Bailouts, Bail-ins, and Banking Industry Dynamics
Online Appendix

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1 Policy Counterfactuals

1.1 Non-Targeted Bail-in Policy

The results from the counterfactual exercise in Section ?? are based on implementing the same size threshold as seen in the bailout policy as well as a probability function to determine whether a bank receives the bail-in or liquidation. However, this size-based policy could create inefficiencies in the banking sector. To examine further, I solve for a second counterfactual equilibrium in which any bank can receive the bail-in when they enter resolution. Further, banks will only be liquidated if the value to the creditors is greater under liquidation than it is under bail-in. The value to the creditors of liquidation can be defined as

$$VC_L = \min\{b', \max\{c_L G(\lambda', \ell', s') - c_F - \delta, 0\}\} \tag{1}$$

and the value to the creditor of bail-in as

$$VC_I = \min\{b', \mathop{\mathbb{E}}_{\delta'|\delta}(V^{d\leq 0}(\delta, \lambda', \hat{n}'(\lambda'))\} \tag{2}$$

where $\hat{n}' = G(\lambda', \ell', s') - \delta$. Due to the firesale and fixed costs of liquidation, it is most likely that the value of bail-in will be higher in equilibrium. However, it is possible that the fixed cost of operating c_O as seen in Equation ?? is high enough that continuing even after a bail-in is very costly and the creditor would prefer the repayment from liquidation. The value of resolution is then

$$\begin{aligned} V_R(\delta, \lambda', \ell', s', b') = \mathbb{1}_{VC_L > VC_I} V_L(\delta, \lambda', \ell', s', b') \\ +(1 - \mathbb{1}_{VC_L > VC_I}) \max\{0, \mathop{\mathbb{E}}_{\delta'|\delta}(V^{d\leq 0}(\delta', \lambda', \hat{n}'(\lambda')) - b'\}. \end{aligned} \tag{3}$$

This implies price schedules of

$$\begin{aligned} q_N(\delta, \lambda, \ell', s', b') = \frac{1}{1+r_F}\big[\big(1 - \sum_{\lambda' \in \Omega_N(\delta, \ell', s', b')} F(\lambda'|\lambda)\big) \\ + \sum_{\lambda' \in \Omega_N(\delta, \ell', s', b')} \min\{1, \max\{\frac{\mathop{\mathbb{E}}_{\delta'|\delta}(V^{d\leq 0}(\delta', \lambda', \hat{n}'(\lambda'))}{b'}, \max\{\frac{c_L G(\lambda', \ell', s') - c_F - \delta}{b'}, 0\}\}\} F(\lambda'|\lambda)\big] \end{aligned} \tag{4}$$

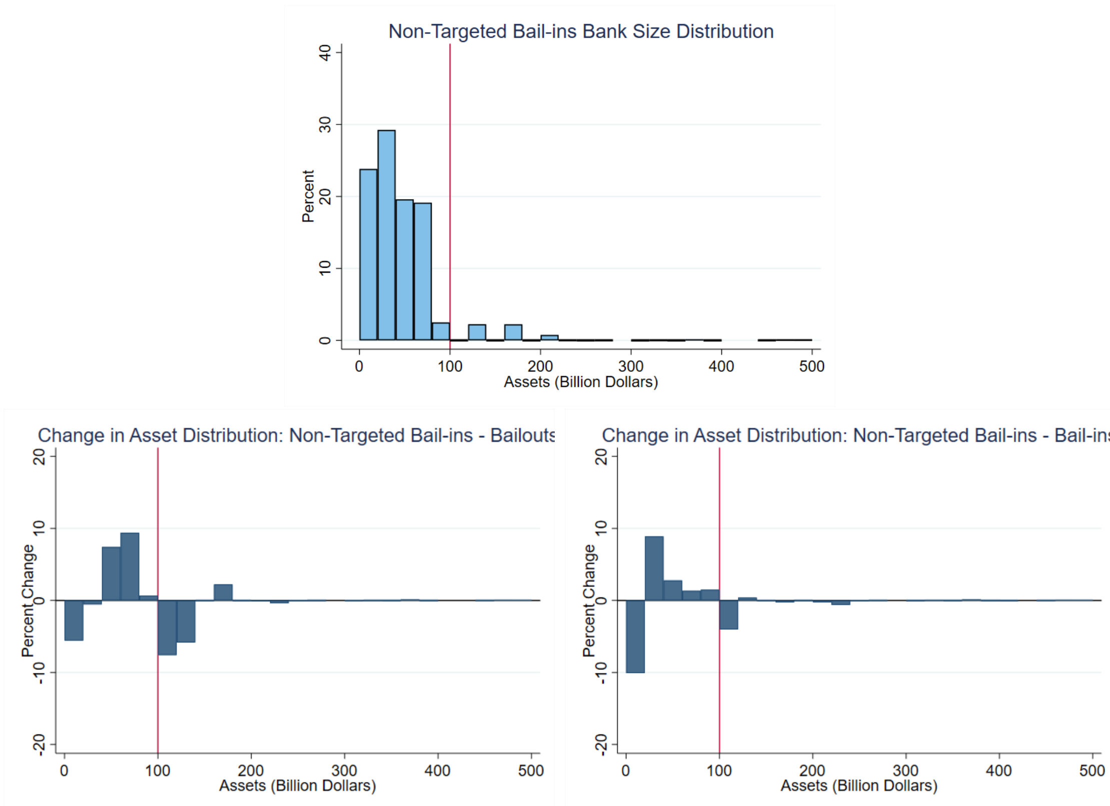
where Ω_N is the set of loan default rate realizations such that the bank will enter resolution. The last row of Equation 4 represents the repayment to the creditors in resolution, either from liquidation or bail-in. The repayment is a maximum of 100% and a minimum of 0% of the debt claim b', but the interior value of repayment depends on if the value of bail-in or liquidation is higher to the creditor.

The results of the non-targeted bail-in are summarized in the third column of Table **??**. In equilibrium, the value of a bail-in is always greater than the value of liquidation due to the costly firesale and fixed costs associated with the liquidation. This policy decreases the price of uninsured debt for banks below the TBTF threshold due to their access to the bail-in. For these banks, I find that the average repayment to creditors in the event of a bail-in is 81% of their original debt claim. This is in great contrast to the average 11% repayment that the creditors would have received in liquidation in this equilibrium. With access to cheaper funding, these banks lend more compared to both the benchmark and the counterfactual, which can be seen in the bottom row of Figure 1. These figures calculate the change in the size distribution from the bailouts or bail-ins equilibria to the non-targeted bail-ins equilibrium. Compared to either solution, the non-targeted bail-in policy decreases the mass of banks with less than \$10B in assets as these small banks now have cheaper funding to invest in higher quantities of assets. However, without the size threshold of \$100B, fewer banks grow to such a level, as seen by the decrease in the mass of banks just to the right of the threshold. The share of big banks decreases to 6%, compared to 18% under the benchmark and 10% under the counterfactual.

Borrowing uninsured debt is now cheaper for entering banks, who receive the smallest value of insured deposits and are constrained from making large quantities of risky loans due to having no internal funding to start. Now, with cheaper debt, these entrants do not need to earn as high of a return on their lending to choose to enter. Therefore, the risky loan return that satisfies the free entry condition is 1.066, down from 1.067 under the benchmark. At this lower return, firm demand for bank loans increases, and the aggregate amount of lending increases from \$4.61T under the benchmark to \$4.72T.

The average risky asset fraction decreases to 39.8% under the non-targeted bail-in policy. Without the incentive to quickly surpass the \$100B threshold, banks choose to smooth their returns more by investing in more safe assets. However, average uninsured leverage and total leverage increase compared to the counterfactual. Debt prices have decreased for banks and there are greater returns to earn from borrowing to fund investment in assets rather than using internal funding. The change in assets when banks cross the \$100B

Figure 1: Size Distribution under Non-Targeted Bail-ins



threshold appears very large under the non-targeted bail-in policy. However, this is driven by a composition effect. Under the benchmark and the counterfactual, there were banks, specifically those with $\delta = \delta_M$ who would drastically increase their assets to grow over the threshold. Under this policy in which the threshold is not needed for access to the bail-in, the banks that grow over the threshold are only banks who are switching from δ_M to δ_H, creating a very large increase in assets.

The failure rate of banks is lower under the non-targeted bail-in policy than the benchmark or counterfactual. This is due to the decreased mass of banks engaging in very risky lending or over leveraging themselves in order to grow quickly above the TBTF threshold. However, the rate of bail-ins is higher under the non-targeted policy than the counterfactual because small banks, who fail at the highest rates, are bailed in now. Nonetheless, bail-ins avoid the deadweight losses from the firesale of assets that occurs in liquidation, so total resolution costs are the lowest under the non-targeted bail-in policy.

The enactment of the bail-in policy was just one example of new regulations imposed

Table 1: Comparison of Results Across Resolution Policies

	Bailouts	Bail-ins	Non-Targeted Bail-ins
R^ℓ	1.067	1.069	1.066
Avg. Interest Income on Loans (%)	4.8	5.2	4.7
Agg. Lending ($T)	4.61	4.46	4.73
Avg. Assets ($B)	34.3	26.1	45.7
Share of Big Banks (%)	17.6	10.2	6.0
Gini Coefficient of Bank Assets	0.43	0.46	0.43
Avg. Change in Assets (%)	9.5	9.7	9.0
Avg. Change in Assets over Threshold (%)	69.2	63.9	112.4
Avg. Risky Assets Fraction (%)	47.4	42.5	39.8
Avg. Leverage of Entrants	0.95	0.95	0.94
Avg. Leverage	0.96	0.94	0.96
Avg. Uninsured Leverage	0.45	0.36	0.40
Avg. Net Interest Margin	1.37	1.36	1.32
Avg. Repayment under Bailout/Bail-in (%)	100.0	45.7	81.2
Max Repayment under Bailout/Bail-in (%)	100.0	48.0	100.0
Avg. Interest Rate (%)	2.17	2.12	1.92
Avg. TBTF Subsidy (bps)	254	40	33
Failure Rate (%)	0.82	0.45	0.45
Bailout/Bail-in Rate (%)	0.41	0.03	0.40
Big Bank Failure Rate (%)	2.88	1.00	0.44
Resolution Costs ($B)	44.8	8.3	7.1
Avg. Dividend to Assets (%)	0.27	0.67	0.38
Share of Dividend Issuers (%)	53.2	60.6	46.0

Table 2: Comparison of Capital Requirement Counterfactuals

	Bailouts	Bail-ins	Higher Cap. Req.	Size Dependent	Incorrect Size Dependent
R^ℓ	1.067	1.069	1.072	1.069	1.068
Agg. Lending ($T)	4.61	4.46	4.20	4.46	4.52
Avg. Assets ($B)	29.7	21.8	30.23	21.7	29.2
Share of Big Banks (%)	17.6	10.2	16.9	9.5	18.2
Avg. Risky Assets Fraction (%)	47.4	42.5	52.4	42.7	47.9
Avg. Leverage of Entrants	0.95	0.95	0.92	0.95	0.95
Avg. Leverage	0.96	0.96	0.92	0.95	0.96
Avg. Uninsured Leverage	0.44	0.36	0.37	0.32	0.30
Failure Rate (%)	0.82	0.45	0.79	0.45	0.77
Bailout/Bail-in Rate (%)	0.41	0.03	0.37	0.05	0.36
Big Bank Failure Rate (%)	2.88	1.00	2.92	1.45	2.87
Resolution Costs ($B)	44.9	6.5	31.0	15.4	33.5
Default Rate Allocative Efficiency	-.0038	-00.72	-.0036	-.0074	-.0043

This table compares statistics of the steady state equilibria of the benchmark model with higher capital requirements (Column 4), with the size-dependent capital requirements (Column 5), and with incorrect size-dependent capital requirements (Column 6) to those of the original benchmark model (Column 2) and bail-in counterfactual (Column 3).

on banks in response to the financial crisis. Another includes the adjustment of capital requirements, a frequently studied and discussed way to combat bank moral hazard. In this section, I solve for two new counterfactuals related to changing capital requirements and compare the steady state distributions and statistics to those from the original bailout and bail-in equilibria.

1.2 Higher Capital Requirements

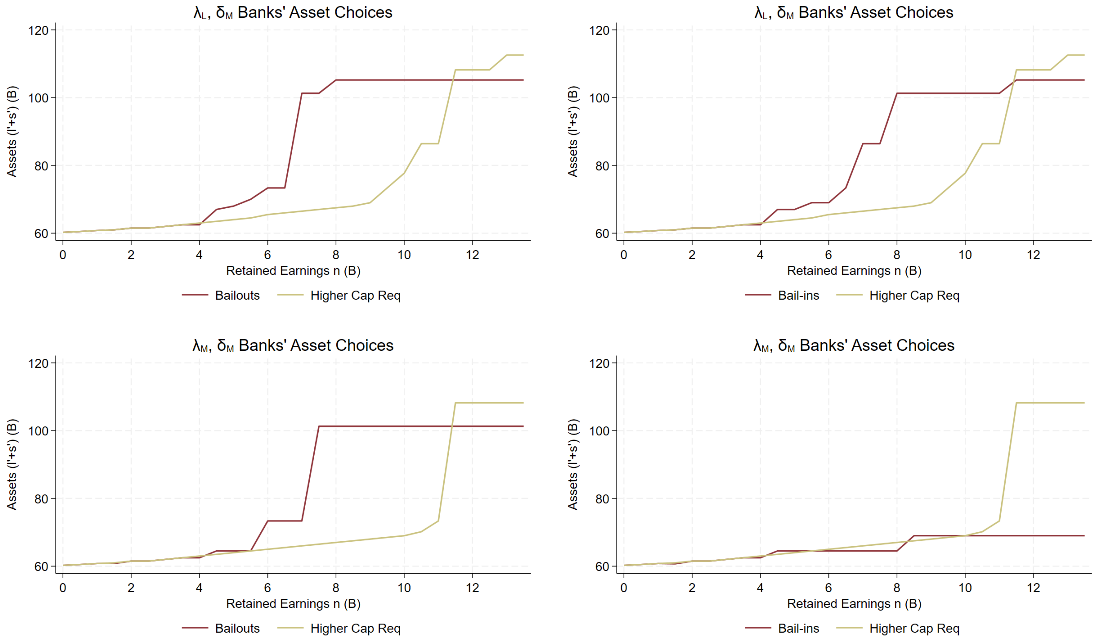
In this section, I solve for a counterfactual in which the capital requirement α is increased from the level used in the benchmark model, 4%, to the Basel II regulatory level, 8%, in the benchmark framework of bailouts. Aggregate statistics from the steady state distribution under this scenario can be found in Column 4 of Table 2.

Higher capital requirements for all banks decrease the value of entering as a bank. Therefore, the equilibrium return on lending R^ℓ must increase compared to the benchmark model. In fact, the new equilibrium R^ℓ is even higher than that of the bail-in counterfactual model. Despite big banks having a positive probability of bailout and therefore a TBTF subsidy on their debt prices, these big banks are constrained by capital requirements, lowering their value. Further, a bank has to grow large enough to take advantage of this subsidy and therefore, the entrants require a higher return on lending to choose to enter. With a higher required return on lending, aggregate lending decreases to \$4.20B, compared to \$4.61B under the benchmark model and \$4.46 under the counterfactual bail-in model.

Asset choice policy functions of banks with the medium insured deposits (δ_M) under the higher capital requirement can be found in Figure 2. The top left figure plots the asset choices of banks with the lowest default rate λ_L under the benchmark bailout model and this higher capital requirement bailout model. Despite the higher return on lending, higher capital requirements have a substantial effect on the asset decisions when net cash is low and capital requirements are more binding. The banks still jump above the \$100B threshold, but not until they have over \$11B in net cash, compared to the only \$6.5B they need under the benchmark model. However, when the banks do choose asset values over the threshold, they actually choose a higher level of assets than chosen under the benchmark model due to their increased expected return on lending. The same result can be seen in the bottom left figure in which I plot the asset policy functions of banks with λ_M instead. The higher capital requirement banks are again more constrained and need to build more net cash before they can grow above the \$100B threshold. Further, the choice of assets once they cross the threshold is once again higher due to the higher return on lending.

The top right figure compares the policy functions of banks with the lowest default rate λ_L under the bail-in counterfactual and this counterfactual with bailouts but higher capital requirements. The higher capital requirement banks are again more constrained than the banks in the bail-in model and choose fewer assets when net cash is low. When the higher capital requirement banks do choose assets over \$100B, they once again choose an asset value higher than that chosen by the bail-in banks due to the higher return on lending and the positive value of the bailout probability. However, the largest change between the bail-in counterfactual and the higher capital requirement one can be seen in the bottom right figure, which plots the asset policy functions of λ_M banks. A key feature of the bail-in counterfactual is that these banks do not grow over the \$100B threshold and become big banks. The higher capital requirements is not enough though to offset the additional value from a positive bailout probability though, and there is a much larger share of big banks in this counterfactual. As seen in Table 2, the share of big banks in the higher capital requirements model is 15.8% compared to the 10.2% in the bail-in model.

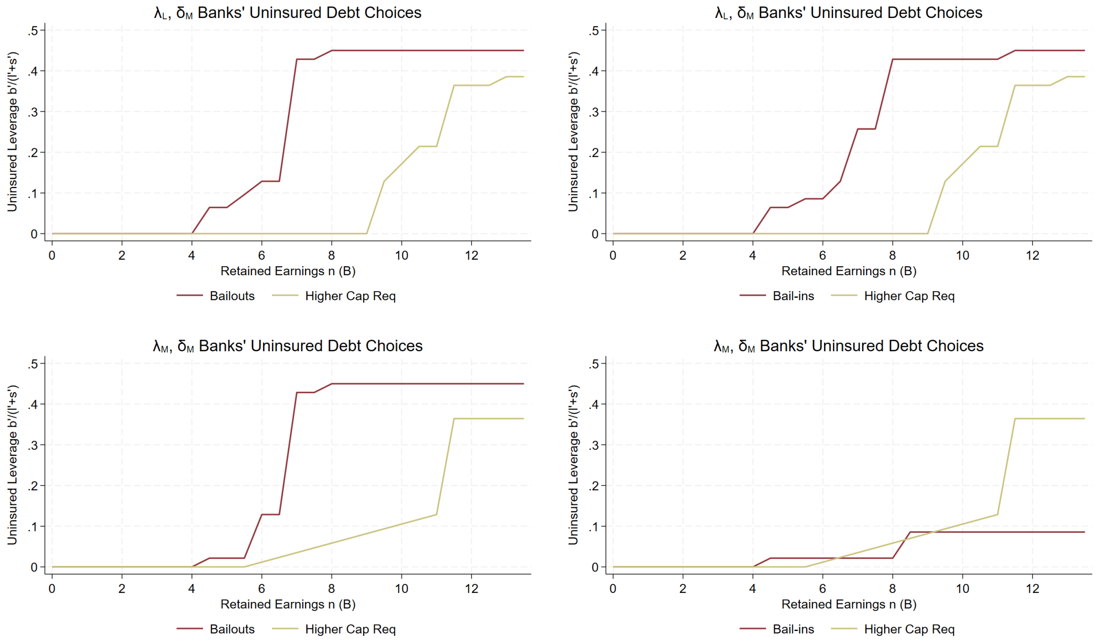
Figure 2: Asset Policy Functions under Higher Capital Requirements



The corresponding debt policy functions can be found in Figure 3. Given the higher capital requirements, banks borrow less uninsured debt. However, given that banks still grow above the \$100B threshold when they have the medium default rate λ_M, this corresponds to higher overall uninsured leverage than under the bail-in counterfactual.

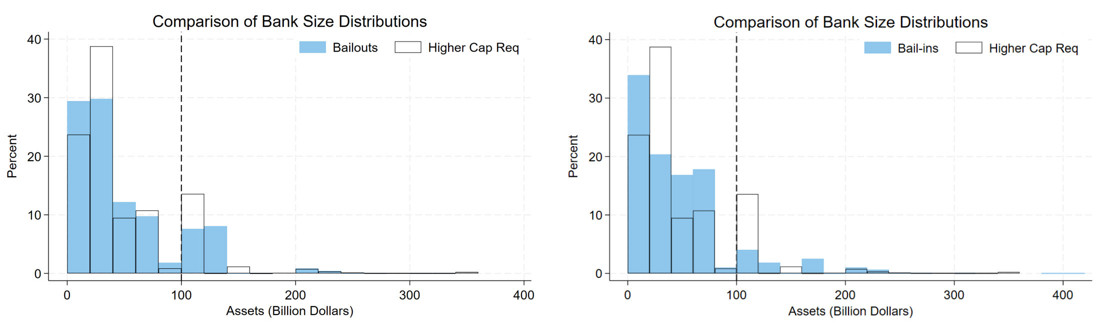
The resulting size distributions can be found in Figure 4, in comparison to those under the bailout (left) and bail-in (right) distributions. The share of big banks under the higher capital requirements is only 0.7% lower than that under the benchmark model. However, big banks stay slightly smaller on average due to the constraints from higher capital requirements. There is a smaller share of banks with assets between \$0 and \$20B and a higher share between \$20-40B due to two complementary forces. First, banks earn a higher return on lending under the higher capital requirements, therefore the gross value of assets $R^{\ell}(1-\lambda')\ell' + Rs'$ can be higher, even for the same value of ℓ'. Second, due to the higher required return on lending R^{ℓ}, demand for loans from firms is significantly lower. However, there are still big banks lending a significant amount. These banks meet a large amount of the demand for loans by firms and leave less room for entrants; therefore, the mass of entrants is smaller. This same effect can be seen to an even greater extent in the right graph, which compares the size distribution under higher capital requirements to that of the bail-in model. In addition to a smaller mass of the smallest banks, the key difference

Figure 3: Uninsured Leverage Policy Functions under Higher Capital Requirements



between these two distributions is the missing mass between \$60 and \$100B under higher capital requirements and the increased mass point just above \$100B. Even with higher capital requirements, banks with both λ_L and λ_M will jump above the \$100B threshold, unlike under bail-in where only the λ_L banks do so. The discrete increase in asset choices results in missing mass just under the threshold and increased mass just over it. Despite the higher return on lending, capital requirements restrict banks and the average assets level is lower at \$24.7B, compared to \$34.3B. Further, a smaller share of banks grow large, only 15.8%, compared to under the benchmark model, but this is still significantly higher

Figure 4: Comparison of Size Distributions under Higher Capital Requirements



than the share of big banks under bail-in.

An interesting finding is that the average uninsured leverage ($\frac{b'}{\ell'+s'}$) of banks decreases under the higher capital requirements, but the average risky assets fraction ($\frac{\ell'}{\ell'+s'}$) increases. While we would expect banks to decrease this fraction, as risky assets hold a risk weight of 1, banks can more substantially decrease the capital requirement by decreasing leverage. Further, the banks now earn a greater return on risky lending. Therefore, banks appear to decrease their uninsured debt by a greater extent but increase their risky asset fractions slightly in order to raise their expected profits.

Even though banks need to hold more capital, the failure rate of big banks is actually slightly higher (2.92% compared to 2.88%). This difference stems from a greater portion of banks with λ_M in equilibrium, which have a greater probability of receiving λ_H next period, thus increasing the overall failure rate. There are more λ_M big banks due to the slower growth rate of banks with λ_L, which increases the probability that they will switch to λ_H before they raised enough net cash to weather negative shocks.

Individual big banks may have a higher probability of failing under the higher capital requirements scenario, yet the cost of these resolutions is lower. Banks are choosing lower levels of uninsured debt, which reduces the necessary transfer in a bail-in. Further, the return on lending is higher, and therefore, the bank has more funds from its loans that were not defaulted upon, further decreasing the transfer needed in a bailout.

Finally, the last row of Table 2 summarizes the default rate allocative efficiencies for each equilibria. The default rate allocative efficiency measure under these higher capital requirements is -.0036, even higher than -.0038 under the benchmark. While banks lend less under the higher capital requirements, the higher capital requirements apply to all banks, and therefore have little effect on the relationship between default rates and share of lending. The increase in the measure is driven by the choice of banks to relatively decrease their leverage more than their risky asset fraction to meet the higher capital requirements. This is particularly true of the medium default rate banks jumping over the \$100B. To qualify for the bailout, these banks need \$100B in total assets and they choose to reach this with a greater fraction of risky assets compared to the benchmark, resulting in a greater share of risky lending by banks with higher expected default rates.

While increasing capital requirements for all banks does decrease the failure rate of banks and the cost of resolution, the decrease in aggregate lending is substantial. Replacing bailouts with bail-ins dominates increasing capital requirements in regards to promoting lending and reducing big bank failure.

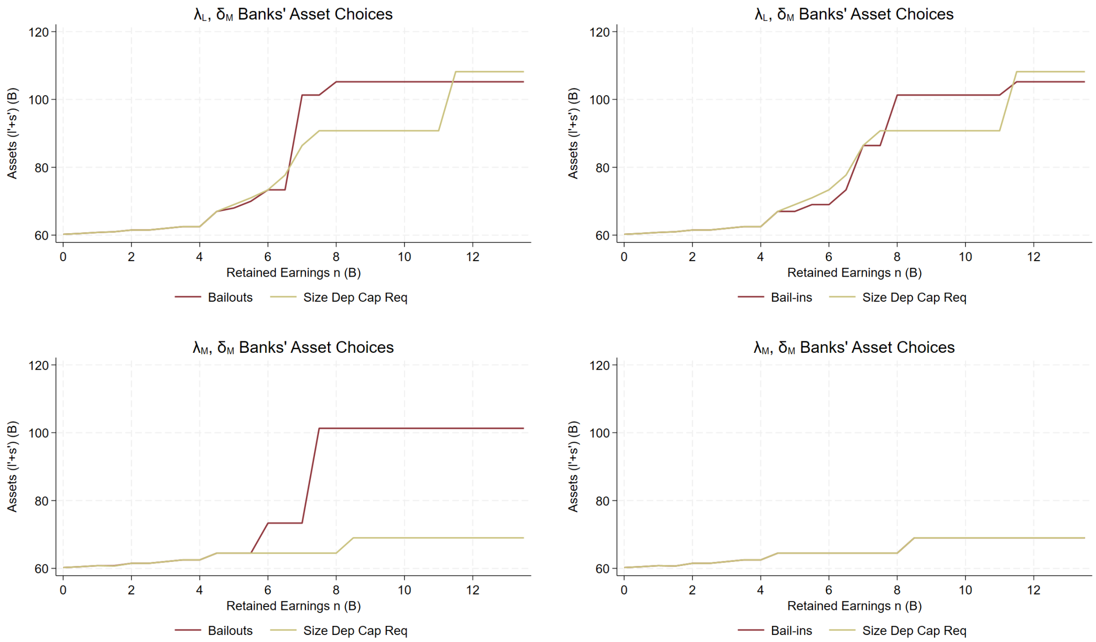
1.3 Size Dependent Capital Requirements

In this section, the capital requirement is increased to 8% if the bank has assets greater than \$100B, the asset threshold at which the bailout probability becomes positive. Results from this counterfactual can be found in Column 5 of Table 2. This policy counterfactual is in-line with size-dependent capital requirements enacted in the Dodd-Frank Act and can be used to compare how higher capital requirements for banks with bailout expectations can reduce big bank failure relative to replacing bailout expectations with bail-in expectations.

Figure 5 plots the asset policy functions of banks as a function of their net cash and current default rate for banks with the medium insured deposits under the bailout, bail-in, and size-dependent capital requirements models. Banks avoid crossing the \$100B threshold until they have built up enough net cash to help them meet the higher capital requirements. We can see that they stay in the realm of \$90-96B in assets when their net cash n varies from \$7.5-11B. However, once they do choose assets above the threshold, their assets are actually higher than under bailout or bail-in, for the same value of net cash n. Despite having to hold more capital, banks are actually earning more on their risky lending than under the benchmark model. Therefore, the optimal choice of assets has increased, as long as they can use more equity to fund it to avoid violating the capital requirements. Compared to the bail-in world, banks earn approximately the same rate on their lending. However, these banks benefit from the subsidy on their debt prices and increased equity value from a bailout compared to a bail-in. This increases the optimal choice of assets relative to the bail-in counterfactual.

The corresponding uninsured leverage policy functions can be found in Figure 6. The plots in the top row demonstrate the uninsured leverage policy functions of banks with the lowest default rate λ_L. When banks are below the \$100B threshold and are not subject to the higher capital requirements, they make similar uninsured leverage decisions as those by banks under both the original bailout (left) and bail-in (right) models. However, because the banks stall growing over the threshold and having to face the higher constraint, they borrow less. Even when the banks do choose assets above the threshold, they still borrow less uninsured debt. This is because more leverage binds the capital requirement, so banks are more willing to fund their assets with equity. In the plots in the bottom row, we see that the λ_M banks behave just like those in the bail-in model. Due to the higher capital requirements over the threshold, these banks choose assets significantly below it. They will always be liquidated if they fail, and therefore, their debt and equity values are very

Figure 5: Policy Functions under Size Dependent Capital Requirements



similar to those in the bail-in counterfactual.

Figure 7 plots the corresponding size distributions. Compared to the original bailout model, the distribution of banks around the \$100B threshold is substantially smoother. The constraint of higher capital requirements offsets some of the benefit of having a positive probability of bailout and more λ_L banks stay below the threshold. Further, the λ_M banks no longer grow above the threshold, and therefore, this size distribution is more similar to that under bail-in. The main difference between the bail-in and size dependent capital requirement distributions is that the latter has more mass between \$80-99B and less above \$100B due to the penalty of the higher capital requirements reducing the number of λ_L banks jumping over the threshold. These banks specifically benefit the most from the bail-in pricing and still jump in that counterfactual scenario. However, the higher capital requirements from the size-dependent requirement negates much of this value and banks purposely grow at a slower rate. The share of big banks in the economy is reduced from 10.2% to 9.5%.

Aggregate statistics for the size-dependent capital requirements steady state can be found in Column 5 of Table 2. In general, these statistics are very similar as those under bail-in. However, due to the higher capital requirements when over the threshold, banks choose lower uninsured debt levels and increase their risky asset fractions slightly.

Figure 6: Uninsured Leverage Policy Functions under Size Dependent Capital Requirements

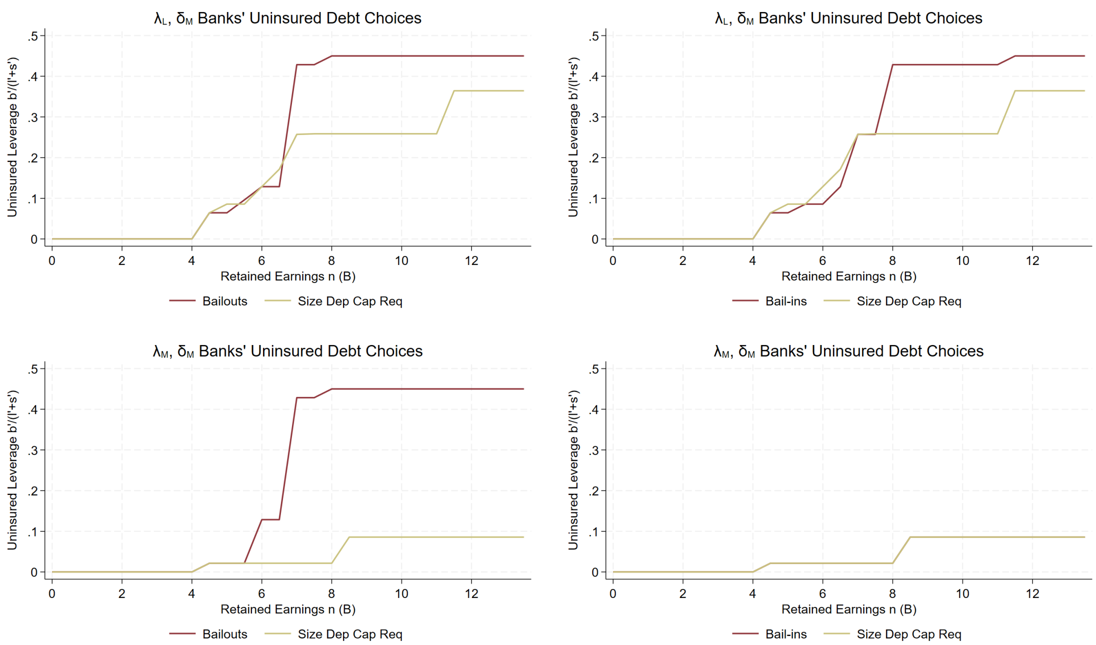
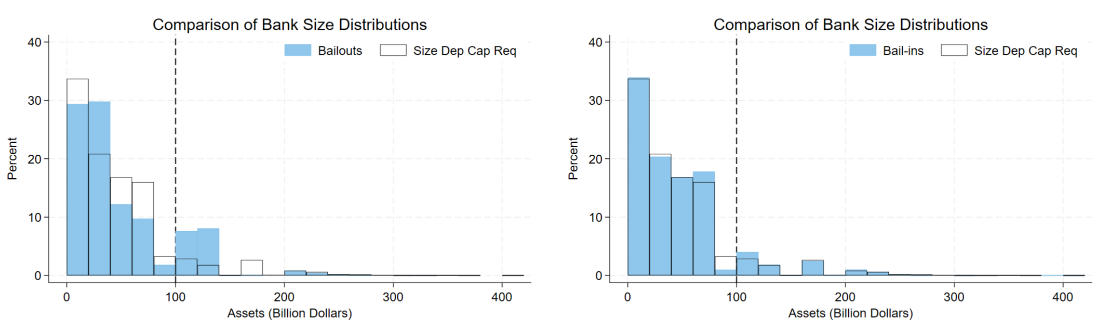


Figure 7: Comparison of Size Distributions under Size Dependent Capital Requirements



The largest deviation between this equilibrium and the bail-in one is in resolution costs, which are almost double for the size-dependent capital requirements scenario due to the cost of bailout transfers that are still needed. This suggests that bail-ins may be a better option to reducing big bank failure costs while promoting aggregate lending, but that size-dependent capital requirements still provide vast improvements if reducing bailout expectations to zero is not possible.

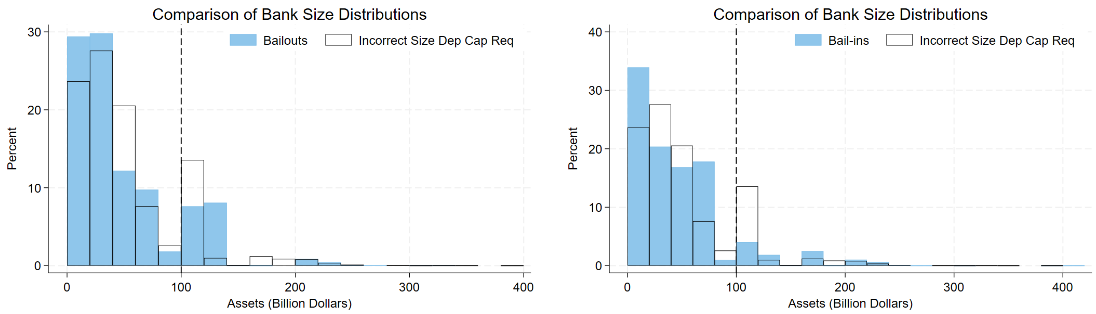
In fact, size-dependent capital requirements improve default rate allocative efficiency more than the bail-in does. Higher capital requirements lead to banks increasing their risky asset fraction slightly as they decrease leverage instead. As majority of banks subject to the higher capital requirements in this scenario are the lowest default rate banks, this results in a slight increase in the share of lending by banks with the lowest expected default rates.

1.4 Mismatched Size Dependent Capital Requirements

Section 1.3 demonstrated that size dependent capital requirements can replicate many of the benefits of bail-in expectations without the commitment to bail-ins. However, these results rely on capital requirements increasing at the same threshold at which bailout expectations increase. If these two thresholds were not aligned, the benefits of bail-ins may not be realized. In this section, I solve for an equilibrium in which banks with assets above \$100B are considered "too big to fail" and subject to a $\bar{\rho}$% probability of bailout when they fail, but higher capital requirements are only imposed on banks with at least \$110B in assets.

Figure 8 compares the size distribution of banks in this equilibrium to that of the benchmark model (left) and the bail-in counterfactual model (right). Compared to the benchmark model, the main difference in this distribution is that banks previously in the \$110-120B range now stay in the \$100-110B range. These banks will still have the positive probability of bailout if they fail, but are not subject to the higher capital requirements yet. In order to remain in this range, big banks borrow less and issue more dividends instead of borrowing more to grow slightly larger. This can be seen in Column 6 of Table 2. Average uninsured leverage decreases from 0.44 under the benchmark to only 0.30. However, these banks still borrow enough such that they will not be able to repay their debt if they receive the high default rate, and the big bank failure rate barely changes from 2.88% to 2.87%.

Figure 8: Comparison of Size Distributions under Mismatched Size Dependent Capital Requirements



Failure rates and the share of big banks are much closer to those of the benchmark equilibrium than the bail-in counterfactual, thus depleting the bail-in benefits associated with size dependent capital requirements in Section 1.3. Further, aggregate lending is 2.0% lower than in the benchmark model, suggesting even fewer advantages to size dependent capital requirements if they do not align with "too big to fail" beliefs.