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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 policy that tolerates few withdrawals.

Key words: Bank resolution, intervention delay, global games, suspension of convertibility, bank run
JEL Classification: G28,G21,G33, D8, E6

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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); 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, impacts the depositors' propensity to run on the bank. I study intervention policies that maximize bank stability, and then I discuss how efficiency maximizing policies, i.e., policies that maximize the bank's investment value, deviate from stability maximizing policies.

Studying such questions is important, since 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 determination (PCA). 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). Since 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, therefore, 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

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

[2] Given an intervention, the FDIC is, therefore, required to apply the least costly resolution method when it comes to resolving small banks. While insured deposits are guaranteed, under receivership, the FDIC is prohibited from protecting uninsured deposits if, as a result, losses to the insurance fund would increase. 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.

modeled as partial since unconditional insurance exists neither in the U.S. nor in Europe. Only 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 while 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 whether 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 'prompt corrective action (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 and holds assets until maturity, potentially at a reduced management efficiency.

As the main contribution, I demonstrate 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, i.e. if the RA tolerates too few withdrawals until intervention, then 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. As a consequence, 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. 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 payoffs to depositors who roll over. This payoff externality is standard in the bank run literature (Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005). An intervention bounds this payoff externality more tightly, the less regulatory forbearance is imposed. As the first effect, if the RA pursues a laxer policy and forbears more, then 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 under the mandatory stay decline, and the incentive to run on the bank goes up. I call this effect the 'payoff effect'. One might, therefore, believe that instant intervention minimizes the run-propensity. But this is not true, due to a second effect which is new to the literature. The depositors are afraid of an intervention since they recognize that both intervention procedures reduce resources either by costly liquidation of assets or by managing assets less skillfully, at a expertise than the bank. I show, the intervention makes depositors who roll over worse off ('unconditional intervention externality') and does so to an extent that these depositors wish they had run on the bank to withdraw ('conditional intervention externality'). The anticipation of an intervention does not prevent but increases the incentive to run. This gives rise to the second effect: As the RA forbears more, runs have to be larger for triggering the feared intervenion. Thus, an intervention is believed[3] 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-reducing intervention is believed to occur less frequently against the alarming effect that, given an intervention, resources under mandatory stay are smaller.

The result that regulatory intervention does not necessarily reduce but can increase the

[3]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.

depositor's run-propensity is in contrast to Diamond and Dybvig (1983), where regulatory intervention policy can completely deter runs from happening ex ante. The deterrence of runs is possible there, since the assets are safe, and since the regulator manages assets at the same expertise level as the bank.

To explain the non-monotonic response to changes in regulatory forbearance, the fear of intervention is strongest under conservative policy and vanishes under lax policy. Given an intervention, conservative policy seizes more assets than lax policy where the regulator intervenes only once the run has progressed further. Therefore, at the margin, the costly liquidation of the seized assets under PCA, respectively the switch of the asset's management following a suspension intervention causes a more severe drop in resources under conservative than under lax policy. Thus, bank stability improves in regulatory forbearance for low forbearance levels since the fear of intervention dominates the payoff effect that given an intervention, resources are higher. In contrast, 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, since, once withdrawals rise further to hit the intervention threshold, the intervention does not reduce the payoffs any further. Only the payoff effect remains active, implying that 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 while under high levels of insurance they are at odds. Therefore, given low levels of insurance, there may be no rationale for too conservative intervention policies. Moreover, due to the existence of preemptive depositor behavior, conservative and lax intervention policies can attain perfectly 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 of 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 hardly face any losses and do not withdraw from the bank even for severe solvency shocks. As a consequence, investment in bank assets is mostly continued, even though the assets fail often. 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 limit 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, in 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.[4] 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. Since 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 we cannot tell from this paper what would happen if we could design policies jointly with the bank's debt structure.

2 Discussion of the Literature

This paper adds to the literature on bank runs and their prevention. Diamond and Dybvig (1983) show that suspension policies can deter runs altogether if a regulator stops withdrawals beyond a critical measure. Chari and Jagannathan (1988) discuss how suspension policies help with deterring panic runs when depositors have asymmetric information. Ennis and Keister (2009) consider ex post optimal intervention delay when a regulator realizes that a run has been happening. Keister and Mitkov (2016) show how

[4] If state-contingent policy was possible, this would bring new challanges such as equilibrium multiplicity, (Angeletos et al., 2006)

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 which 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 where 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, in 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 distinct 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 that 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, instead, the suspension policy endogenously determines the ex ante run likelihood. Andolfatto et al. (2017) show that 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, in 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 vanishes. 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 that

paper, fund managers can rebuild cash buffers after redemption by selling illiquid assets which reduces future share value, and can thus cause runs. In this paper, the mechanism is the other way around. The regulatory intervention does not reduce but increases pro rata shares, given an intervention. Nevertheless, runs occur more frequently, since the intervention reduces value relative to no intervention.

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.[5] 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 her expert skills on behalf of her lenders.

For obtaining 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 that preemptive depositor behavior can also arise under general intervention mechanisms and shows that 'interval intervention' can fix threshold intervention mechanisms such as PCA and the 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 illiquid assets. Like this paper, they find the run likelihood to be non-montone in the intervention delay, and contribute by studying lack of commitment while here, the regulator is fully committed to his policy.

3 Model

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

[5] The incorporation of 'impatient' types who instantly need to consume is straight forward.

(2005) model and then highlight deviations as the model progresses.

There are three time-periods, $t = 0, 1, 2$ and no discounting. A bank finances a risky, illiquid asset by raising deposits. There are constant returns to scale. The initial bank investment is normalized to one unit. There is free entry, such that the bank is in perfect competition with other banks and makes zero profit. There is a continuum of bank depositors $i \in [0, 1]$. At time zero, depositors are symmetric, and each 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 $t = 2$ here.[6]

Asset For each unit invested at $t = 0$, the asset pays off $H > 2$ at $t = 2$ with probability θ and zero otherwise, where $\theta \sim U[0, 1]$ is the unobservable, random state of the economy.[7] 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 that there exists a boundary state $\overline{\theta} \in (0, 1)$ such that for state realizations above $\overline{\theta}$ the asset pays off the high return for sure, 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 on a share of the bank's return on investment in $t = 2$, receiving the withdrawal-contingent pro rata share

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

[6] Beginning with the seminal contribution of Diamond and Dybvig (1983), there is a large literature that 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, while 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.

[7] While 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. Since $p(\cdot)$ is strictly increasing, incorporating the same function into 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 $\overline{\theta} \to 1$.

if the asset pays off. If the asset fails to pay, then 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 $\varepsilon_i \sim U[-\varepsilon, +\varepsilon]$. Since signals are correlated, they additionally transmit information about the other agents' signals. A depositors' 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 since 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 the more agents withdraw early since the bank is required to sell more asset 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, pay the face value Z_1 to withdrawing depositors, and 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 Goldstein and Pauzner (2005) model who can intervene to deter withdrawals before the bank becomes illiquid. The intervention limits the payoff externality and can, therefore, gurantee a minimum pro rata share to depositors who roll over.

3.1 Resolution Authority and Deposit Insurance

The strategic *resolution authority* (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

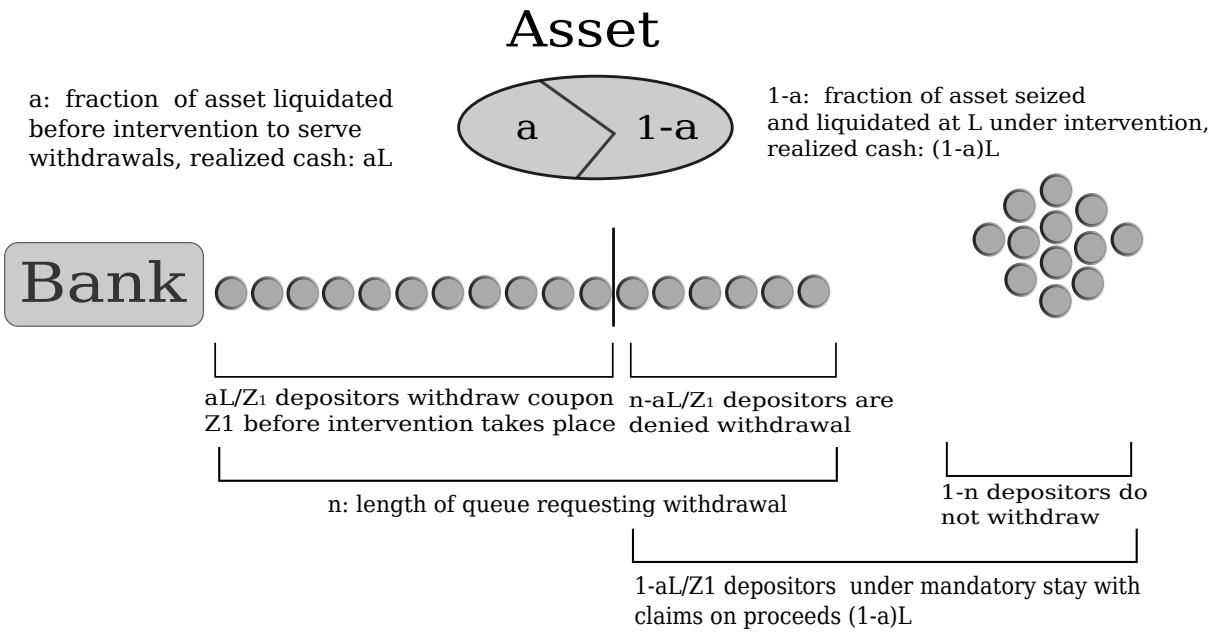


Figure 1: Forbearance determines the maximum deposit outflow until intervention and pro-rata shares under the mandatory stay.

a forbearance minimum $\underline{a} > 0$, since she observes the withdrawals with a delay.[8] An alternative interpretion 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.[9] While 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

[8] I require a minimum forbearance level since 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 has also legal reasons. In the U.S., the FDIC has to obey a forbearance minimum. The asset to debt ratios has to be below a critical threshold; otherwise, intervention is not legally justified. As a recent example from Europe, in September 2017, bondholders 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).

[9] 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).

forbearance policy enforces a minimum reserve ratio equal to the pro rata share.[10]

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.[11] Since 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.

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 whom she serves the short-term coupon Z_1.[12] Then, the RA takes over control, seizes and protects the remaining asset share $1 - a$ by suspending convertibility and imposing a mandatory deposit stay. Conditional

[10] 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.

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

[12] 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.

on the occurrence of a resolution, a depositor who requests withdrawal has, therefore, 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 that are subject to the mandatory stay, see Figure 1. The depositors under the mandatory stay are comprised 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. This model nests the Goldstein and Pauzner (2005) 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, $n \leq aL/Z_1$, then 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 $\gamma Z_1 - Z_2(n)$.[13]

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	$\begin{cases} \max(Z_2(n), \gamma Z_1) & , p = \theta \\ \gamma Z_1 & , p = 1-\theta \end{cases}$
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 impacts 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.

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. There exists a unique trigger signal $\theta^*(a, \gamma) \in [\underline{\theta}, \overline{\theta}]$ 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.

[13] 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 where the bailout is financed from outside of the model.

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 will spend much of the following analysis on determining how the depositors' run-propensity θ^* reacts to changes in the RA's regulatory forbearance a. But for understanding how the equilibrium changes in forbearance, it is helpful to first gain intuition on the depositors' equilibrium behavior at a given forbearance level.

Fix regulatory forbearance a. Consider the common knowledge game where all depositors observe the state perfectly. If the state realizes at the extremes $[0, \underline{\theta}) \cup (\overline{\theta}, 1]$, then 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 since the asset pays off with a too low 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 for sure, the aggregate risk and the maturity mismatch between the bank's asset and liabilities dissolve, 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 rise, the necessary asset liquidation for servicing withdrawals reduces the pro rata share $Z_2(n)$. Therefore, 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, so that a strategic complementarity in actions arises, and 'withdraw' is optimal for high volume withdrawals. Second, with a regulatory intervention mechanism, early withdrawals impose a payoff externality on depositors who roll over, since 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 Goldstein and Pauzner (2005) 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, i.e. 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 since 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 since asset liquidation is costly. Given a resolution, a depositor can never receive a payoff as high under a mandatory stay as she could gain 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 to be high enough for triggering 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, since the payoff to 'roll over' is below the payoff to 'withdraw' for all withdrawal levels that trigger an intervention, i.e. for all withdrawals above threshold La/Z_1, irrespective of the intervention regime. Likewise, the feature can be seen in Figure 3, since for all withdrawal levels that trigger an intervention, the relative payoff Δ to 'roll over' versus 'withdraw' is negative, irrespective of the intervention regime.

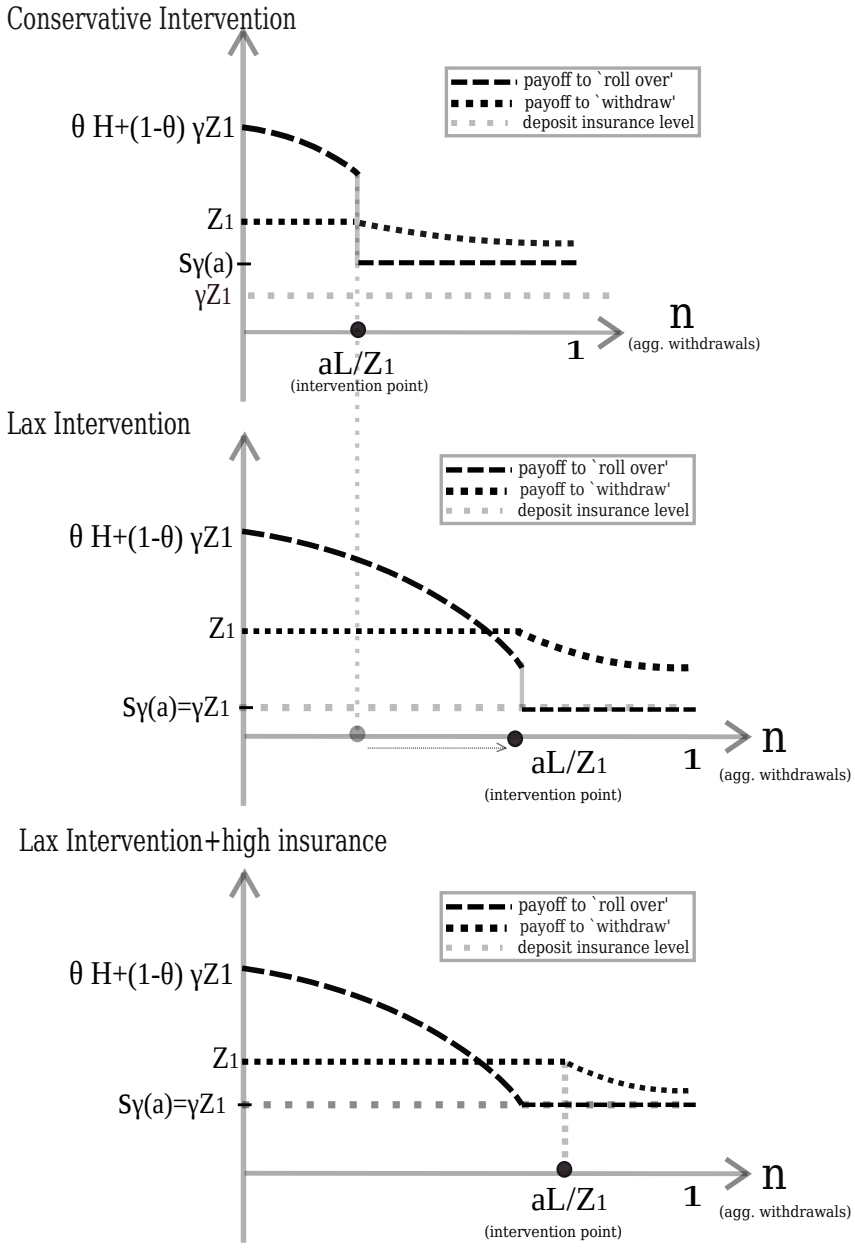


Figure 2: Payoffs to 'roll over' versus 'withdraw' as a function of withdrawals n for states $\theta \in [\underline{\theta}, \overline{\theta}]$. As long as withdrawals are low, 'roll over' is optimal since the associated payoffs exceed the face value Z_1. For high volume withdrawals the pay off to 'roll over' drops below the face value and 'withdraw' becomes optimal (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 depositors' optimal response to switch from 'roll over' to 'withdraw' since PCA liquidates illiquid assets (origin of preemptive behavior). Middle+ Bottom: Under lax intervention, the payoff externality is not sufficiently bounded so that 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 depositors' 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 depositors' fear of intervention vanishes.

In Diamond and Dybvig (1983), in contrast, the anticipation of a 'suspension intervention', can deter runs ex ante. In section 5, I, however, show that also a suspension intervention can cause adverse depositor behavior once aggregate asset risk is introduced and when assuming that the regulator has lower asset management skills than the bank. Since the PCA intervention does not provide for a special case of adverse depositor behavior I will 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 to be high, she withdraws. A self-fulfilling bank resolution occurs, if many depositors anticipate withdrawals to be high, withdraw and *cause* the bank's resolution, thus justifying their actions ex post.

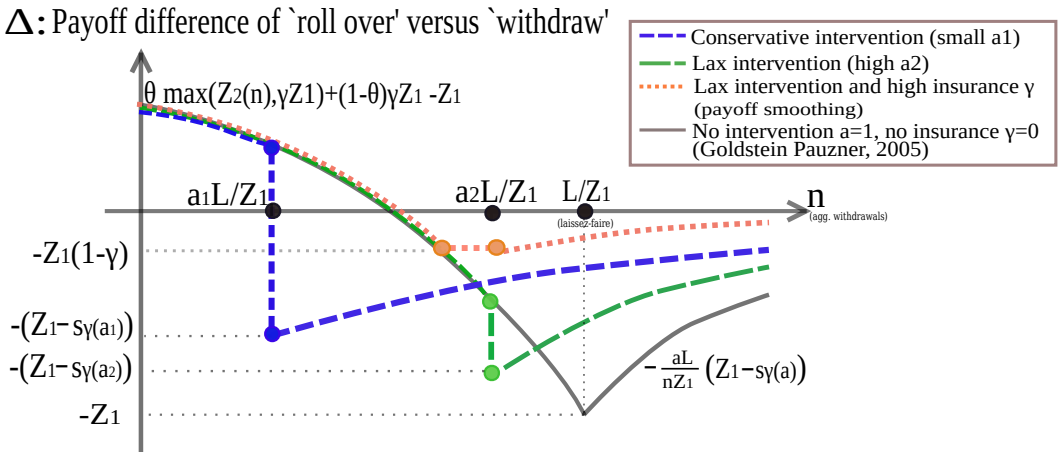


Figure 3: Optimal response for different intervention regimes as a function of aggregate withdrawals n. Roll over is optimal at a given n iff the payoff difference Δ is positive. Intervention can cause the optimal response to switch from 'roll over' to 'withdraw' when causing a jump from a positive to negative-valued Δ at the intervention threshold $n = aL/Z_1$ (see blue, conservative intervention). There exist withdrawal levels in $[a_1L/Z_1, a_2L/Z_1]$ for which roll over is optimal under a lax regime (positive $\Delta(n)$) but withdraw is optimal under a conservative regime (negative $\Delta(n)$), meaning that 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 2005 model).

To attain an equilibrium selection, I employ a global game information structure (Carlsson and Van Damme, 1993), similar to Goldstein and Pauzner (2005). The depos-

itors 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. A trigger equilibrium exists, if given that all other depositors play a trigger strategy around signal θ^*, 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 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 to '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.[14] If the depositors follow a trigger strategy around θ^*, then the aggregate withdrawals equal the measure of depositors who observe signals below the trigger. Since 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 from 'roll over' versus '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 a resolution respectively conditional on a resolution. A signal is a trigger signal θ^*, if the depositors are indifferent between 'withdraw' 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

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

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, there exists a unique trigger signal $\theta^*(a)$ that satisfies the payoff indifference equation $F(\theta^*, a) = 0$. Given that all other depositors play a trigger around θ^*, a depositor optimally follows the same strategy since higher signals imply a higher posterior belief on the fundamental. 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^*, there exists a unique *critical state* $\theta_b \in [\underline{\theta}, \overline{\theta}]$ 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 $\theta < \theta_b$ then sufficiently many agents receive a signal below the trigger θ^* such that an intervention occurs. Since 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. Since the state is uniformly distributed, the ex ante probability of a bank resolution equals θ_b, which motivates the following definition; I define

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 that 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 in a way that the ex ante run likelihood[15] is reduced in comparison 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, meaning they now run to withdraw from the bank for a greater signal range, and the run likelihood re-increase ex ante. This gives rise to a trigger function that is U-shaped in regulatory forbearance, see Figure 5.[16] That is, there are bounds to what an intervention can achieve with regard to improving ex ante bank stability. Because regulatory forbearance impacts 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', i.e. 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 that 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, i.e. 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 where depositors are fully insured is excluded from Proposition 4.2, since the depositors then no longer react to their signals in terms of an altered propensity to

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

[16] In a later contribution, and a slightly different model, Matta and Perotti (2021) likewise show that the run-probability is minimized at an interior intervention delay, if intervention entails the liquidation of illiquid assets. If intervention in their model is such that liquidating illiquid assets is prevented, the run-probability is monotonically decreasing as in Schilling (2017).

withdraw. Instead, they roll over for every signal, irrespective of regulatory forbearance, see Lemma 11.1 in the appendix.

Intuition The depositors' non-monotonic response to a tougher regulator is because a change in regulatory forbearance has 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 depositors who is subject to a mandatory deposit stay. The pro rata share reduces the downside risk to the action 'roll over', i.e. the intervention bounds the standard payoff externality with bank runs. The share declines as the RA shows more regulatory forbearance since 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, when anticipating an intervention the incentive to run for withdrawing the deposit persists also for conservative regulatory forbearance levels (conditional intervention externality) since intervention is costly. One might, nevertheless, believe that 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 this is not true due to a second effect.

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 'withdraw' is not dominant, $\theta \in [\underline{\theta}(\gamma), 1]$. Then, the payoff to depositors who roll over either discontinuously drops or stays constant at the intervention threshold $n = aL/Z_1$.*

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

Whenever 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 since for high states the PCA intervention is costly and reduces resources. The proof of this result is non-trivial since the asset is risky so that asset liquidation is efficient for some low states of the world. The proof, however, shows, whenever the PCA intervention increases value, withdrawing from the bank is already dominant so that the depositors had

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.[17] Considering Lemma 4.2 jointly with Lemma 4.1, if a PCA intervention reduces the deposit value, i.e. if (10) holds with strict inequality, then agents who 'roll over' fear the intervention even though it guarantees a minimum pro rata share, should an intervention occur. This holds because the intervention lowers the roll-over-payoffs to an extent that running on the bank for securing the deposit had been optimal. That is, the intervention fuels the panic.[18]

Consequently, and as the second effect, under a more conservative forbearance policy already lower volume withdrawals trigger a costly intervention. Therefore, a depositor believes that a value-reducing intervention occurs more frequently[19], and her relative incentive to withdraw for securing the deposit goes up.

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 that 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 payoff guarantee effect so that the intervention makes the depositors' race for the exit more instead of less extreme. Only for lax regulatory forbearance the payoff guarantee effect dominates, and intervention reduces the bank run likelihood ex ante. The fear of intervention becomes weaker the laxer the intervention regime. This holds since under conservative regulatory forbearance, the intervention causes much instantaneous asset liquidation and a larger reduction in deposit value, in comparison to a laxer intervention regime where the RA seizes fewer assets, so 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

[17] 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'.

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

[19] 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.

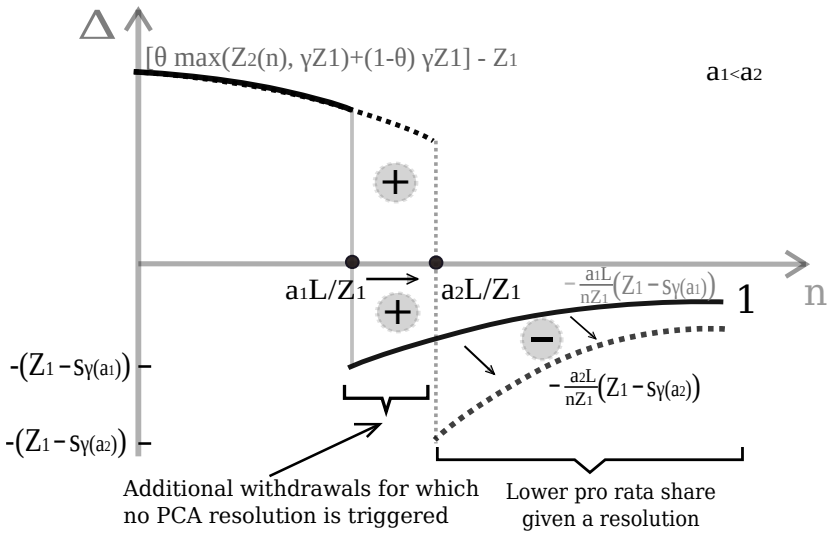
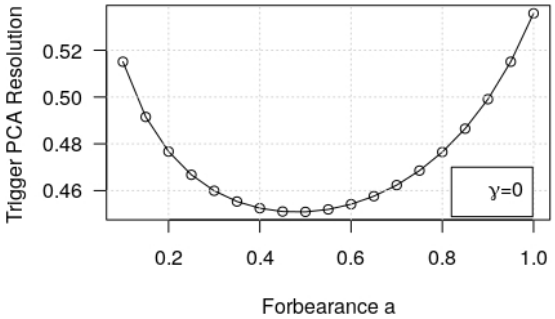


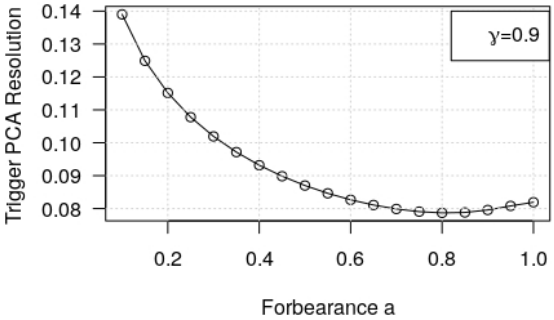
Figure 4: Two-fold change in the expected payoff difference to roll over versus withdraw as regulatory forbearance increases from a_1 to a_2 under a PCA intervention. As the intervention threshold shifts upwards $a_1L/Z_1 \to a_2L/Z_1$, agg. withdrawals have to realize larger for triggering an intervention. 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 $(1-a)$ so 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 ('-').

intervention, i.e. the downward jump of the payoff difference function is less extreme. The fear of intervention vanishes completely under sufficiently lax intervention so that only the payoff guarantee effect remains. This holds since under lax policy, the intervention no longer reduces the depositors' payoffs. The standard payoff externality is no longer sufficiently bounded, so that 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, i.e. inequality (10) holds with equality. As the depositors are no longer afraid of an intervention, a depositor's incentive to preempt the intervention vanishes.[20]

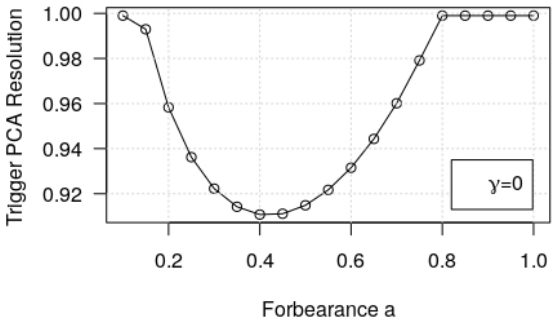
[20]That is, the payoff difference function has become continuous in forbearance at the intervention threshold due to deposit insurance provision. Therefore, marginal changes in forbearance no longer affect the payoff difference function.



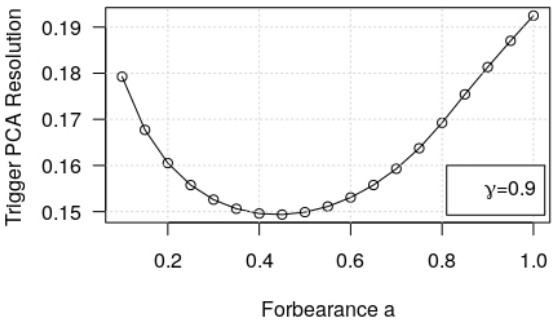
(a) $L = 0.5$



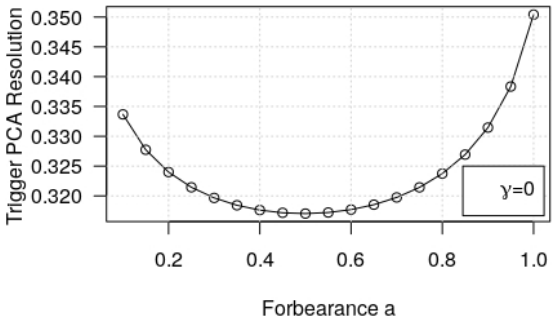
(b) $L = 0.5$



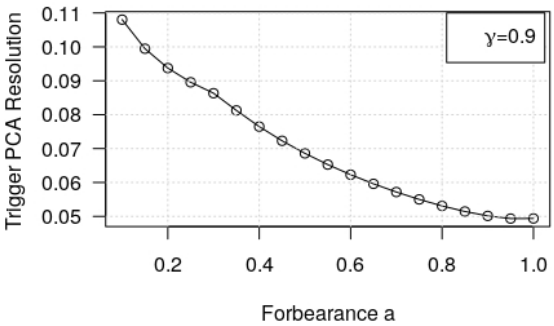
(c) $L = 0.2$



(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, i.e. 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', 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, 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

In the previous section, we have seen 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 will 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.[21]

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.[22] Call r the RA's exogenous investment management skill.

While under a PCA resolution, the liquidation of assets ensures a deterministic but low pro-rata share in $t = 1$, see equation (4), under a suspension resolution, the asset's riskiness implies a risky, state-contingent pro-rata share under a mandatory deposit stay[23]

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

More precisely, when the depositors face their withdrawal decision in $t = 1$, the state is not yet revealed, so that 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

[21] 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.

[22] 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.

[23] 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 while under the suspension intervention the risky return equals θr. With that formulation, the explicit random pro rata under the suspension intervention equals

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

paid. The state-contingent pro-rata share in (12) replaces the PCA pro-rata share in the payoff matrix of the model 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 Equilibium 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, there exists a boundary state $\overline{\theta}_r(a) \in (\underline{\theta}, \overline{\theta})$ so 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, $r < Z_1$, of if she grants too much regulatory forbearance, then the boundary $\overline{\theta}_r(a)$ does not exist. 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.[24] 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), in contrast, a suspension intervention deters runs ex ante

[24] In a model where the RA could adjust her policy to the state, a suspension resolution does not get simpler. To the contrary, as Angeletos, Hellwig, and Pavan (2006) show, since equilibrium multiplicity issues rearise because the RA's policy then conveys information about the state.

because the asset pays for sure so that low forbearance levels guarantee a high pro rata share 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 there exists a range of low state realizations $[0, \underline{\theta})$ for which 'withdraw' is dominant since the asset's payoff likelihood is too low and since deposit insurance coverage is only partial. These arguments establish the existence of an upper and lower dominance region.

Moreover, for *every* forbearance level $a \in [\underline{a}, 1]$ there exist state realizations in a medium range $(\underline{\theta}, \overline{\theta}_S)$ for which a coordination problem with strategic complementarity in actions exists among the depositors. On the one hand, such state realizations imply that 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

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

Since the game structure is identical, the existence and uniqueness result in Proposition 4.1 continues to hold:[25]

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 $\varepsilon \to 0$, there exists a unique trigger signal $\theta^*(a, \gamma)$ which makes a depositor indifferent between 'roll over' and 'withdraw'. Depositors optimally withdraw for signals below the trigger, and otherwise roll over.*

I derive and state the suspension trigger formula in (67) of the appendix.

[25] 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 is a version of my main result in Proposition 4.2 but for the suspension intervention.

Proposition 5.2 (Comparative Statics Trigger: Suspension procedure)
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 $r \in [0, \underline{r})$, *then 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) For $r \in [\overline{r}, H]$*: bank stability monotonically declines in regulatory forbearance, and is maximized at instant intervention* $a = \underline{a}$.

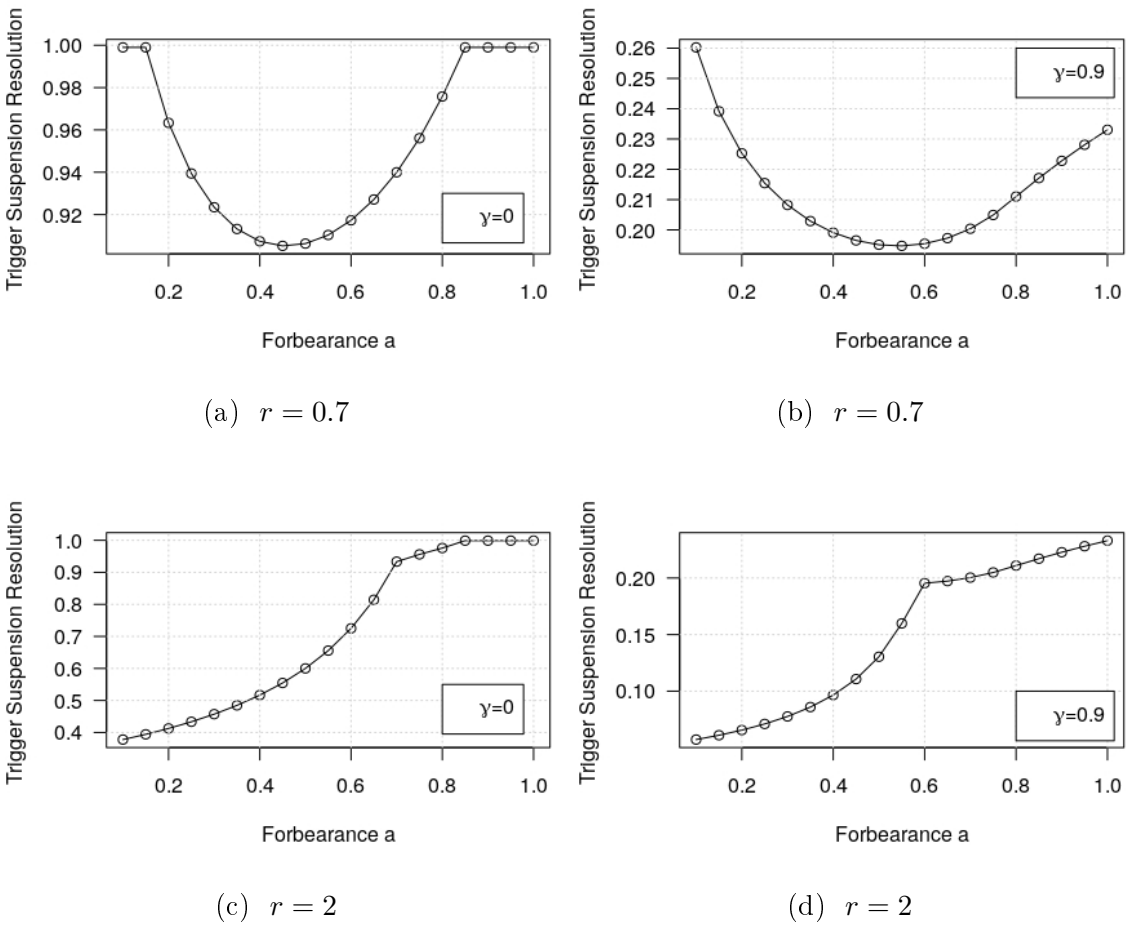
To summarize the result, preemptive depositor behavior exists not only when liquidating assets following a PCA intervention but also if the RA holds assets until maturity but at a lower asset management skill than the bank $r \in [0, \underline{r})$. Therefore, also the effectiveness of a suspension intervention is 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), $a_1 \neq a_2$, i.e., there exist conservative and lax regulatory forbearance levels 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. Only if the RA's asset management skill approaches the bank's expert level, then regulatory forbearance is a well-behaved, monotonic policy tool. In that case, instant intervention maximizes bank stability, see Figures 6c, 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 higher ('payoff effect'). As the second effect, the intervention reduces resources to depositors since the asset's management switches from the bank's expert level H to the RA's skill level r (unconditional intervention externality). Only if the state realizes high in the upper dominance region $[\overline{\theta}, 1]$, then 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 since 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, and the more so, the larger the difference $(H - r)$, since 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.[26] Thus, for states in the range $[0, \overline{\theta})$, there exists an analogous effect as with a PCA intervention: As the RA announces to intervene more conservative, already smaller runs trigger the feared resolution. Thus, the intervention and the according drop in the deposit's value are believed to occur more often, and the depositors' incentives to run for securing their deposit goes up.

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

[26]Even if the RA manages assets as efficiently as the bank at $r = H$, no forbearance level can deter runs ex ante for sure since forbearance does not impact the asset quality (the state).



(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, i.e. 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',

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 since the bank is forced to

sell assets at the low liquidation value L until an intervention occurs while the RA could have realized the 'higher' return r with likelihood θ when intervening to protect assets from liquidation instead. 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 'payoff 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.

6 Policy Goals: Efficiency versus Bank Stability

The previous sections have shown that 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, 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 since the asset is risky. There exist state realizations 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.[27] Efficiency is maximized if the regulatory policy enforces a liquidation of the asset for all states in $[0, \theta_e)$ while investment is continued 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, as noise vanishes, a run with subsequent asset liquidation only occurs for state realizations below the endogenous critical state $\theta_b(a, \gamma)$, see equation (9), which is the depositors' run-propensity that follows the RA's policy. For states above the critical state, investment is continued. Note, we employ the critical state θ_b here instead of the equilibrium trigger signal θ^* since 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

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

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 as[28]

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

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, there exists an interval (θ_b, θ_e) of states for which the depositors do not withdraw from the bank and investment is continued 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 too low run-propensity, 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 from 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, $\theta_b > \theta_e$, then there exists an interval of states (θ_e, θ_b) at which

[28] 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 $\int_{\theta_e}^{\theta_b(a,\gamma)} (\theta H - L)\, d\theta$ respectively 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, 2019).

'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

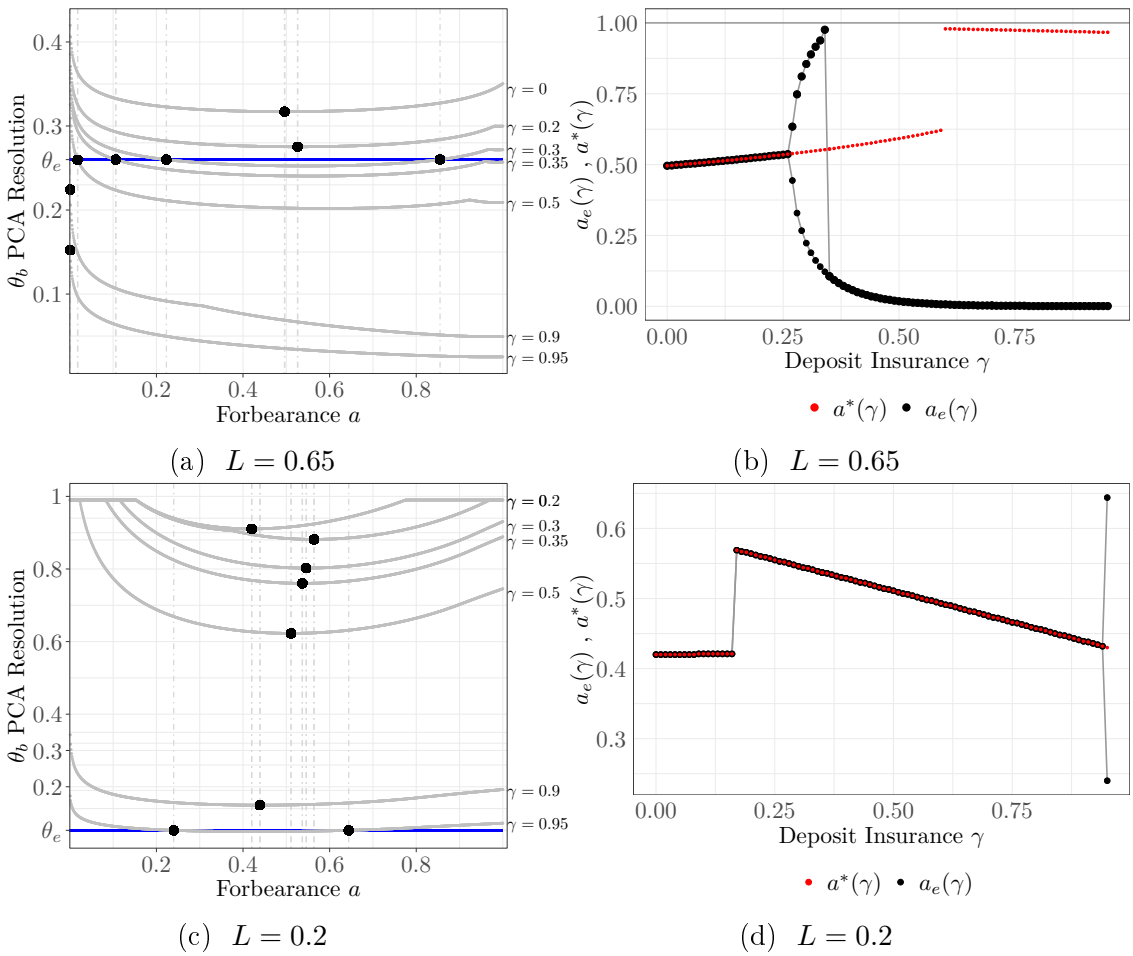
$$\mathbb{P}(\theta \in (\theta_e, \theta_b(\gamma, a))) = \begin{cases} \theta_b(a) - \theta_e, & \theta_b(a) \geq \theta_e \\ 0, & \theta_b(a) < \theta_e \end{cases} \tag{19}$$

A lower run-propensity would increase the value of investment since costly liquidation was prevented more often. Therefore, whenever inefficient runs exist, there is no trade-off between setting policy for improving efficiency and policy for improving bank stability.

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

Corollary 6.1 (Efficient regulatory forbearance under PCA)
There exist bounds for the levels of deposit insurance provision $\underline{\gamma}, \overline{\gamma} \in [0, 1)$ *with* $0 < \underline{\gamma} < \overline{\gamma} < 1$ *such that*
a) If deposit insurance is low, $\gamma \in [0, \underline{\gamma}]$*, then the efficient forbearance level is interior and equal to the maximizer of bank stability,* $a_e = a^* \in (\underline{a}, 1)$*. There is no regulatory conflict between maximizing bank stability and efficiency. The first best outcome is not reached.*
b) As 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 exactly 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 11.1 in the appendix and Proposition 4.2.



(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. This 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, for high insurance they diverge. The forks imply that at some interim insurance levels the efficient forbearance level is simultaneously attained at a lax and a conservative forbearance policy. All plots use $H = 2.5$, $Z_1 = 0.7$, $\theta_e = L/H$.

The results are depicted in Figure 7. The points in the 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. That means, the spread in regulation intensity across the mirrors becomes more extreme while, yet, both mirrors attain first best efficiency and same stability.

The proof is intuitive: Recall that the critical state as a function of regulatory forbearance has a U-shape with interior minimizer ('critical state curve'). For low levels of deposit insurance coverage, the maximization of bank stability and efficiency coincide. This is, since the critical state curve is entirely located above the efficiency cut-off, i.e. the critical state exceeds the efficiency cut-off for every regulatory forbearance level, see Lemma 11.1, so that there is risk of inefficient runs. Because the critical state curve does not intersect with the efficiency cut-off, i.e., 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 since 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 which minimizes the depositors' propensity to withdraw. Because the depositors preempt under a PCA intervention, i.e., 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, there exists no regulatory incentive to intervene more conservative than at a forbearance level a^*, since such intervention would reduce both bank stability and efficiency. In a special setting of no deposit insurance, Matta and Perotti (2021) find a related result that the intervention delay that maximizes welfare can be interior. Here, in contrast in the case $\gamma = 0$, the efficiency maximizer is not only interior but must equal the stability maximum.

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 11.1. 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, there exist two distinct forbearance levels (stability mirrors) $a_{e1} \neq a_{e2}$, $a_{e1} < a_{e2}$ 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 laxer intervention at a_{e2}. The mirrors are visible in the plots of Figure 7b and 7d where the efficient forbearance level forks as deposit insurance is 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 hardly face losses given a resolution, and are therefore insensitive to bad news 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. Since 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. This is since by Lemma 11.2, 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, there exist infinitely many pairs (a, γ) 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 absense 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. 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).[29] Instead, the RA commits to her policy, and then the state is drawn. 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, since fewer assets are liquidated. That is, since the true asset quality is unknown, more regulatory forbearance can have a two-sided effect on efficiency, besides impacting the run-propensity. In contrast, forbearance does not have this two-sided effect in the case of the PCA intervention, since there, irrespective of the forbearance level, the entire asset is liquidated.[30] 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 inefficient runs respectively inefficient continuation of investment by the absence of runs.

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, there exist states $\theta \in (\frac{L}{H}, \frac{L}{r})$ for which the RA should not intervene during a run for protecting assets even though asset liquidation is inefficient. This holds, since 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

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

[29] Angeletos et al. (2006) show, if the RA could make state-dependent policy then the depositors' coordination behavior fails to have a unique equilibrium, giving rise to different issues.

[30] 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 $a \in (\underline{a}, 1]$, there is full liquidation given an intervention.

Note, that $\hat{\theta}_e = \theta_e$ 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, i.e. for $\theta_b > 2\hat{\theta}_e$. If instead the average asset quality the RA protects from intervention is low, $\theta_b \leq 2\hat{\theta}_e$, then 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 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 not protecting low quality assets from liquidation versus the importance $1-\alpha$ of implementing an efficient depositor coordination behavior.

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 versus stability maximizing suspension intervention I)
Consider (H, L, Z_1), $\gamma \in [0,1)$, $r \in (\overline{r}, H]$, and let $\alpha \in (0,1)$ 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 $\theta_b(\underline{a})/2 \geq \hat{\theta}_e$, then stability and efficiency maximization are aligned, and are both maximized under instant intervention $a_e = a^* = \underline{a}$. If $\theta_b(\underline{a})/2 < \hat{\theta}_e$, then the efficient forbearance level may exceed the stability maximizing forbearance level, $a_e \geq a^* = \underline{a}$.

Proposition 5.2 shows that in the case $r \in (\overline{r}, H]$, 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 11.1, 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, i.e., the run is efficient. But there is risk of inefficient continuation of investment by the absence of runs, $\theta_b < \theta_e$. For maximizing efficiency, the RA would like to enforce the asset's liquidation more often. This requires, first, the maximization of the run-propensity, and second, to not protect assets from liquidation in the course of a run by intervening. A laissez-faire policy where 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. Since the depositors are anxious about losing their deposit, they withdraw too often, so that there is now risk of inefficient runs, $\theta_b > \theta_e$, and the risk of inefficient continuation of investment by absence of runs is zero, see Lemma 11.1. In order 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 that 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, i.e. is 'low' relative to the adjusted efficiency cut-off $\hat{\theta}_e$,

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

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

The results change once the RA becomes less skilled at managing assets, since 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 a helpful tool when it comes 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 there still exists a larger stability mirror a_m above the stability maximizer a^*, that is, $a^M < a_m$ but $\theta_b(a^M) = \theta_b(a_m)$. 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 versus stability maximizing suspension intervention II)
Consider (H, L, Z_1), $\gamma \in [0, 1)$, $r \in [0, \underline{r})$. Let $a^* \in (0, 1)$ the interior bank stability maximizer.
(i) Assume deposit insurance is low. If $\theta_b(a^*)/2 > \hat{\theta}_e$, then the efficient forbearance level is located in $(0, a^*]$. If $\theta_b(a^*)/2 \leq \hat{\theta}_e$, then the efficient forbearance level is located in $[a^*, 1]$. Allover, 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, then the efficient forbearance level equals laissez-faire, $a_e = 1$, and stability and efficiency maximization are entirely at odds.

For intuition, under low insurance, risk of inefficient runs exists for every regulatory forbearance level, $\theta_b > \theta_e$, and is minimized by maximizing bank stability, i.e. by setting regulatory forbearance to the interior $a^* \in (0, 1)$. But, similar to the case $r \in (\overline{r}, H]$, 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, is 'high' if

$$\mathbb{E}[\theta | \theta < \theta_b(a^*)] = \theta_b(a^*)/2 > \hat{\theta}_e. \tag{25}$$

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^* since more regulatory forbearance increases both the chance of 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 does 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 there exists risk of inefficient continuation of investment by the absence of runs, $\theta_b < \theta_e$, and all runs that occur are efficient. While 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, since the critical state approaches zero for $\gamma \to 1$ by Lemma 11.1, 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, i.e., 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 $(a^*, 1]$, since 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 $a^M = \underline{a}$, and 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, by 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 while if the state realizes above the critical state, investment is continued. By Lemma 9.3 in the appendix, the loss given a run is zero if regulatory forbearance is sufficiently conservative, i.e. if $a \leq a_{cc}$. But for lax forbearance, $a > a_{cc}$, then 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 is continued. In $t = 2$, the asset fails to pay with likelihood $1-\theta$, in which case the insurance fund owes γZ_1 to all agents. Allover, 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, which takes the value zero if the RA sets a sufficiently conservative forbearance level $a \leq a_{cc}$, and otherwise equals one.

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 upfront 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 $\tau = -S/(1-S) \in (0,1)$, the tax is affordable by all depositors. 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

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 by asset failure' becomes more severe.

8 Conclusion

The suspension of convertibility of demand-deposits has been widely celebrated 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. This, however, is not the entire story. I show that 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 when it comes to 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. There exist trade-offs between the goals of maximizing efficiency and bank stability, that depend on the degree of deposit insurance. Under low levels of insurance, too conservative policy neither maximizes 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 equally 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 depositors' 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 $\Delta^r = s_\gamma(a) - \left[\frac{La}{nZ_1} \cdot Z_1 + (1 - \frac{La}{nZ_1}) s_\gamma(a)\right] = -\frac{La}{n}\left(1 - \frac{s_\gamma(a)}{Z_1}\right)$. 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

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

□

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

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

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:

$$Z_2(\bar{n}) = \gamma Z_1 \tag{30}$$

For every level of insurance $\gamma \in [0, 1)$, such $\bar{n}(\gamma)$ must exist since $Z_2(0) > \gamma Z_1$, 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

$$\bar{n}(\gamma) = \frac{H - \gamma Z_1}{Z_1\left(\frac{H}{L} - \gamma\right)} \in (0, 1]. \tag{31}$$

For withdrawal levels $n \geq \bar{n}(\gamma)$, the payoff to roll over is constant at the insured level since 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*

$$a_c = a_c(\gamma) := \frac{H - \gamma Z_1}{H - \gamma L} \in (0,1) \tag{32}$$

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. That is, 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 $\bar{n}$. That is, the insurance fund has to top up the depositors' payoffs although no intervention occurs.

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

$$\frac{H(1-a_c)}{1 - La_c/Z_1} = \gamma Z_1 \tag{33}$$

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 $a > a_c$. □

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

$$\frac{L(1-a_{cc})}{1 - \frac{a_{cc}L}{Z_1}} = \gamma Z_1 \tag{34}$$

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) Assume $\gamma \in [L/Z_1, 1)$, 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 $a_c \in (a_{cc}, 1)$.

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 $a_{cc} < a_c$. □

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 $a \in (0, 1)$.

Trigger under PCA resolution 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

$$m(a, \gamma) := \min(\bar{n}(\gamma), \frac{aL}{Z_1}) \tag{35}$$

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

$$\int_0^{aL/Z_1} \theta(n, \theta^*) \max(Z_2(n) - \gamma Z_1, 0)\, dn = \int_{aL/Z_1}^1 \frac{aL}{nZ_1} (Z_1 - s_\gamma(a))\, dn + (1 - \gamma)\, aL \tag{36}$$

where

$$\theta(n, \theta^*) = \theta^* + \varepsilon(1 - 2n), \theta^* \in [\underline{\theta} - \varepsilon, \overline{\theta} + \varepsilon] \tag{37}$$

is the inverse of the function $n(\theta, \theta^*)$. Via equation (37) and Lebesgues Dominated Convergence Theorem, as $\varepsilon \to 0$, $\int_0^{aL/Z_1} \theta(n, \theta^*) \max(Z_2(n) - \gamma Z_1, 0)\, dn \to \theta^* \Big(Z_1\, m(a, \gamma) \Big(\frac{H}{L} -$

$\gamma\Big) - H\Big(1 - \frac{Z_1}{L}\Big)\ \ln(1 - m(a,\gamma))\Big)$. since $\int_0^{m(a,\gamma)} Z_2(n)\, dn = \frac{HZ_1}{L} m(a,\gamma) - H(1 - \frac{Z_1}{L})\ \ln(1 - m(a,\gamma))$. Therefore, the trigger under the PCA resolution method equals

$$\lim_{\varepsilon \to 0} \theta^* = \frac{aL\Big((1-\gamma)\ -\ (1 - \frac{s_\gamma(a)}{Z_1}) \ln\Big(\frac{aL}{Z_1}\Big)\Big)}{Z_1\Big(\frac{H}{L} - \gamma\Big) m(a,\gamma) - H\Big(1 - \frac{Z_1}{L}\Big)\ \ln(1 - m(a,\gamma))} \tag{38}$$

□

9.1 PCA intervention destroys value

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

$$\theta \max\left(Z_2(n), \gamma Z_1\right) + (1-\theta)\gamma Z_1 \geq s_\gamma(a), \quad \text{for all } n \in [0, aL/Z_1] \text{ (absent a resolution)} \tag{39}$$

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 (39) is

$$\theta\, \frac{H(1-a)}{1 - aL/Z_1} + (1-\theta)\gamma Z_1 \geq \frac{L(1-a)}{(1 - La/Z_1)}. \tag{40}$$

Let $\theta \geq \underline{\theta} = Z_1(1-\gamma)/(H - \gamma Z_1)$ so that 'withdraw' is not dominant. Therefore, a sufficient condition for (40) 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 since $H > Z_1$ 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, (39) 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 $n \in [0, \bar{n})$, (39) holds with strict inequality by case (ii). For all higher withdrawal levels $n \in [\bar{n}, aL/Z_1)$ (39) holds with equality. □

9.2 Comparative Statics of PCA Trigger

Proof. [Proposition 4.2] We need to distinguish between the three cases: $a \in [0, a_{cc})$, $a \in [a_{cc}, a_c)$, and $a \in [a_c, 1]$. We know that
(i) For all $a \in [0, a_{cc})$: $s_\gamma(a) > \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$.
(ii) For all $a \in [a_{cc}, a_c)$: $s_\gamma(a) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$.
(iii) For all $a \in [a_c, 1]$: $s_\gamma(a) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, \bar{n})$ while $Z_2(n) = \gamma Z_1$ for all $n \in [\bar{n}, aL/Z_1)$.
Case i) (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 (36) can be written using (37) as

$$\theta^*_\varepsilon(a) = \frac{La\left((1-\gamma) - \left(1 - \frac{s_\gamma(a)}{Z_1}\right)\ \ln(La/Z_1)\right) - \varepsilon \int_0^{La/Z_1} (1-2n) \cdot \left(\frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right)\ dn}{\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\ dn - \gamma\ La} \tag{41}$$

Via Lebesgues Dominated Convergence Theorem, as noise vanishes the trigger converges to

$$\lim_{\varepsilon \to 0} \theta^* = \frac{(1-\gamma) - \left(1 - \frac{s_\gamma(a)}{Z_1}\right)\ \ln(\frac{La}{Z_1})}{\frac{1}{La}\left(\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\ dn - \gamma La\right)} \tag{42}$$

Moreover, since the noise term enters multiplicative, we have

$$\left|\frac{\partial}{\partial a}\theta^*_\varepsilon(a) - \frac{\partial}{\partial a}\left(\lim_{\varepsilon \to 0} \theta^*\right)\right| = \varepsilon \left|\underbrace{\frac{\partial}{\partial a}\left(\frac{\int_0^{La/Z_1} (1-2n) \cdot \left(\frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right)\ dn}{\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\ dn - \gamma\ La}\right)}_{\equiv const(a)}\right| \tag{43}$$

$$\leq \varepsilon \sup_{a \in [\underline{a}, 1]} |const(a)| \to 0, \text{ as } \varepsilon \to 0 \tag{44}$$

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 (42), and let

$C(a)$ its denominator:

$$D(a) = (1-\gamma) - \left(1 - \frac{L(1-a)}{Z_1 - La}\right) \ \ln(\frac{La}{Z_1}) \tag{45}$$

$$C(a) = \frac{1}{La}\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\, dn - \gamma \tag{46}$$

Consider the limit $\varepsilon \to 0$ 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 $\frac{H(1-Z_1 n/L)}{1-n}$ is strictly decreasing in n, because $H(1-a)/(1-La/Z_1) > \gamma Z_1$ since we consider $a \in [0, a_{cc})$, 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

$$C'(a) = -\frac{1}{La^2}\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\, dn + \frac{1}{a}\frac{H(1-a)}{Z_1 - La} \tag{47}$$

C' is negative since $\frac{H(1-Z_1 n/L)}{1-n}$ is strictly decreasing on $[0, La/Z_1]$,

$$C'(a) < -\frac{1}{La^2}\ La\frac{H(1-a)}{Z_1 - La} + \frac{1}{a}\frac{H(1-a)}{Z_1 - La} = 0 \tag{48}$$

For the term $D'(a)$, using the logarithm inequality $\ln(\frac{La}{Z_1}) > (La - Z_1)/(La)$,

$$D'(a) = -\frac{L(1-L/Z_1)}{Z_1(1-La/Z_1)^2}\ \ln(\frac{La}{Z_1}) - \frac{1}{a}\left(1 - \frac{L(1-a)}{Z_1(1-La/Z_1)}\right) \tag{49}$$

$$< \frac{1}{a}\ \frac{1-L/Z_1}{1-La/Z_1} - \frac{1}{a}\left(1 - \frac{L/Z_1(1-a)}{(1-La/Z_1)}\right) = 0 \tag{50}$$

implying $\lim_{a\to 0}\ D'(a) \leq 0$. Altogether, bank stability is generically non-monotone in forbearance since 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

$$F(a) = \frac{1}{La/Z_1}\int_0^{La/Z_1} \underbrace{\frac{H(1-Z_1 n/L)}{1-n}}_{f(n)}\, dn \tag{51}$$

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 $c \to 0$ since 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,

$$C'(a) = \frac{1}{aZ_1}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) \tag{52}$$

with $\lim_{a\to 0}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) = 0$. Moreover, with (50), (52), and since the trigger is bounded $\theta^* \in [\underline{\theta}, \overline{\theta}]$,

$$\begin{aligned}
\lim_{a\to 0}\frac{\partial F_0}{\partial a} &= \lim_{a\to 0}\left(\theta^* C'(a) - D'(a)\right) && (53)\\
&\geq \lim_{a\to 0}\left(\frac{1}{a}\right)\left(\underline{\theta}\,\frac{1}{Z_1}\lim_{a\to 0}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) - \lim_{a\to 0}\left(aD'(a)\right)\right) && (54)\\
&= \lim_{a\to 0}\left(\frac{1}{a}\right)\left(-\lim_{a\to 0}\left(aD'(a)\right)\right) \geq 0, && (55)
\end{aligned}$$

since $\lim_{a\to 0} D'(a) \leq 0$. 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, $a_{cc} = 0$.

Recall that following (41), away from the limit the derivative of the trigger $\theta^*_\varepsilon(a)$ converges uniformly to the derivative of the limit of the trigger. We can therefore work with the limit directly. From above, the trigger becomes

$$\lim_{\varepsilon\to 0}\theta^* = \frac{(1-\gamma)(1-\ln(\frac{La}{Z_1}))}{\frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma} \tag{56}$$

Observe that the denominator $C(a)$ has not changed. Call the numerator now

$$\hat{D}(a) := (1-\gamma)(1-\ln(\frac{La}{Z_1})) \tag{57}$$

and see that

$$\hat{D}'(a) = -(1-\gamma)\,\frac{1}{a} \tag{58}$$

Following the reasoning as in case i), the limit payoff difference function becomes $F_0(\theta^*, a) = \theta^* C(a) - \hat{D}(a)$. Then, with (52)

$$\begin{aligned}
\lim_{a\to 0} \frac{\partial F_0}{\partial a} &= \theta^*\, C'(a) - \hat{D}'(a) && (59)\\
&= \lim_{a\to 0} \frac{1}{a}\left(\theta^* \frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) + (1-\gamma)\right) && (60)\\
&\geq \lim_{a\to 0} \frac{1}{a}\left(\underline{\theta} \frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1} - f(c)\right) + (1-\gamma)\right) && (61)\\
&= \lim_{a\to 0} (1-\gamma)\,\frac{1}{a} > 0 && (62)
\end{aligned}$$

since $\frac{H(1-a)}{1-La/Z_1} - f(c) \to 0$ as $a \to 0$. Therefore, we have $\lim_{a\to 0} \frac{\partial \theta^*}{\partial a} < 0$, meaning that bank stability improves in forbearance for sufficiently low forbearance levels when simultaneously these levels lie 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, forbearance is so high that 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 insurance fund becomes liable, and needs to top up the difference. Then, the payoff difference equation becomes

$$\begin{aligned}
0 = &\int_0^{\bar{n}} \left(\gamma Z_1 + \theta(n, \theta^*) \cdot \left(\frac{H(1 - Z_1 n/L)}{1-n} - \gamma Z_1\right) - Z_1\right)\, dn && (63)\\
&- \int_{\bar{n}}^{La/Z_1} Z_1\,(1-\gamma)\; dn - \int_{La/Z_1}^{1} \frac{La}{nZ_1}\,(Z_1 - \gamma Z_1)\, dn && (64)
\end{aligned}$$

At the limit, the trigger becomes

$$\lim_{\varepsilon\to 0}\theta^* = \frac{La\ \ (1-\gamma)\,(1-\ln(La/Z_1))}{\int_0^{\bar{n}}\cdot\left(\frac{H(1-Z_1 n/L)}{1-n}-\gamma Z_1\right)\ dn} \tag{65}$$

Crucially, see that $\bar{n}$, and thus the denominator of the trigger are independent of forbearance. We know from above that, as noise vanishes, the derivative of the trigger converges uniformly to the limit of the derivative of the trigger, so that we can work with the derivative of the limit directly. Then we can show that for all forbearance levels $a \in [a_c, 1]$, the trigger strictly increases (stability deteriorates) in forbearance:

$$\frac{\partial}{\partial a}\lim_{\varepsilon\to 0}\theta^* = -\frac{(1-\gamma)\,L\,\ln(La/Z_1))}{\int_0^{\bar{n}}\cdot\left(\frac{H(1-Z_1 n/L)}{1-n}-\gamma Z_1\right)\ dn} > 0 \tag{66}$$

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.
Since 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. □

10 Proofs: Suspension Resolution

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

$$\lim_{\varepsilon\to 0}\theta^* = \frac{aL\,(1-\gamma)\left(1-\ln\left(\frac{aL}{Z_1}\right)\right)}{Z_1\left(\frac{H}{L}-\gamma\right)m(a) - H\left(1-\frac{Z_1}{L}\right)\ln(1-m(a)) - R(a)\frac{aL}{Z_1}\ln\left(\frac{aL}{Z_1}\right)} \tag{67}$$

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

$$R(a,\gamma) := \max\left(\frac{r(1-a)}{1-La/Z_1} - \gamma Z_1, 0\right). \tag{68}$$

The payoff indifference equation (36) becomes

$$\int_0^{aL/Z_1} \theta(n,\theta^*)\, \max(Z_2(n)-\gamma Z_1, 0)\, dn + \int_{aL/Z_1}^1 \frac{aL}{nZ_1}\, \theta(n,\theta^*) R(a)\, dn \tag{69}$$

$$= \int_{aL/Z_1}^1 \frac{aL}{nZ_1}\, (1-\gamma) Z_1\, dn + (1-\gamma)\, aL \tag{70}$$

Together with equation (37), away from the limit the trigger equals

$$\theta^*_\varepsilon(a) = \frac{(1-\gamma)\, La\, (1-\ln(\frac{La}{Z_1})) - \varepsilon \left[\int_0^{\frac{La}{Z_1}} (1-2n) \max\left(0, \frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right) dn + R(a,\gamma)\, \frac{La}{Z_1} \int_{\frac{La}{Z_1}}^1 \frac{(1-2n)}{n}\, dn \right]}{\int_0^{La/Z_1} \max\left(0, \frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right) dn + R(a,\gamma)\, \frac{La}{Z_1} \int_{La/Z_1}^1 \frac{1}{n} \cdot dn} \tag{71}$$

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

$$\lim_{\varepsilon \to 0} \theta^* = \frac{(1-\gamma)\, La\, (1-\ln(\frac{La}{Z_1})}{\int_0^{La/Z_1} \max\left(0, \frac{H(1-Z_1 n/L)}{1-n} - \gamma Z_1\right) dn + R(a,\gamma)\, \frac{La}{Z_1} \int_{La/Z_1}^1 \frac{1}{n} \cdot dn} \tag{72}$$

The definition (35) then delivers (67). □

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 $\hat{a}_{cc}(\gamma, r) \in (0,1)$,

$$\hat{a}_{cc}(\gamma, r) = \frac{r - \gamma Z_1}{r - L\gamma} \tag{73}$$

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

$$\frac{H(1-a)}{1-La/Z_1} \geq \frac{r(1-a)}{1-La/Z_1}, \qquad \text{for all } a \in [0,1] \tag{74}$$

By definition of $\hat{a}_{cc}(\gamma)$ and $a_c(\gamma)$ from Lemma 9.2, if $\hat{a}_{cc}(\gamma) \in (0,1)$, then

$$\frac{H(1-a_c(\gamma))}{1-La_c(\gamma)/Z_1} = \gamma Z_1 = \frac{r(1-\hat{a}_{cc}(\gamma))}{1-L\hat{a}_{cc}(\gamma)/Z_1}, \tag{75}$$

and by $H \geq r$ it follows $a_c(\gamma) \in (\hat{a}_{cc}, 1)$. Likewise, if $\hat{a}_{cc} = 0$, then $a_c(\gamma) \in (\hat{a}_{cc}, 1)$ since $a_c(\gamma) > 0$ 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 $\gamma \in [0,1)$:

$$\theta \max\left(Z_2(n), \gamma Z_1\right) + (1-\theta)\gamma Z_1 \geq s_\gamma(a,\theta), \quad \text{for all } n \in [0, aL/Z_1] \text{ (absent a resolution)} \tag{76}$$

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 (76) are equal, so that the suspension intervention makes no difference to the payoffs. □

10.1 Comparative Statics of Suspension Trigger

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 $[0, \hat{a}_{cc}) \cup [\hat{a}_{cc}, a_c) \cup [a_c, 1]$. The monotonicity properties of the trigger in forbearance will depend on the subinterval at which the slope is measured.[31] We need to discuss three cases:

[31] 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.

(i) For all $a \in [0, \hat{a}_{cc})$: $s_\gamma(a,\theta) > \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1$.
(ii) For all $a \in [\hat{a}_{cc}, a_c)$: $s_\gamma(a,\theta) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, aL/Z_1)$.
(iii) For all $a \in [a_c, 1]$: $s_\gamma(a,\theta) = \gamma Z_1$ and $Z_2(n) > \gamma Z_1$ for all $n \in [0, \bar{n})$ while $Z_2(n) = \gamma Z_1$ for all $n \in [\bar{n}, aL/Z_1)$.

As in the case of the PCA resolution, since the noise term enters θ^*_ε linearly, and since all integrands are bounded, one can show that the derivative of the trigger $\frac{\partial}{\partial a}\theta^*_\varepsilon$ in (71) converges uniformly to the derivative of the limit $\frac{\partial}{\partial a}\lim_{\varepsilon\to 0}\theta^*$ in (72), 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

$$\lim_{\varepsilon\to 0}\theta^* = \frac{(1-\gamma)\,(1-\ln(\frac{La}{Z_1}))}{\frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma - \left(\underbrace{\frac{r(1-a)}{1-la/Z_1} - \gamma Z_1}_{R(a,\gamma)}\right)\frac{1}{Z_1}\ln(\frac{La}{Z_1})} \tag{77}$$

Let $D_s(a)$ denote the numerator in (77), and let $C_s(a)$ its denominator:

$$D_s(a) = (1-\gamma)\,(1-\ln(\frac{La}{Z_1})) \tag{78}$$

$$C_s(a) = \frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma - R(a,\gamma)\,\frac{1}{Z_1}\ln(\frac{La}{Z_1}) \tag{79}$$

Consider the limit payoff difference function $F_{0,s}(\theta^*, a) \equiv \lim_{\varepsilon\to 0} F_s(\theta^*_\varepsilon, a)$, where

$$F_{0,s}(\theta^*, a) = \theta^* C_s(a) - D_s(a) \tag{80}$$

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 $\frac{\partial F_{0,s}}{\partial\theta^*} > 0$ since

$$\frac{\partial F_{0,s}}{\partial\theta^*} = C_s(a) > \frac{1}{La}\int_0^{La/Z_1}\frac{H(1-Z_1 n/L)}{1-n}\,dn - \gamma > \frac{1}{La}\frac{H(1-a)}{1-La/Z_1} - \gamma > 0$$

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

$$D_s'(a) = -\frac{(1-\gamma)}{a} < 0 \tag{81}$$

and with $\frac{\partial}{\partial a} R(a,\gamma) = -\frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)^2}$ it holds

$$C_s'(a) = -\frac{1}{La^2}\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\, dn + \frac{1}{aZ_1}\left(\frac{H(1-a)}{1-La/Z_1} - R(a,\gamma)\right) \tag{82}$$

$$+ \frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)^2}\ \ln(La/Z_1) \tag{83}$$

Case $r \in [0, \underline{r})$: We instantly see that for $r \to 0$, by the definition (68) we have $R(a,\gamma) \to 0$. Moreover, by the mean value theorem for integrals, there exists $c_s \equiv c_s(a) \in [0, La/Z_1]$ 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 $c_s \to 0$. Since f is continuous, then $\lim_{a\to 0} f(c_s) = f(0) = H$. Thus,

$$\lim_{a\to 0}\left[-\frac{1}{La}\int_0^{La/Z_1} \frac{H(1-Z_1 n/L)}{1-n}\, dn + \frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1}\right)\right] \tag{84}$$

$$= \lim_{a\to 0}\left[-\frac{1}{Z_1} f(c_s) + \frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1}\right)\right] = 0 \tag{85}$$

Then altogether with (84) and (85),

$$\lim_{a\to 0}\lim_{r\to 0}\frac{\partial F_0}{\partial a} = \lim_{a\to 0}\lim_{r\to 0}\left(\theta^* C_s'(a) - D_s'(a)\right) = \lim_{a\to 0}\frac{1}{a}(1-\gamma) > 0 \tag{86}$$

since 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, $\lim_{a\to 0}\lim_{r\to 0}\frac{\partial \theta^*}{\partial a} < 0$. Since 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 (82)

$$C_s'(a) < -\frac{1}{aZ_1} R(a,\gamma) - \frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)} < 0 \tag{87}$$

because $\frac{H(1-Z_1 n/L)}{1-n}$ 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, with (87)

$$\lim_{r\to H} \frac{\partial F_0}{\partial a} = \lim_{r\to H} \left(\theta^* C_s'(a) - D_s'(a)\right) \tag{88}$$

$$< \lim_{r\to H} \frac{\underline{\theta}}{a}\Big[-\frac{1}{Z_1} R(a,\gamma) - \frac{r(1-L/Z_1)}{Z_1(1-La/Z_1)} + \frac{(1-\gamma)}{\underline{\theta}}\Big] \tag{89}$$

$$= \frac{\underline{\theta}}{a}\Big[-\frac{1}{Z_1}\left(\frac{H(1-a)}{1-La/Z_1} - \gamma Z_1\right) - \frac{H(1-L/Z_1)}{Z_1(1-La/Z_1)} + \frac{(1-\gamma)}{\underline{\theta}}\Big] = 0 \tag{90}$$

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 (56), 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 (65), monotonicity properties therefore coincide. Consequently, the trigger increases in forbearance for all $a \in [a_c, 1]$.

To summarize, consider two cases:
(a) Consider $\gamma \in [0, r/Z_1)$. Then we know by Lemma 10.2, that 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) For insurance $\gamma \in [r/Z_1, 1)$, 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 since 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 intercal $[a_c, 1]$ 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. $\square$

11 Proofs: Deposit Insurance

Lemma 11.1 (Comp stats of trigger in deposit insurance)**.** *(a) For every forbearance level, bank stability monotonically increases (the trigger declines) in deposit insurance coverage.*
(b) As insurance coverage becomes full, depositors have a dominant strategy to roll over, i.e. the trigger 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 trigger curve exceeds the efficiency cut-off for every forbearance level $a \in [\underline{a}, 1]$, $\theta^*(a, 0) > \theta_e$.

Lemma 11.2 (Comp stats of trigger in deposit insurance)**.** *For every forbearance level, there exists a unique level of deposit insurance such that $\theta^*(a, \gamma) = \theta_e$.*

Proof. [Lemma 11.1] We show that in the case of PCA the trigger monotonically declines 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

$$F = \int_0^{La/Z_1} (\theta(n, \theta^*) \max(Z_2(n), \gamma Z_1) + (1 - \theta(n, \theta^*))\gamma Z_1 - Z_1) \, dn \tag{91}$$

$$- \int_{La/Z_1}^1 \frac{La}{nZ_1} \, (Z_1 - s_\gamma(a)) \, dn \tag{92}$$

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. Since 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.

(b) We next show that the trigger for both PCA and suspension intervention goes 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,

$$\lim_{\gamma \to 1} F = \begin{cases} \int_0^{La/Z_1} \theta(n, \theta^*) \left(Z_2(n) - Z_1\right) dn > 0, & \text{for } a \leq a_c(1) \\ \int_0^{\bar{n}} \theta(n, \theta^*) \left(Z_2(n) - Z_1\right) dn > 0 & \text{for } a \in (a_c(1), 1] \end{cases} \tag{93}$$

where $\bar{n} \in (0, aL/Z_1)$. Since 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

$$\lim_{\varepsilon \to 0} \theta^*(a, 0) = \frac{1 - \ln(La/Z_1) \left(1 - \frac{1}{Z_1} \frac{L(1-a)}{1 - aL/Z_1}\right)}{\frac{1}{La} \int_0^{La/Z_1} \frac{H(1 - Z_1 n/L)}{1-n} dn} \tag{94}$$

Because $\frac{H(1-Z_1 n/L)}{1-n}$ is decreasing in n, and by the logarith law $\ln(1+x) < x$ for $x > -1$, we have

$$\lim_{\varepsilon \to 0} \theta^*(a, 0) > \frac{1 - \left(\frac{La}{Z_1} - 1\right) \left(1 - \frac{1}{Z_1} \frac{L(1-a)}{1 - aL/Z_1}\right)}{\frac{H}{Z_1}} = \frac{2Z_1 - L}{H} \geq \frac{Z_1}{H} \geq \frac{L}{H} = \theta_e \tag{95}$$

by $Z_1 \geq L$. Now assume $a \in [a_{cc}, a_c]$. Then, at $\gamma = 0$

$$\lim_{\varepsilon \to 0} \theta^*(a, 0) = \frac{1 - \ln(La/Z_1)}{\frac{1}{La} \int_0^{La/Z_1} \frac{H(1 - Z_1 n/L)}{1-n} dn} > \frac{Z_1(2 - La/Z_1)}{H} \geq \frac{Z_1}{H} \geq \frac{L}{H} = \theta_e \tag{96}$$

since $a_c = 1$ and thus $a \leq 1$. □

Proof. [Lemma 11.2] 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 By part (c) of Lemma (11.1), 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 11.1, 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.

$\square$