a run would imply the RA protects maximally many assets from liquidation. Therefore, instant intervention does maximize bank stability but not necessarily efficiency. Specifically, the forbearance level that maximizes efficiency can be larger than $a = \underline{a}$, if the average asset quality that triggers a run under instant intervention, $\mathbb{E}[\theta|\theta < \theta_b(\underline{a})] = \theta_b(\underline{a})/2$, is a lemon, that is, is low relative to the adjusted efficiency cut-off $\hat{\theta}_e$,

$$\theta_b(\underline{a})/2 < \hat{\theta}_e. \tag{23}$$

If and only if $\theta_b(\underline{a})/2 \geq \hat{\theta}_e$, instant intervention maximizes efficiency and bank stability simultaneously.

The results change once the RA becomes less skilled at managing assets, because the depositors may preempt the regulator. Preemptive depositor behavior and the resulting U-shape of the critical state curve imply the existence of stability mirrors. Stability mirrors turn out to be helpful to eliminating inefficient forbearance levels. Define

$$a^M = \inf\{a \in [\underline{a}, a^*) : \text{ there exists } a_m \in [a^*, 1] \text{ with } \theta_b(a) = \theta_b(a_m)\} \tag{24}$$

as the smallest forbearance level below the global stability maximizer a^* for which a larger stability mirror a_m above the stability maximizer a^* exists, that is, $a^M < a_m$ but $\theta_b(a^M) = \theta_b(a_m)$. Assume for simplicity, that a^* is not only the global but the unique local stability maximizer.[34] By the U-shape of the critical state and the definition of a^M, all forbearance levels in $[a^M, a^*)$ possess a larger stability mirror in $(a^*, 1]$.

Corollary 6.3 (Efficient- vs. stability-maximizing suspension intervention II)
Consider (H, L, Z_1), $\gamma \in [0, 1)$, $r \in [0, \underline{r})$. Let $a^* \in (0, 1)$ be the interior bank stability maximizer, and the unique local bank stability maximizer.
(i) Assume deposit insurance is low. If $\theta_b(a^*)/2 > \hat{\theta}_e$, the efficient forbearance level is located in $(0, a^*]$. If $\theta_b(a^*)/2 \leq \hat{\theta}_e$, the efficient forbearance level is located in $[a^*, 1]$. In either case, efficiency and stability maximization can but do not have to coincide.
(ii) Assume deposit insurance is high. Then, the efficient forbearance level is located in $(\underline{a}, a^M) \cup \{1\}$, where the latter set never includes the stability maximizer a^*. If laissez faire globally minimizes bank stability, the efficient forbearance level equals laissez faire, $a_e = 1$, and stability and efficiency maximization are at odds.

For intuition, under low insurance, the risk of inefficient runs exists for every regulatory forbearance level, $\theta_b > \theta_e$, and is minimized by maximizing bank stability, that is, by setting regulatory forbearance to the interior $a^* \in (0, 1)$. But, similar to the case in which $r \in (\overline{r}, H]$, the efficient forbearance level might differ from a^*, depending on the average asset quality the RA protects given an intervention. At the regulatory forbearance level a^*, the average asset quality that is protected from liquidation given an intervention, $\mathbb{E}[\theta|\theta < \theta_b(a^*)] = \theta_b(a^*)/2$, is high if

$$\theta_b(a^*)/2 > \hat{\theta}_e. \tag{25}$$

In that case, the continuation of investment under the RA's management is more efficient than liquidation, and the efficient forbearance level is located in $(0, a^*]$. It cannot be located above a^* because more regulatory forbearance increases both the chance of

[34] If there exist additional local critical state minimizers, the result in Corollary 6.3 (ii) continues to hold if either laissez faire is the global critical state maximizer or instant intervention is the global critical state maximizer and laissez faire is the second highest maximizer. The result (ii) in Corollary 6.3 and its proof would need to be adapted, following the same reasoning, if there exists an interior global critical state maximizer or if instant intervention is the global critical state maximizer and there exists an interior second largest maximizer. The first case has not been observed in the plots under extensive numerical analysis but could not be ruled out analytically. In either case, proceed as follows: Given high deposit-insurance provision, each local critical state maximizer which possesses no larger stability mirror is a candidate for the efficient forbearance level. Therefore, laissez faire is always a candidate for the efficient forbearance level. All forbearance levels along an upwards sloping part of the critical state curve are dominated by the local maximizer located at the end of that upwards sloping part of the curve. There exist pairs of and n-tuple stability mirrors, for which the largest mirror dominates all others. All forbearance levels located on a downward sloping part of the critical state curve that lack a larger stability mirror are candidates for the efficient forbearance level.

inefficient runs and the chance and extent of liquidating high-quality assets, by delaying intervention when a run occurs. Thus, stability and efficiency maximization can but do not have to be at odds. Now, consider the opposite case, where the average asset quality is low relative to the benchmark $\hat{\theta}_e$. Then, given an intervention, the liquidation of assets on average attains a higher value than the continuation of investment under the RA's management. The efficient forbearance level is therefore located in $[a^*, 1]$ to allow more liquidation until an asset-protecting intervention occurs. Thus, again, stability and efficiency maximization are not necessarily at odds.

If deposit-insurance provision is high, the depositors withdraw too seldom. At every regulatory forbearance level, the risk of inefficient continuation of investment due to the absence of runs exists, $\theta_b < \theta_e$, and all runs that occur are efficient. Although the interior forbearance level a^* minimizes the run propensity, it also maximizes the chance of inefficient continuation of investment and is therefore not efficient. Moreover, because the critical state approaches zero for $\gamma \to 1$ by Lemma 10.4, the average asset quality the RA protects from liquidation undercuts the adjusted efficiency cut-off for all forbearance levels, $\theta_b(a)/2 < \hat{\theta}_e, \quad$ for all $a \in (\underline{a}, 1]$. That is, the RA should not protect assets by intervention. The efficient policy requires the RA to jointly maximize the run propensity and the extent of assets liquidation given a run. See first that by the U-shape of the critical state curve $\theta_b(a)$, all regulatory forbearance levels in $[a^*, 1)$ are dominated by laissez faire, $a = 1$: given an intervention, every forbearance level in $[a^*, 1)$ protects more (low-quality) assets from liquidation and implies a lower run propensity θ_b, that is, a higher risk of inefficient continuation of investment by the absence of runs, than a laissez-faire policy. Second, consider lower forbearance levels in $[a^M, a^*)$ that possess a larger stability mirror in $(a^*, 1]$. Stability mirrors implement identical run propensities but imply different levels of liquidation given a run. Every forbearance level in $[a^M, a^*)$ is dominated by its larger mirror in $(a^*, 1]$, because the latter allows more liquidation of low-quality assets until intervention while attaining the same run propensity. The mirrors in $[a^*, 1)$, in return, are dominated by laissez faire. That is, the efficient forbearance level must be located in $(\underline{a}, a^M) \cup \{1\}$. Observe that by the U-shape of the critical state, the bank stability maximizer is never among the candidates of the efficient forbearance level, $a^* \notin (\underline{a}, a^M) \cup \{1\}$. If laissez faire minimizes bank stability globally, then $a^M = \underline{a}$ must hold, such that the efficient forbearance level equals a laissez-faire policy $a_e = 1$. In that case, stability and efficiency maximization are entirely at odds.

7 Losses to the Deposit Insurance Fund and Taxation

Lastly, I clarify the impact of regulatory forbearance on the expected loss incurred by the deposit-insurance fund and the according tax that is required for financing insurance ex-ante. The insurance fund can incur losses for two reasons, either due to a run or, when a run remains absent, to a failure of the asset to pay. Consider the case of a PCA resolution. Call $S < 0$ the expected loss of the fund per unit invested in the contract.

To determine the loss, recall that as noise vanishes, $\varepsilon \to 0$, a run occurs if the true state realizes below the critical state θ_b, whereas if the state realizes above the critical state, investment continues. By Lemma 9.3 in the appendix, the loss given a run is zero if regulatory forbearance is sufficiently conservative, that is, if $a \leq a_{cc}$. But for lax forbearance, $a > a_{cc}$, given an intervention, the insured value of the deposit exceeds the liquidation value of the remaining assets per claimant, $\gamma Z_1 > (1-a)L/(1-aL/Z1)$. Therefore, lax forbearance imposes losses on the deposit-insurance fund. Absent a run, all agents roll over their deposit and investment continues. In $t = 2$, the asset fails to pay with likelihood $1-\theta$, in which case the insurance fund owes γZ_1 to all agents. As a consequence, the expected loss of the fund per unit invested equals

$$\lim_{\varepsilon \to 0} S(a,\gamma) = -\theta_b \underbrace{\mathbf{1}_{\{a>a_{cc}\}} \left(1 - \frac{aL}{Z_1}\right) \left(\gamma Z_1 - \frac{(1-a)L}{1-\frac{aL}{Z_1}}\right)}_{\text{loss given a run}} - (1-\theta_b) \underbrace{\gamma Z_1 \int_{\theta_b}^{1} (1-\theta)\, d\theta}_{\substack{\text{loss by asset failure,} \\ \text{given absence of a run}}}, \tag{26}$$

where the critical state $\theta_b = \theta_b(a,\gamma)$ changes with the policy, thus impacting the expected loss, and where $\mathbf{1}_{\{a>a_{cc}\}}$ is an indicator function, that takes the value of 0 if the RA sets a sufficiently conservative forbearance level $a \leq a_{cc}$, and 1 otherwise.

A given policy (a,γ) determines the expected loss S and therefore pins down the budget-balancing lump-sum tax τ charged ex-ante. Every depositor is taxed up front and only invests $(1-\tau)$ units in the demand-deposit contract with the bank. Therefore, the tax is pinned down by the expected loss of the insurance fund and the budget-balancing constraint

$$\int_0^1 \tau \, di = (1-\tau)\,(-S), \tag{27}$$

where $i \in [0,1]$ denotes a depositor. By $\tau = -S/(1-S) \in (0,1)$, all depositors can afford the tax. Moreover, by $S > -\gamma Z_1$, the tax undercuts the insured value of the deposit $\tau < \gamma Z_1$. The tax increases in the insurance fund's exposure $(-S)$.

By the preemptive depositor behavior, that is, the non-monotoncity of the critical state, and the asset's riskiness I conclude the following

Corollary 7.1
Neither the insurance fund's exposure nor the tax for financing insurance necessarily decline as regulatory forbearance becomes more conservative.

Moreover, following the efficiency discussion in section 6, the expected loss of the deposit-insurance fund does not monotonically decline as the run likelihood goes down, because inefficient continuation of investment can arise or become more likely. If the chance of a run, θ_b, declines, the loss given a run is incurred less often but investment in the asset is continued more frequently and for lower asset qualities. Therefore, the expected loss due to asset failure becomes more severe.

8 Conclusion

The suspension of convertibility of demand deposits has been widely discussed in the literature as a means to prevent bank runs. A suspension intervention protects the bank's investment from costly liquidation, thus guaranteeing a minimum continuation value to the invested deposit. However, this story is not complete. I show suspension comes with a considerable drawback if bank assets are risky and if the regulator is not as skilled in managing assets as the bank. In that case, suspension intervention can backfire by causing a probabilistic form of front-running by the depositors. Bank stability is maximized at an intermediate intervention delay. Neither laissez-faire nor an aggressive conservative intervention policy are optimal for minimizing the run-propensity.

These results hold equivalently for a PCA intervention, where the regulator seizes and liquidates all of the remaining assets given an intervention. Trade-offs exist between the goals of maximizing efficiency and bank stability. These trade-offs depend on the degree of deposit insurance. Under low levels of insurance, policy that is too conservative maximizes neither stability nor efficiency. For high levels of deposit insurance, laissez faire is always among the candidates for the efficiency-maximizing intervention policy, under both a PCA and a suspension intervention. Lax policies can be as or even more stable and efficient than aggressive, conservative policies.

The rationale for aggressive intervention policies needs to be reconsidered.

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9 Proofs: PCA Resolution

Proof. [Proposition 4.1] For a given policy (a, γ), the depsitors' game is equivalent to a version of the game in Goldstein and Pauzner (2005): Conditional on resolution, the payoff difference from rolling over versus withdrawing equals $\Delta^r = s_\gamma(a) - \Big[\frac{La}{nZ_1} \cdot Z_1 + (1 - \frac{La}{nZ_1}) s_\gamma(a)\Big] = -\frac{La}{n}\left(1 - \frac{s_\gamma(a)}{Z_1}\right)$. Absent a resolution, the payoff difference equals $\Delta^s = \theta \max(Z_2(n), \gamma Z_1) + (1-\theta)\,\gamma Z_1 - Z_1 = \theta \max(Z_2(n) - \gamma Z_1, 0) - Z_1(1-\gamma)$. See that by symmetry of taxation, the tax does not impact the payoff difference, and thus optimal behavior. The payoff difference function has the same monotonicity properties in the state θ and the aggregate withdrawals n as the payoff difference function in Goldstein and Pauzner (2005). Moreover, the noise distribution is the same. Thus, their proof goes exactly through. By the uniqueness of a trigger equilibrium, the proportion of withdrawing depositors n is a deterministic function of the state and is given by

$$n(\theta, \theta^*) = \mathbb{P}(\theta_i < \theta^* | \theta) = \mathbb{P}(\varepsilon_i < \theta^* - \theta | \theta) = \begin{cases} \frac{1}{2} + \frac{\theta^* - \theta}{2\varepsilon}, & \theta_i \in [\theta^* - \varepsilon, \theta^* + \varepsilon] \\ 1, & \theta_i < \theta^* - \varepsilon \\ 0, & \theta_i > \theta^* + \varepsilon \end{cases} \tag{28}$$

$\square$

Lemma 9.1 (PCA Trigger). *At the limit, the trigger under a PCA resolution method equals*

$$\lim_{\varepsilon \to 0} \theta^* = \frac{aL\Big((1-\gamma) - (1 - \frac{s_\gamma(a)}{Z_1}) \ln\left(\frac{aL}{Z_1}\right)\Big)}{Z_1\left(\frac{H}{L} - \gamma\right) m(a, \gamma) - H\left(1 - \frac{Z_1}{L}\right) \ln(1 - m(a, \gamma))} \tag{29}$$

where $m(a, \gamma) = \min(\bar{n}(\gamma), \frac{aL}{Z_1})$, *and* $\bar{n}(\gamma) = \frac{H - \gamma Z_1}{H\frac{Z_1}{L} - \gamma Z_1}$.

Proof. [Lemma 9.1] Set $a = 1$. Implicitly define $\bar{n}(\gamma) \in (0, L/Z_1)$ as the level of aggregate withdrawals at which, absent a resolution, the payoff to roll-over hits the insurance value of the deposit: $Z_2(\bar{n}) = \gamma Z_1$. For every level of insurance $\gamma \in [0, 1)$, such $\bar{n}(\gamma)$ must exist because $Z_2(0) > \gamma Z_1$, because $Z_2(n)$ monotonically and continuously declines in n, and because $Z_2(L/Z_1) \leq \gamma Z_1$. One can show that $\bar{n}(\gamma) = \frac{H - \gamma Z_1}{Z_1\left(\frac{H}{L} - \gamma\right)} \in (0, 1]$. For withdrawal levels $n \geq \bar{n}(\gamma)$, the payoff to roll-over is constant at the insured level because the insurance fund becomes liable, $\max(Z_2(n), \gamma Z_1) = \gamma Z_1$. Only for $n \in [0, \bar{n})$, we have $Z_2(n) > \gamma Z_1$.

Lemma 9.2. *Fix deposit insurance* $\gamma \in [0, 1)$, *pinning down* $\bar{n}(\gamma)$. *Consider intervention at* $a \in (\underline{a}, 1)$. *For every insurance level* $\gamma \in [0, 1)$, *there exists a unique forbearance level* $a_c = a_c(\gamma) := \frac{H - \gamma Z_1}{H - \gamma L} \in (0, 1)$ *such that*

(a) If and only if $a \leq a_c$, then $\bar{n} \geq aL/Z_1$, meaning $Z_2(n) \geq \gamma Z_1$ for all $n \in [0, aL/Z_1]$.
(b) For $a > a_c(\gamma)$, it holds $\bar{n} \in [0, aL/Z_1)$. In that case, only for $n \in [0, \bar{n}]$, we have $Z_2(n) \geq \gamma Z_1$. For all withdrawal levels in $n \in [\bar{n}, aL/Z_1)$, we have $Z_2(n) \leq \gamma Z_1$.

That is, if regulatory forbearance is sufficiently conservative $a \leq a_c(\gamma)$, then the absence of an intervention implies that the payoff to roll-over is strictly above the insured level, conditional on the asset paying off. Consequently, at the given forbearance level the insurance fund does not become liable absent an intervention, unless the asset fails to pay. For laxer forbearance levels $a > a_c(\gamma)$, the RA imposes losses on the insurance fund whenever the aggregate withdrawals realize above $\bar{n}$. Therefore, the insurance fund has to top up the depositors' payoffs although no intervention occurs.

Lemma 9.3. *Fix deposit insurance $\gamma \in [0, 1)$.*
(a) If insurance is such that $\gamma \in [0, L/Z_1)$, then a unique forbearance level $a_{cc} = a_{cc}(\gamma) \in (0, 1)$ exists where a_{cc} satisfies $\frac{L(1-a_{cc})}{1-\frac{a_{cc}L}{Z_1}} = \gamma Z_1$. Then, for all $a \in [0, a_{cc})$ it holds $s_\gamma(a) > \gamma Z_1$, while for all $a \in [a_{cc}, 1]$ it holds $s_\gamma(a) = \gamma Z_1$.
(b) If $\gamma \in [L/Z_1, 1)$, then $s_\gamma(a) = \gamma Z_1$ for all $a \in [0, 1]$, and we set $a_{cc} \equiv 0$.
(c) For all insurance levels $\gamma \in [0, 1)$ it holds $a_c \in (a_{cc}, 1)$.

To summarize, for every insurance level $\gamma \in [0, 1)$ we can partition the interval of possible forbearance levels into subintervals $[0, a_{cc}) \cup [a_{cc}, a_c) \cup [a_c, 1]$. The depositors payoffs and thus monotonicity properties of the trigger in forbearance depend on the subinterval at which the slope is measured. Later on, the constraint $a \in (\underline{a}, 1]$ is considered and whether $\underline{a}$ exceeds or undercuts a_{cc} and a_c. But for now, we consider all $a \in (0, 1)$.

In a trigger equilibrium, when observing the trigger signal θ^*, a depositors' posterior belief on θ is uniformly distributed on $[\theta^* - \varepsilon, \theta^* + \varepsilon]$ and her belief on the aggregate withdrawals are uniformly distributed on $[0, 1]$. By definition of a trigger equilibrium, the marginal depositor who observes the trigger must be indifferent in her action, requiring the expected payoff difference to equal zero. Define

$$m(a, \gamma) := \min(\bar{n}(\gamma), \frac{aL}{Z_1}) \tag{30}$$

From equation (8), the marginal depositors' expected payoff difference given her signal θ^* equals zero if and only if

$$\int_0^{aL/Z_1} \theta(n, \theta^*)\, \max(Z_2(n) - \gamma Z_1, 0)\, dn = \int_{aL/Z_1}^{1} \frac{aL}{nZ_1}\, (Z_1 - s_\gamma(a))\, dn + (1 - \gamma)\, aL \tag{31}$$

where

$$\theta(n,\theta^*) = \theta^* + \varepsilon(1-2n), \theta^* \in [\underline{\theta}-\varepsilon, \overline{\theta}+\varepsilon] \tag{32}$$

is the inverse of the function $n(\theta,\theta^*)$. Via equation (32) and Lebesgues Dominated Convergence Theorem, as $\varepsilon \to 0$, $\int_0^{aL/Z_1} \theta(n,\theta^*) \max(Z_2(n)-\gamma Z_1, 0)\, dn \to \theta^* \Big(Z_1\, m(a,\gamma)\Big(\frac{H}{L}-\gamma\Big) - H\Big(1-\frac{Z_1}{L}\Big) \ln(1-m(a,\gamma))\Big)$. because $\int_0^{m(a,\gamma)} Z_2(n)\, dn = \frac{HZ_1}{L} m(a,\gamma) - H(1-\frac{Z_1}{L}) \ln(1-m(a,\gamma))$. Therefore, the trigger under the PCA resolution method equals

$$\lim_{\varepsilon\to 0} \theta^* = \frac{aL\Big((1-\gamma) - (1-\frac{s_\gamma(a)}{Z_1}) \ln\Big(\frac{aL}{Z_1}\Big)\Big)}{Z_1\Big(\frac{H}{L}-\gamma\Big) m(a,\gamma) - H\Big(1-\frac{Z_1}{L}\Big) \ln(1-m(a,\gamma))} \tag{33}$$

□

Proof. [Lemma 9.2] Fix $\gamma \in [0,1)$. Define $a_c(\gamma)$ implicitly via

$$\frac{H(1-a_c)}{1-La_c/Z_1} = \gamma Z_1 \tag{34}$$

Such $a_c(\gamma) \in (0,1)$ must exist by the monotonicity of $Z_2(n)$, and by $H > Z_1 > L$. Then for all $a \leq a_c$, it follows $\bar{n} \geq aL/Z_1$. Therefore, using the definition of $\bar{n}$, for all $n \in [0, aL/Z_1]$ it holds $Z_2(n) \geq \gamma Z_1$. Vice versa for $a > a_c$. □

Proof. [Lemma 9.3] (a) Assume $\gamma Z_1 < L$. The function $\frac{L(1-a)}{1-La/Z_1}$ monotonically and continuously declines, takes the value L in $a=0$ and takes the value zero in $a=1$. Thus, there exists a unique $a_{cc}(\gamma) \in (0,1]$ at which $\frac{L(1-a)}{1-La/Z_1} = \gamma Z_1$. For all $a \in [0, a_{cc})$, it holds $\frac{L(1-a)}{1-La/Z_1} > \gamma Z_1$, and thus $s_\gamma(a) > \gamma Z_1$. For all $a \in [a_{cc}, 1]$, $\frac{L(1-a)}{1-La/Z_1} \leq \gamma Z_1$ and therefore $s_\gamma(a) = \gamma Z_1$.
(b) If $\gamma Z_1 \geq L$, then $\gamma Z_1 > \frac{L(1-a)}{1-La/Z_1}$ for all $a \in [0,1]$ and thus $s_\gamma(a) = \gamma Z_1$ for all $a \in [0,1]$.
(c) If $\gamma Z_1 \geq L$, then $a_{cc} = 0$, and thus immediately $a_c > a_{cc}$. If $\gamma Z_1 < L$, then $a_{cc} \in (0,1)$. But a_c and a_{cc} jointly satisfy the equation $\frac{L(1-a_{cc})}{1-a_{cc}L/Z_1} = \gamma Z_1 = \frac{H(1-a_c)}{1-a_cL/Z_1}$. Both functions $\frac{L(1-a)}{1-aL/Z_1}, \frac{H(1-a)}{1-aL/Z_1}$ are strictly and continuously decreasing in a. Thus, $L < H$ requires $a_{cc} < a_c$. □

Proof. [Lemma 4.2] We show that for all possible forbearance levels $a \in (\underline{a}, 1]$ and insurance levels $\gamma \in [0,1)$:

$$\theta \max\left(Z_2(n), \gamma Z_1\right) + (1-\theta)\gamma Z_1 \geq s_\gamma(a), \quad \text{for all } n \in [0, aL/Z_1] \tag{35}$$

From Lemmata 9.2 and 9.3: If $\gamma \in [0, L/Z_1)$, then we can partition the range of possible

forbearance levels into $[0, a_{cc}) \cup [a_{cc}, a_c) \cup [a_c, 1]$. For $\gamma \in [L/Z_1, 1)$, $a_{cc} = 0$, and only the partition $[a_{cc}, a_c) \cup [a_c, 1]$ is relevant.
Case (i): Let $a \in [0, a_{cc})$. Then $Z_2(n) \geq \frac{H(1-a)}{1-aL/Z_1} > \gamma Z_1$ for all $n \in [0, aL/Z_1]$ and $s_\gamma(a) = L(1-a)/(1-La/Z_1)$. Thus, a sufficient condition for (35) is

$$\theta \frac{H(1-a)}{1-aL/Z_1} + (1-\theta)\gamma Z_1 \geq \frac{L(1-a)}{(1-La/Z_1)}. \tag{36}$$

Let $\theta \geq \underline{\theta} = Z_1(1-\gamma)/(H-\gamma Z_1)$ so that withdraw is not a dominant action. Therefore, a sufficient condition for (36) is $\gamma Z_1 + \underline{\theta}\left(\frac{H(1-a)}{1-aL/Z_1} - \gamma Z_1\right) \geq \frac{L(1-a)}{(1-La/Z_1)}$. This inequality is equivalent to requiring $(Z_1 - L)\,[H(1-a) + \gamma(Ha - Z_1)] \geq 0$. By $Z_1 > L$, it suffices to check whether $H(1-a) + \gamma(Ha - Z_1) > 0$ for all $a \in [0, a_{cc})$. The latter is equivalent to requiring $(H - \gamma Z_1)/(H(1-\gamma)) > a$ for all $a \in [0, a_{cc})$. But this is always the case because $H > Z_1$ and thus $(H - \gamma Z_1)/(H(1-\gamma)) > 1$ while always $a < 1$.

Case (ii), let $a \in [a_{cc}, a_c)$. Then $Z_2(n) \geq \frac{H(1-a)}{1-aL/Z_1} > \gamma Z_1$ for all $n \in [0, aL/Z_1]$ and $s_\gamma(a) = \gamma Z_1$. Then, (35) follows with strict inequality immediately. Likewise for case (iii), $a \in [a_c, 1]$. There exists $\bar{n} \in [0, aL/Z_1)$: for $n \in [0, \bar{n})$ we have $Z_2(n) > \gamma Z_1$. For $n \in [\bar{n}, aL/Z_1)$, $Z_2(n) < \gamma Z_1$. Also, for all $a \in [a_c, 1]$, it holds $s_\gamma(a) = \gamma Z_1$. Thus, for all withdrawal levels $n \in [0, \bar{n})$, (35) holds with strict inequality by case (ii). For all higher withdrawal levels $n \in [\bar{n}, aL/Z_1)$ (35) holds with equality. □

Proof. [Proposition 4.2] We need to distinguish between the three cases: $a \in [0, a_{cc})$, $a \in [a_{cc}, a_c)$, and $a \in [a_c, 1]$.
Case (i) Let $a \in [0, a_{cc})$, so that $s_\gamma(a) > \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$. Such a range must exist whenever insurance is such that $\gamma Z_1 < L$. Away from the limit, the payoff indifference equation (31) can be written using (32) as

$$\theta^*_\varepsilon(a) = \frac{La\left((1-\gamma) - \left(1 - \frac{s_\gamma(a)}{Z_1}\right)\ \ln(La/Z_1)\right) - \varepsilon\ \int_0^{La/Z_1} (1-2n)\cdot\left(\frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right)\ dn}{\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\ dn - \gamma\ La} \tag{37}$$

Via Lebesgues Dominated Convergence Theorem, the limit of the trigger equals

$$\lim_{\varepsilon\to 0} \theta^* = \frac{(1-\gamma) - \left(1 - \frac{s_\gamma(a)}{Z_1}\right)\ \ln(\frac{La}{Z_1})}{\frac{1}{La}\left(\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\ dn - \gamma La\right)} \tag{38}$$

Moreover, because the noise term enters multiplicative, we have

$$\left|\frac{\partial}{\partial a}\theta^*_\varepsilon(a) - \frac{\partial}{\partial a}\left(\lim_{\varepsilon\to 0}\theta^*\right)\right| = \varepsilon\left|\underbrace{\frac{\partial}{\partial a}\left(\frac{\int_0^{La/Z_1}(1-2n)\cdot\left(\frac{H(1-Z_1n/L)}{1-n}-\gamma Z_1\right)\,dn}{\int_0^{La/Z_1}\frac{H(1-Z_1n/L)}{1-n}\,dn-\gamma\, La}\right)}_{\equiv const(a)}\right| \tag{39}$$

$$\leq \varepsilon \sup_{a\in[\underline{a},1]}|const(a)| \to 0,\ \text{as } \varepsilon\to 0 \tag{40}$$

Therefore, the derivative $\frac{\partial}{\partial a}\theta^*_\varepsilon(a)$ converges uniformly to the derivative of the limit $\lim_{\varepsilon\to 0}\theta^*$. As a consequence, $\lim_{\varepsilon\to 0}\frac{\partial}{\partial a}\theta^*_\varepsilon(a) = \frac{\partial}{\partial a}\lim_{\varepsilon\to 0}\theta^*_\varepsilon(a)$ and we can work with the derivative of the limit directly, to save on notation. Let $D(a)$ denote the numerator in (38), $D(a) := (1-\gamma)-\left(1-\frac{L(1-a)}{Z_1-La}\right)\ \ln(\frac{La}{Z_1})$, and let $C(a)$ its denominator, $C(a) := \frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1n/L)}{1-n}\,dn-\gamma$. Consider the limit $\varepsilon\to 0$ of the payoff-difference function $F_0(\theta^*,a)=\theta^*C(a)-D(a)$ where $\theta^*=\lim_{\varepsilon\to 0}\theta^*_\varepsilon$. For given a, the equilibrium trigger satisfies $F_0(\theta^*,a)=0$. We want to show $\lim_{a\to 0}\frac{\partial\theta^*}{\partial a}<0$. Employing the implicit function theorem, we know that $\frac{\partial\theta^*}{\partial a}=-\frac{\partial F_0}{\partial a}/\frac{\partial F_0}{\partial\theta^*}$. We immediately see that $\frac{\partial F_0}{\partial\theta^*}=C(a)>0$, where $C(a)>0$ holds because $\frac{H(1-Z_1n/L)}{1-n}$ is strictly decreasing in n, because $H(1-a)/(1-La/Z_1)>\gamma Z_1$ by $a\in[0,a_{cc})$, and due to $Z_1>La$. Next, we have $\frac{\partial F_0}{\partial a}=\theta^*C'(a)-D'(a)$. To determine the sign, the trigger is always positive. See that C' is negative because $\frac{H(1-Z_1n/L)}{1-n}$ is strictly decreasing on $[0,La/Z_1]$, $C'(a)=-\frac{1}{La^2}\int_0^{La/Z_1}\frac{H(1-Z_1n/L)}{1-n}\,dn+\frac{1}{a}\frac{H(1-a)}{Z_1-La}<-\frac{1}{La^2}\,La\frac{H(1-a)}{Z_1-La}+\frac{1}{a}\frac{H(1-a)}{Z_1-La}=0$. For the term $D'(a)$, using the logarithm inequality $\ln(\frac{La}{Z_1})>(La-Z_1)/(La)$,

$$D'(a) = -\frac{L(1-L/Z_1)}{Z_1(1-La/Z_1)^2}\ \ln(\frac{La}{Z_1}) - \frac{1}{a}\left(1-\frac{L(1-a)}{Z_1(1-La/Z_1)}\right) \tag{41}$$

$$< \frac{1}{a}\ \frac{1-L/Z_1}{1-La/Z_1} - \frac{1}{a}\left(1-\frac{L/Z_1(1-a)}{(1-La/Z_1)}\right) = 0 \tag{42}$$

implying $\lim_{a\to 0}\ D'(a)\leq 0$. Altogether, bank stability is generically non-monotone in forbearance because the sign of $\frac{\partial F_0}{\partial a}=\theta^*C'(a)-D'(a)$ may depend on the relative size of C' and D'. We can however show that immediate intervention is never optimal from a stability point of view: Consider the function

$$F(a) = \frac{1}{La/Z_1}\int_0^{La/Z_1}\underbrace{\frac{H(1-Z_1n/L)}{1-n}}_{f(n)}\,dn \tag{43}$$

Since $\frac{H(1-Z_1 n/L)}{1-n}$ is a continuous function on a compact interval $[0, La/Z_1]$, by the mean value theorem for integrals there exists a $c \in [0, La/Z_1]$ such that $f(c) = F(a)$. As $a \to 0$, we have $c \to 0$ because the bounded interval $[0, La/Z_1]$ collapses to the point zero. Therefore, $\lim_{a\to 0} F(a) = \lim_{c\to 0} f(c) = H$. Therefore,

$$C'(a) = \frac{1}{aZ_1}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) \tag{44}$$

with $\lim_{a\to 0}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) = 0$. Moreover, with (42), (44), and because the trigger is bounded $\theta^* \in [\underline{\theta}, \overline{\theta}]$,

$$\lim_{a\to 0}\frac{\partial F_0}{\partial a} = \lim_{a\to 0}\left(\theta^* C'(a) - D'(a)\right) \tag{45}$$

$$\geq \lim_{a\to 0}\left(\frac{1}{a}\right)\left(\underline{\theta}\,\frac{1}{Z_1}\lim_{a\to 0}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) - \lim_{a\to 0}\left(aD'(a)\right)\right) \tag{46}$$

$$= \lim_{a\to 0}\left(\frac{1}{a}\right)\left(-\lim_{a\to 0}\left(aD'(a)\right)\right) \geq 0, \tag{47}$$

because $\lim_{a\to 0} D'(a) \leq 0$. Therefore, we have $\lim_{a\to 0}\frac{\partial\theta^*}{\partial a} \leq 0$, meaning that bank stability improves in forbearance for sufficiently low forbearance levels $a \in [0, a_{cc})$.

Case (ii) Let $a \in [a_{cc}, a_c)$, so that given a resolution, $n \in [La/Z_1, 1]$, the pro-rata share to rolling over is constant at the insured amount $s_\gamma(a) = \gamma Z_1$, and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$. This scenario in particular applies to the case $\gamma Z_1 \geq L$ so that $s_\gamma(a) = \gamma Z_1$ for all $a \in [0,1]$, and thus, $a_{cc} = 0$. From above, the trigger becomes

$$\lim_{\varepsilon\to 0}\theta^* = \frac{(1-\gamma)(1-\ln(\frac{La}{Z_1}))}{\frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma} \tag{48}$$

Observe that the denominator $C(a)$ has not changed. Call the numerator now $\hat{D}(a) := (1-\gamma)(1-\ln(\frac{La}{Z_1}))$ and see that $\hat{D}'(a) = -(1-\gamma)\,\frac{1}{a}$. Following the reasoning of case (i), the limit payoff difference function becomes $F_0(\theta^*, a) = \theta^* C(a) - \hat{D}(a)$. Then, with (44)

$$\lim_{a\to 0}\frac{\partial F_0}{\partial a} = \theta^*\,C'(a) - \hat{D}'(a) = \lim_{a\to 0}\frac{1}{a}\left(\theta^*\frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) + (1-\gamma)\right) \tag{49}$$

$$\geq \lim_{a\to 0}\frac{1}{a}\left(\underline{\theta}\frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) + (1-\gamma)\right) = \lim_{a\to 0}(1-\gamma)\,\frac{1}{a} > 0 \tag{50}$$

because $\frac{H(1-a)}{1-La/Z_1} - f(c) \to 0$ as $a \to 0$. Therefore, we have $\lim_{a\to 0} \frac{\partial\theta^*}{\partial a} < 0$ if also $a \in [a_{cc}, a_c)$. This in particular applies to the case $\gamma Z_1 \geq L$, where $a_{cc} = 0$.

To wrap up cases (i) and (ii): If insurance is such that $\gamma \in [0, L/Z_1)$, then $a_{cc} \in (0, a_c)$ exists and we have shown that for $a \in [0, a_{cc})$, $\lim_{a\to 0} \frac{\partial\theta^*}{\partial a} \leq 0$. If insurance is such that $\gamma \in [L/Z_1, 1)$, then $a_{cc} = 0$. Then, case (ii) shows that for all $a \in [a_{cc}, a_c) = [0, a_c)$ we have $\lim_{a\to 0} \frac{\partial\theta^*}{\partial a} < 0$. Consequently, *independently* of the level of deposit insurance $\gamma \in [0, 1)$, it holds $\lim_{a\to 0} \frac{\partial\theta^*}{\partial a} \leq 0$.

Last, consider high forbearance levels $a \in [a_c, 1]$, so that $s_\gamma(a) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, \bar{n})$ while $Z_2(n) = \gamma Z_1$ for all $n \in [\bar{n}, aL/Z_1)$. That is, the pro-rata share receivable when rolling over may undercut the insured value of the deposit even absent a resolution, $\frac{H(1-a)}{1-La/Z_1} < \gamma Z_1$. The payoff difference equation becomes

$$0 = \int_0^{\bar{n}} \left(\gamma Z_1 + \theta(n, \theta^*) \cdot \left(\frac{H(1 - Z_1 n/L)}{1 - n} - \gamma Z_1\right) - Z_1\right) \, dn \tag{51}$$

$$- \int_{\bar{n}}^{La/Z_1} Z_1 \left(1 - \gamma\right) \, dn - \int_{La/Z_1}^{1} \frac{La}{nZ_1} \left(Z_1 - \gamma Z_1\right) dn \tag{52}$$

At the limit, the trigger becomes

$$\lim_{\varepsilon\to 0} \theta^* = \frac{La \ (1-\gamma)\left(1 - \ln(La/Z_1)\right)}{\int_0^{\bar{n}} \cdot \left(\frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right) \, dn} \tag{53}$$

Crucially, see that $\bar{n}$, and thus the denominator of the trigger are independent of forbearance. Then, the trigger strictly increases (stability deteriorates) in forbearance for all forbearance levels $a \in [a_c, 1]$:

$$\frac{\partial}{\partial a} \lim_{\varepsilon\to 0} \theta^* = -\frac{(1-\gamma)\, L \, \ln(La/Z_1))}{\int_0^{\bar{n}} \cdot \left(\frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right) \, dn} > 0 \tag{54}$$

Last, recall that the range $a \in [a_c, 1]$ exists (and is non-empty) independently of the level of deposit insurance. Thus, for all possible $\gamma \in [0, 1)$, the trigger strictly increases in forbearance for high forbearance levels.

Because for all levels of deposit insurance, the trigger declines for $a \to 0$ but increases for $a \in (a_c, 1]$, the trigger minimizer $a^* \in (\underline{a}, 1)$ has to be interior. $\square$

10 Proofs: Suspension Resolution

Lemma 10.1. *At the limit $\varepsilon \to 0$, the trigger under a suspension resolution equals*

$$\lim_{\varepsilon\to 0} \theta^* = \frac{aL\,(1-\gamma)\left(1-\ln\left(\frac{aL}{Z_1}\right)\right)}{Z_1\left(\frac{H}{L}-\gamma\right)m(a) - H\left(1-\frac{Z_1}{L}\right)\,\ln(1-m(a)) - R(a)\frac{aL}{Z_1}\,\ln\left(\frac{aL}{Z_1}\right)} \tag{55}$$

where $m(a,\gamma) = \min(\bar{n}(\gamma), \frac{aL}{Z_1})$.

Proof. [Lemma 10.1] With the state-contingent pro rata share $s_\gamma(a,\theta)$ given in equation (12), $s_\gamma(a,\theta) = \gamma Z_1 + \theta\,\max\left(\frac{r(1-a)}{1-La} - \gamma Z_1, 0\right)$, define a short-cut for the incremental payoff above the insured level of the deposit payable if the asset pays off

$$R(a,\gamma) := \max\left(\frac{r(1-a)}{1-La/Z_1} - \gamma Z_1, 0\right). \tag{56}$$

The payoff indifference equation (31) becomes

$$\int_0^{aL/Z_1} \theta(n,\theta^*)\,\max(Z_2(n)-\gamma Z_1, 0)\,dn + \int_{aL/Z_1}^1 \frac{aL}{nZ_1}\,\theta(n,\theta^*)R(a)\,dn \tag{57}$$

$$= \int_{aL/Z_1}^1 \frac{aL}{nZ_1}\,(1-\gamma)Z_1\,dn + (1-\gamma)\,aL \tag{58}$$

Together with equation (32), away from the limit the trigger equals

$$\theta^*_\varepsilon(a) = \frac{(1-\gamma)\,La\,(1-\ln(\frac{La}{Z_1})) - \varepsilon\left[\int_0^{\frac{La}{Z_1}} (1-2n)\max\left(0, \frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right)\,dn + R(a,\gamma)\,\frac{La}{Z_1}\,\int_{\frac{La}{Z_1}}^1 \frac{(1-2n)}{n}\,dn\right]}{\int_0^{La/Z_1} \max\left(0, \frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right)\,dn + R(a,\gamma)\,\frac{La}{Z_1}\,\int_{La/Z_1}^1 \frac{1}{n}\cdot dn} \tag{59}$$

By Lebesgue's dominated convergence theorem, the trigger at the limit becomes

$$\lim_{\varepsilon\to 0} \theta^* = \frac{(1-\gamma)\,La\,(1-\ln(\frac{La}{Z_1})}{\int_0^{La/Z_1} \max\left(0, \frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right)\,dn + R(a,\gamma)\,\frac{La}{Z_1}\,\int_{La/Z_1}^1 \frac{1}{n}\cdot dn} \tag{60}$$

The definition (30) then delivers (55). □

Lemma 10.2. *Fix r, Z_1, and deposit insurance $\gamma \in [0,1)$.*
(a) Assume insurance is such that $\gamma \in [0, r/Z_1)$. Then, there exists $\hat{a}_{cc}(\gamma, r) \in (0,1)$, $\hat{a}_{cc}(\gamma,r) = \frac{r-\gamma Z_1}{r-L\gamma}$, such that for all $a \in [0, \hat{a}_{cc}(\gamma))$, it holds $\frac{r(1-a)}{1-La/Z_1} > \gamma Z_1$, and thus

$R(a,\gamma) > 0$. *In contrast, for all* $a \in [\hat{a}_{cc}(\gamma), 1]$, *it holds* $\frac{r(1-a)}{1-La/Z_1} \leq \gamma Z_1$, *and thus* $R(a,\gamma) = 0$, *and* $s_\gamma(a,\theta) = \gamma Z_1$.
(b) Assume insurance is such that $\gamma \in [r/Z_1, 1)$. *Then, for all* $a \in [0,1]$ *it holds* $\frac{r(1-a)}{1-La/Z_1} \leq \gamma Z_1$, *and thus* $R(a,\gamma) = 0$, *and* $s_\gamma(a,\theta) = \gamma Z_1$. *In that case, set* $\hat{a}_{cc}(\gamma) \equiv 0$.
(c) Independently of deposit insurance, it holds $\hat{a}_{cc}(\gamma) < a_c(\gamma)$.

Proof. [Lemma 10.2] It holds $\frac{r(1-a)}{1-La/Z_1} > \gamma Z_1$ if and only if $r - \gamma Z_1 \geq a(r - L\gamma)$.
(a) Assume $r > \gamma Z_1$. Then, the left hand side is positive, and by $L < Z_1$, also $r - L\gamma > 0$. Thus, there exists $\hat{a}_{cc}(\gamma) = (r - \gamma Z_1)/(r - L\gamma) \in (0,1)$ with $\frac{r(1-a)}{1-La/Z_1} > \gamma Z_1$ for all $a \in [0, \hat{a}_{cc}(\gamma))$ and $\frac{r(1-a)}{1-La/Z_1} \leq \gamma Z_1$ for all $a \in [\hat{a}_{cc}(\gamma), 1]$.
(b) Assume, $r \leq \gamma Z_1$. The term $\frac{r(1-a)}{1-La/Z_1}$ is strictly decreasing in a, thus reaching its maximum r in $a = 0$. Therefore, if $r \leq \gamma Z_1$, then $\frac{r(1-a)}{1-La/Z_1} \leq \gamma Z_1$ for all $a \in [0,1]$. In that case, set $\hat{a}_{cc}(\gamma) \equiv 0$.
(c) By $H \geq r$, it holds $\frac{H(1-a)}{1-La/Z_1} \geq \frac{r(1-a)}{1-La/Z_1}$, for all $a \in [0,1]$. By definition of $\hat{a}_{cc}(\gamma)$ and $a_c(\gamma)$ from Lemma 9.2, if $\hat{a}_{cc}(\gamma) \in (0,1)$, then $\frac{H(1-a_c(\gamma))}{1-La_c(\gamma)/Z_1} = \gamma Z_1 = \frac{r(1-\hat{a}_{cc}(\gamma))}{1-L\hat{a}_{cc}(\gamma)/Z_1}$, and by $H \geq r$ it follows $a_c(\gamma) \in (\hat{a}_{cc}, 1)$. Likewise, if $\hat{a}_{cc} = 0$, then $a_c(\gamma) \in (\hat{a}_{cc}, 1)$ because $a_c(\gamma) > 0$ by Lemma (9.2). □

Lemma 10.3 (Suspension intervention destroys deposit value)**.** *Under a suspension resolution with* $H > r$, *depositors who roll over are always worse off than absent a resolution, no matter the withdrawal level, the forbearance policy or the level of deposit insurance.*

Proof. [Lemma 10.3] Following the proof of Lemma 4.2, we show that for all possible forbearance levels $a \in [\underline{a}, 1]$ and insurance levels $\gamma \in [0,1)$:

$$\theta \max\left(Z_2(n), \gamma Z_1\right) + (1-\theta)\gamma Z_1 \geq s_\gamma(a,\theta), \quad \text{for all } n \in [0, aL/Z_1] \tag{61}$$

where by definition (12), $s_\gamma(a,\theta) = \gamma Z_1 + \theta \max\left(\frac{r(1-a)}{1-La/Z_1} - \gamma Z_1, 0\right)$ is the pro rata share the depositors receive in $t = 2$ after a suspension intervention. By definition of $Z_2(n)$, for $H > r$, it holds for all $n \in [0, aL/Z_1]$, $Z_2(n) > \frac{r(1-a)}{1-La/Z_1}$. Therefore, $\frac{r(1-a)}{1-La/Z_1} > \gamma Z_1$ implies $Z_2(n) > \gamma Z_1$, but not vice versa, and the claim follows. For $r = H$, the left and the right hand side in (61) are equal, so that the suspension intervention makes no difference to the payoffs. □

Proof. [Proposition 5.2]

According to Lemma 10.2: Analogous to the case of a PCA resolution, under a suspension resolution, for every insurance level $\gamma \in [0,1)$ we can partition the interval of possible forbearance levels into subintervals $[0, \hat{a}_{cc}) \cup [\hat{a}_{cc}, a_c) \cup [a_c, 1]$.[35] We need to discuss three cases.

As in the case of the PCA resolution, because the noise term enters θ^*_ε linearly, and because all integrands are bounded, one can show that the derivative of the trigger $\frac{\partial}{\partial a}\theta^*_\varepsilon$ in (59) converges uniformly to the derivative of the limit $\frac{\partial}{\partial a}\lim_{\varepsilon\to 0}\theta^*$ in (60), for $\varepsilon \to 0$. Therefore, we can take derivatives of the limit directly, to save on notation.

Case (i): Let $\gamma \in [0, r/Z_1)$ so that $\hat{a}_{cc}(\gamma, r) \in (0,1)$ exists. Then the interval $[0, \hat{a}_{cc}(\gamma, r))$ is non-empty. For $a \in [0, \hat{a}_{cc}(\gamma, r))$ we know that $s_\gamma(a,\theta) > \gamma Z_1$, and thus $R(a,\gamma) > 0$. Moreover, $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$. Then, the trigger becomes

$$\lim_{\varepsilon\to 0}\theta^* = \frac{(1-\gamma)\,(1-\ln(\frac{La}{Z_1}))}{\frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma - \left(\underbrace{\frac{r(1-a)}{1-la/Z_1} - \gamma Z_1}_{R(a,\gamma)}\right)\frac{1}{Z_1}\ln(\frac{La}{Z_1})} \tag{62}$$

Let $D_s(a)$ denote the numerator in (62), $D_s(a) = (1-\gamma)\,(1-\ln(\frac{La}{Z_1}))$, and let $C_s(a)$ its denominator, $C_s(a) = \frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma - R(a,\gamma)\ \frac{1}{Z_1}\ln(\frac{La}{Z_1})$. Consider the limit payoff difference function $F_{0,s}(\theta^*, a) \equiv \lim_{\varepsilon\to 0} F_s(\theta^*_\varepsilon, a)$, where $F_{0,s}(\theta^*, a) = \theta^* C_s(a) - D_s(a)$. For given a, the equilibrium trigger must satisfy $F_{0,s}(\theta^*, a) = 0$. As in the case of PCA, we want to show $\lim_{a\to 0}\frac{\partial\theta^*}{\partial a} < 0$. Employing the implicit function theorem, we know that $\frac{\partial\theta^*}{\partial a} = -\frac{\partial F_{0,s}}{\partial a}/\frac{\partial F_{0,s}}{\partial\theta^*}$. We immediately see that $\frac{\partial F_{0,s}}{\partial\theta^*} > 0$ because $\frac{\partial F_{0,s}}{\partial\theta^*} = C_s(a) > \frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma > \frac{1}{La}\frac{H(1-a)}{1-La/Z_1} - \gamma > 0$, because $R(a,\gamma) > 0$, $\ln(\frac{La}{Z_1}) < 0$, and because $\frac{H(1-Z_1 n/L)}{1-n}$ is strictly decreasing in n, with $H(1-a)/(1-La/Z_1) > \gamma Z_1$ and $Z_1 > La$. Next, we have $\frac{\partial F_0}{\partial a} = \theta^* C_s'(a) - D_s'(a)$. To determine the sign of the derivative, see that $D_s'(a) = -\frac{(1-\gamma)}{a} < 0$. With $\frac{\partial}{\partial a}R(a,\gamma) = -\frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)^2}$ it holds

$$C_s'(a) = -\frac{1}{La^2}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn + \frac{1}{aZ_1}\left(\frac{H(1-a)}{1-La/Z_1} - R(a,\gamma)\right) \tag{63}$$

$$+\ \frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)^2}\ \ln(La/Z_1) \tag{64}$$

Case $r \in [0, \underline{r})$: We instantly see that for $r \to 0$, by the definition (56) we have $R(a,\gamma) \to 0$. Moreover, by the mean value theorem for integrals, there exists $c_s \equiv c_s(a) \in$

[35]Note, later on, only forbearance levels $a \in [\underline{a}, 1]$ are considered but to reduce notation here, I will abstract from explicitly making case distinctions such as whether $\underline{a}$ exceeds or undercuts $\hat{a}_{cc}$ and a_c.

$[0, La/Z_1]$ with $f(c_s) = \frac{1}{La/Z_1} \int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\, dn$ where $f(n) = \frac{H(1-Z_1 n/L)}{1-n}$. Therefore, as $a \to 0$, the compact interval $[0, La/Z_1]$ collapses to the point zero, and necessarily $c_s \to 0$. Because f is continuous, then $\lim_{a\to 0} f(c_s) = f(0) = H$. Thus,

$$\lim_{a\to 0}\left[-\frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1n/L)}{1-n}\,dn+\frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1}\right)\right] \tag{65}$$

$$= \lim_{a\to 0}\left[-\frac{1}{Z_1}f(c_s)+\frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1}\right)\right] = 0 \tag{66}$$

Then altogether with (65) and (66), $\lim_{a\to 0}\lim_{r\to 0}\frac{\partial F_0}{\partial a} = \lim_{a\to 0}\lim_{r\to 0}(\theta^* C_s'(a) - D_s'(a)) = \lim_{a\to 0}\frac{1}{a}(1-\gamma) > 0$, because the trigger θ^* is uniformly bounded in $[\underline{\theta}, \overline{\theta}]$. Therefore, $\lim_{a\to 0}\lim_{r\to 0}\frac{\partial F_0}{\partial a} > 0$, and thus, $\lim_{a\to 0}\lim_{r\to 0}\frac{\partial \theta^*}{\partial a} < 0$. Because the result holds for $r \to 0$, it must also hold in an environment $[0, \underline{r}), \underline{r} > 0$ around zero.

Case $r \in [\overline{r}, H]$: Let $r, a > 0$. In that case, via (63) $C_s'(a) < -\frac{1}{aZ_1}R(a,\gamma) - \frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)} < 0$, because $\frac{H(1-Z_1n/L)}{1-n}$ is strictly decreasing, and via $\ln(1+x) < x$ for all $x > -1$. Next, observe that the trigger is bounded from below by the lower dominance region $\theta^* \geq \underline{\theta} = Z_1(1-\gamma)/(H-\gamma Z_1) > 0$. Therefore,

$$\lim_{r\to H}\frac{\partial F_0}{\partial a} = \lim_{r\to H}(\theta^* C_s'(a) - D_s'(a)) \tag{67}$$

$$< \lim_{r\to H}\frac{\underline{\theta}}{a}\Big[-\frac{1}{Z_1}R(a,\gamma) - \frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)} + \frac{(1-\gamma)}{\underline{\theta}}\Big] \tag{68}$$

$$= \frac{\underline{\theta}}{a}\Big[-\frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1} - \gamma Z_1\right) - \frac{H(1-L/Z_1)}{Z_1(1-La/Z_1)} + \frac{(1-\gamma)}{\underline{\theta}}\Big] = 0 \tag{69}$$

where the last step follows from plugging in the lower dominance region. Therefore, $\lim_{r\to H}\frac{\partial F_0}{\partial a} < 0$, for $a > 0$ bounded away from zero, and thus, $\lim_{r\to H}\frac{\partial\theta^*}{\partial a} > 0$. Moreover, the result must hold in an environment of H, $(\overline{r}, H]$, with $\overline{r} \in [\underline{r}, H)$ and holds weakly on $[\overline{r}, H]$.

Case (ii): Let $a \in [\hat{a}_{cc}(\gamma, r), a_c)$. This case is in particular relevant if insurance is such that $\gamma \in [r/Z_1, 1)$, which implies $\hat{a}_{cc}(\gamma, r) = 0$ by Lemma 10.2. For $a \in [\hat{a}_{cc}(\gamma, r), a_c)$, it holds $s_\gamma(a, \theta) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$. Therefore, preferences are independent of the RA's management efficiency r, so that also the trigger and its monotonicity are independent of r. Moreover, preferences are identical to those of case (ii) of the PCA resolution, so that the trigger under the suspension resolution coincides with the trigger under PCA, given in (48), and so do monotonicity properties. Consequently,

the monotonicity of the trigger in forbearance is generically ambiguous, but for $a \to 0$, the trigger strictly declines (stability improves) in forbearance.
Case (iii) For $a \in [a_c(\gamma), 1]$ it holds $s_\gamma(a, \theta) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, \bar{n})$ while $Z_2(n) = \gamma Z_1$ for all $n \in [\bar{n}, aL/Z_1)$. Therefore, the trigger and its monotonicity are independent of r. Moreover, the case (iii) of suspension intervention is equivalent to the case (iii) of the PCA resolution: The trigger under suspension coincides with the trigger under PCA, given in (53), monotonicity properties therefore coincide. Consequently, the trigger increases in forbearance for all $a \in [a_c, 1]$.

To summarize:
(a) If $\gamma \in [0, r/Z_1)$, then by Lemma 10.2 the interval $[0, \hat{a}_{cc}(\gamma))$ is non-empty. Case (i) above shows that for (a, r) sufficiently small, we have $\frac{\partial \theta^*}{\partial a} < 0$. In contrast, for $r \to H$, then $\frac{\partial \theta^*}{\partial a} > 0$ as long as a is strictly positive.
(b) If $\gamma \in [r/Z_1, 1)$, we know that $\hat{a}_{cc}(\gamma) = 0$, so that case (i) becomes irrelevant and case (ii) takes over. From there, we know that for all forbearance levels $a \in [\hat{a}_{cc}, a_c) = [0, a_c(\gamma))$, $\frac{\partial \theta^*}{\partial a} < 0$ as a becomes small. The size of r is irrelevant here because by $s_\gamma(a) = \gamma Z_1$ the trigger is independent of r.
Summarizing (a) and (b), *independently* of the deposit insurance level, the trigger declines in forbearance if forbearance and r are small. Yet, as a becomes large, case (iii) applies and shows that also for r small the trigger strictly increases in forbearance if forbearance is sufficiently large in $a \in [a_c, 1]$. Recall that the interval $[a_c, 1]$ is non-empty for every level of deposit insurance.
For $r \to H$ while keeping γ fixed, the interval $[r/Z_1, 1)$ becomes empty, the case $\gamma \in [r/Z_1, 1)$ becomes void, and the case $\gamma \in [0, r/Z_1)$ always applies by $H > Z_1$. Further, $\hat{a}_{cc} \to a_c$ as $r \to H$. Therefore, the case (ii) never applies, and one transitions from case (i) to (iii) directly as forbearance increases in the range $[0, \hat{a}_{cc}) \cup [\hat{a}_{cc}, 1]$. Therefore, for r large, the trigger monotonically increases in forbearance over the full range $[0, 1]$ of possible forbearance levels. $\square$

Lemma 10.4 (Comparative statics of trigger in deposit insurance I)**.** *(a) For every forbearance level, bank stability monotonically increases (the critical state declines) in deposit insurance coverage.*
(b) As insurance coverage becomes full, depositors have a dominant strategy to roll-over, i.e. the critical state goes to zero $\theta^*(a) \to 0$, for all $a \in (\underline{a}, 1]$ so bank runs do not occur in equilibrium.
(c) For $\gamma = 0$, the critical state curve exceeds the efficiency cut-off for every forbearance

level $a \in [\underline{a}, 1]$, $\theta_b(a, 0) > \theta_e$.

Lemma 10.5 (Comparative statics of trigger in deposit insurance II)**.** *For every forbearance level, there exists a unique level of deposit insurance such that* $\theta_b(a, \gamma) = \theta_e$.

Proof. [Lemma 10.4] (a) We show that in the case of PCA the trigger, and thus, the critical state monotonically decline in γ. Using the notation and results of Lemma 9.1: Fix γ, then a_{cc} and a_c are determined with $0 \leq a_{cc}(\gamma) < a_c(\gamma) \leq 1$. The general payoff difference function equals

$$F = \int_0^{La/Z_1} (\theta(n, \theta^*) \max(Z_2(n), \gamma Z_1) + (1 - \theta(n, \theta^*))\gamma Z_1 - Z_1) \, dn \tag{70}$$

$$- \int_{La/Z_1}^{1} \frac{La}{nZ_1} (Z_1 - s_\gamma(a)) \, dn \tag{71}$$

Clearly, $\frac{\partial}{\partial \theta^*} F = \int_0^{La/Z_1} \left(\frac{\partial}{\partial \theta^*} \theta(n, \theta^*) \left(\max(Z_2(n), \gamma Z_1) - \gamma Z_1 \right) \right) dn > 0$. First, consider an arbitrary $a \in [0, a_{cc}) \subset [0, a_c)$. Then $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$ and $s_\gamma(a) > \gamma Z_1$, so that $s_\gamma(a)$ is in particular independent of γ. Because Z_2 is independent of γ too, $\frac{\partial}{\partial \gamma} F = \int_0^{La/Z_1} ((1 - \theta(n, \theta^*)) Z_1) \, dn > 0$. If $a \in [a_{cc}, a_c)$, then $s_\gamma(a) = \gamma Z_1$ but still $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$. In that case, $\frac{\partial}{\partial \gamma} F = \int_0^{La/Z_1} ((1 - \theta(n, \theta^*)) Z_1) \, dn + \int_{La/Z_1}^1 \frac{La}{nZ_1} Z_1 \, dn > 0$. If $a \in [a_c, 1]$, then $s_\gamma(a) = \gamma Z_1$ remains. But only for $n \in [0, \overline{n})$ it holds $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$. For $n \in [\overline{n}, aL/Z_1)$, we have $Z_2(n) \leq \gamma Z_1$, and thus $\max(Z_2(n), \gamma Z_1) = \gamma Z_1$. Then, $\frac{\partial}{\partial \gamma} F = \int_0^{\bar{n}} ((1 - \theta(n, \theta^*)) Z_1) \, dn + \int_{\bar{n}}^{La/Z_1} Z_1 \, dn + \int_{La/Z_1}^1 \frac{La}{nZ_1} Z_1 \, dn > 0$. Allover, for given (a, γ), the equilibrium trigger θ^* needs to satisfy $F(a, \gamma, \theta^*) = F_a(\gamma, \theta^*) = 0$. Therefore, the change of the trigger due to a changeof γ can be described by the implicit function theorem via $(\partial \theta^*)/(\partial \gamma) = -\left(\frac{\partial F}{\partial \gamma} \right) / \left(\frac{\partial F}{\partial \theta^*} \right)$. Thus, we have shown that $(\partial \theta^*)/(\partial \gamma) < 0$ for every possible a. In the case of suspension intervention, the analogous proof applies. At the limit $\varepsilon \to 0$, the trigger and the critical state, as well as their derivatives coincide.

(b) We next show that the trigger, and thus, the critical state under both a PCA and a suspension intervention go to zero, as $\gamma \to 1$. In that case, $s_\gamma = \gamma Z_1 \to Z_1$ for all a. Therefore $(Z_1 - s_\gamma) \to 0$, and because $\int_{La/Z_1}^1 \frac{La}{nZ_1} dn$ is bounded,

$$\lim_{\gamma \to 1} F = \begin{cases} \int_0^{La/Z_1} \theta(n, \theta^*) \left(Z_2(n) - Z_1 \right) dn > 0, & \text{for } a \leq a_c(1) \\ \int_0^{\bar{n}} \theta(n, \theta^*) \left(Z_2(n) - Z_1 \right) dn > 0 & \text{for } a \in (a_c(1), 1] \end{cases} \tag{72}$$

where $\bar{n} \in (0, aL/Z_1)$. Because the equilibrium trigger needs to satisfy $F_a(\gamma, \theta^*) =$

0, the latter requires $\theta^* \to 0$. Last, $\theta^* \to 0$ is feasible because $\underline{\theta} \to 0$ for $\gamma \to 1$. Thus, the equilibrium trigger indeed goes to zero as insurance becomes complete, for every forbearance level. That is, under complete insurance, the trigger is constant in forbearance.

(c) Set $\gamma = 0$. Observe that $a_c(0) = 1$ and that $\underline{a}$ can be close to zero. Therefore, we only need to check the intervals $[0, a_{cc})$ and $[a_{cc}, a_c)$. Let $a \in [0, a_{cc})$. Then the trigger at $\gamma = 0$ at the limit $\varepsilon \to 0$ equals

$$\lim_{\varepsilon \to 0} \theta^*(a, 0) = \frac{1 - \ln(La/Z_1)\left(1 - \frac{1}{Z_1}\frac{L(1-a)}{1-aL/Z_1}\right)}{\frac{1}{La}\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\,dn} \tag{73}$$

Because $\frac{H(1-Z_1 n/L)}{1-n}$ is decreasing in n, and by the logarithm law $\ln(1+x) < x$ for $x > -1$, we have $\lim_{\varepsilon \to 0} \theta^*(a, 0) > \frac{1-\left(\frac{La}{Z_1}-1\right)\left(1-\frac{1}{Z_1}\frac{L(1-a)}{1-aL/Z_1}\right)}{\frac{H}{Z_1}} = \frac{2Z_1 - L}{H} \geq \frac{Z_1}{H} \geq \frac{L}{H} = \theta_e$, by $Z_1 \geq L$. Now assume $a \in [a_{cc}, a_c]$. Then, at $\gamma = 0$, $\lim_{\varepsilon \to 0} \theta^*(a, 0) = \frac{1-\ln(La/Z_1)}{\frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn} > \frac{Z_1(2-La/Z_1)}{H} \geq \frac{Z_1}{H} \geq \frac{L}{H} = \theta_e$, because $a_c = 1$ and thus $a \leq 1$. □

Proof. [Lemma 10.5] We want to show that for every forbearance level there exists a unique level of deposit insurance such that the efficiency cut-off is attained. To proof single-crossing, see that by part (c) of Lemma (10.4), for every forbearance level the trigger is above the efficiency cut-off when setting $\gamma = 0$, $\theta^*(a, 0) > \theta_e$. By part (b) of Lemma 10.4, the trigger goes to zero as $\gamma \to 1$, at every forbearance level. Thus, for every forbearance level, the trigger is continuous and monotonically decreasing in γ, taking values above θ_e for γ small and goes down to zero for $\gamma \to 1$, implying, that the trigger satisfies single-crossing of the efficiency cut-off for every a.

□