The Redistributive Effects of Financial Deregulation*

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Abstract

Financial sector capital has some of the characteristics of a public good. If the financial sector suffers a capital shortfall, it is forced to contract credit, which hurts the real economy. Bankers do not take this externality into account when they choose their optimal trade-off between risk and return. Financial regulation to internalize this externality curtails risk-taking, which reduces profits in the financial sector in good times but protects the real economy from costly credit crunches in bad times. By contrast, financial deregulation redistributes from the real economy towards the financial sector by enabling greater risk-taking and higher bank profits on the upside but more severe credit crunches on the downside. If losses in the financial sector are sufficiently large, agents in the real economy find it optimal to restore financial sector capital via bailouts, which mitigates the credit crunch. Financial deregulation also increases the incidence of bailouts, which shifts the distribution of resources further towards bankers.

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1 Introduction

The financial sector is often considered the heart of a modern market economy (see e.g. Caballero, 2010). It plays the central role of intermediating capital to its most productive use and touches upon most production processes in the economy.

If the financial sector experiences a crisis and finds itself short of capital, the rest of the economy suffers. During a crisis, the financial sector can no longer fulfill its job of intermediating savings to productive investment opportunities. Firms can no longer obtain the loans they require to implement their optimal investment plans. In turn, they cut back on their demand for complementary productive factors, such as labor, land and natural resources. This hurts the owners of such factors, e.g. workers experience unemployment and declines in their wages. Furthermore, savers can no longer channel their savings to the most productive use; they see the interest rates on their deposits decline, even though other sectors in the economy would have productive uses for their savings.

We illustrate these effects during the financial crisis of 2008/09 in Figure 1.¹ The first panel depicts the decline in bank equity during the crisis. (We used the

¹For a detailed description of data sources, see appendix A
market value of bank equity since book values do not account for many of the expected losses.) Panel 2 shows the decline and recovery of the wage bill over the course of the crisis. Panel 3 illustrates the decline in commodity prices, and Panel 4 shows the effects of the financial crisis on the spread between interest rates for risky borrowing and safe rates. Similar effects have been observed during financial crises for centuries (see e.g. Reinhart and Rogoff, 2009).

Given the central role that the financial sector plays in the market economy, society has developed mechanisms to ensure that financial institutions have sufficient capital to adequately perform their role of financial intermediation. Ex-ante, i.e. before financial distress materializes, society imposes regulations on the financial sector to ensure that it holds sufficient capital to withstand downturns with minimal damage to the rest of the economy. Ex-post, i.e. during financial crises, society frequently offers financial support in the form of guarantees and bailouts. Often, such bailouts are given on an ad-hoc basis, even if no formal legal mechanism to do so is in place, and even if policymakers have made prior commitments to refrain from bailouts. In a modern economy, the full collapse of a country’s financial system is viewed as just too expensive to allow.

The contribution of this paper is (i) to analyze how changes in aggregate bank capital affect output and the distribution of resources in the economy, (ii) to show that risk-taking in the financial sector has asymmetric payoffs for bankers and for the rest of society and (iii) to draw lessons for the redistributive effects of financial policies such as financial deregulation and bailouts.

We capture the special role of the financial sector by assuming that it plays a bottleneck role in the economy: it is the only sector that can engage in financial intermediation, i.e. to channel capital into productive investments. This assumption applies to the financial sector in a broad sense, including broker-dealers, the shadow financial system and all other actors that engage in financial intermediation. For simplicity, we will refer to all actors in the financial sector broadly defined as “bankers.”

Furthermore, we assume two types of financial imperfections. First, the financial sector suffers from a commitment problem and needs to have sufficient capital in order to engage in financial intermediation. This captures the standard notion that bankers need to have “skin in the game” to guarantee that they have proper incentives. Second, insurance markets between bankers and the rest of society are incomplete. We capture this by making the extreme assumption that the holdings of bank equity are concentrated in the hands of bankers (representing the financial elite). More generally, a sufficient condition is that the holdings of bank equity are not proportionally distributed across society.

\textsuperscript{2}See e.g. Jeanne and Korinek (2012) for a detailed discussion and evaluation of the efficiency implications of ex-ante versus ex-post policy measures to deal with financial crises.

\textsuperscript{3}Our basic results continue to hold as long as there are no perfect substitutes that can replace the financial sector when it experiences a large decline in its capital position.

\textsuperscript{4}An alternative assumption would be that bankers are able to extract a significant fraction
We find that changes in bank capital affect banks and workers asymmetrically depending on whether financial constraints on bankers are binding: As long as aggregate bank capital is abundant so that financial constraints on bankers are loose at the level of the macroeconomy, bankers can optimally fulfill their function of intermediating capital to the rest of the economy. As a result, output is at the first-best level, and fluctuations in aggregate bank capital have no significant implications for the real economy. By contrast, when aggregate bank capital declines below a certain threshold, binding financial constraints force bankers to cut back on intermediating credit to the rest of the economy. The resulting credit crunch causes output to contract, and the wage bill goes down while lending spreads increase. These relative price movements hurt workers but benefit bankers.

At a technical level, such price movements constitute pecuniary externalities. When bank capital is in short supply, financial intermediation is constrained and real capital investment is rationed. The marginal returns on scarce new investment go up – bankers earn a scarcity rent because they play a bottleneck role in the economy, having an exclusive hold on the technology to intermediate capital. The returns to abundant complementary factors, in particular the wage bill earned by workers, goes down.

Our findings are consistent with the US experience over the past decade: record profits in the financial sector in the first half of the 2000s were not associated with proportional increases in real capital investment, and the benefits were largely confined to the financial elite (see e.g. Philippon and Reshef, 2013). By contrast, record losses in 2007-09 quickly led to sharp declines in financial intermediation and real capital investment, with substantial losses for society at large.

Workers are averse to fluctuations in bank capital since they lose on the downside but have nothing to gain on the upside. Therefore they would like to limit risk-taking by bankers. In a sense, financial regulation to limit risk-taking in the banking sector is a substitute for missing risk-sharing markets. Bankers, by contrast, gain on the upside and shift part of the losses that occur on the downside to workers. Bankers therefore collectively prefer more risk-taking and lighter financial regulation.

We can express these findings as a Pareto-frontier, where higher levels of risk-taking correspond to higher levels of welfare for bankers and lower levels of welfare for workers. We can interpret financial regulations to limit risk-taking as moving the economy along this Pareto frontier to increase worker welfare at the expense of bank profits.

We also find that other distortions that increase risk-taking in the financial sector lead to redistributions from workers to bankers. We investigate an example where bankers are non-atomistic and show that they have strong incentives to increase risk-taking to redistribute expected surplus from workers to themselves, even if they act competitively in the market for loans. This highlights a
new dimension of welfare losses from concentrated banking systems for the rest of society.

Next we analyze the effects of financial innovation. We argue that financial innovation enables the financial sector to take on more risk in the quest for higher returns. The greater risk hurts workers, whereas the greater returns mostly benefit bankers.

The second part of our paper analyzes bailouts. When aggregate bank capital is sufficiently scarce, workers benefit if they provide a transfer to bankers. Such a bailout transfer mitigates the financial constraint, eases the credit crunch in the economy and softens the fall in wages. Technically, the bailout is beneficial because of the pecuniary externality from increased bank capital to higher wages. Clearly, bankers benefit from the transfer as well. Therefore bailouts generate a Pareto improvement, and it is difficult to commit not to provide them. If aggregate bank capital is what matters for financial intermediation, then emergency lending and/or equity injections into banks are only beneficial to the extent that they are given at preferential rates that include an implicit transfer from workers to bankers.

Bailouts generate a second type of rents for bankers, which we term bailout rents: A significant part of the efficiency gains from bailouts accrues to bankers since they receive a straight transfer from workers. In fact, the optimal bailout is determined such that the marginal benefit of transferring the last dollar is zero for workers, whereas the marginal benefit for bankers is strictly positive. Again, banks are able to obtain this rent because of their exclusive role in the process of credit intermediation.

The incentives for risk-taking in the financial sector are increased even if bailouts are provided in lump-sum fashion – they alleviate shortages of bank capital and therefore reduce the precautionary behavior of bankers. In addition, if bailouts are contingent on the capital levels of individual financial institutions or if individual banks have market power so they anticipate that their financial position influences aggregate bank capital, then bailouts lead to even higher risk-taking and, in parallel, higher bailouts rents. This second effect corresponds to the traditional “moral hazard” effect of bailouts.

Bailouts generate efficiency gains that shift the economy’s Pareto frontier outwards, but the shift is generally biased towards bankers, i.e. bankers benefit more from the introduction of the bailout technology than workers. The increase in risk-taking that is induced by bailouts benefits bankers and hurts workers.

**Literature**

This paper is related to a growing literature on the effects of financial imperfections in macroeconomics (see e.g. Gertler and Kiyotaki, 2010, for an overview). Most of this literature describes how binding financial constraints may amplify and propagate shocks (see e.g. Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997) and lead to significant macroeconomic fluctuations that affect output, employment and interest rates. However, little emphasis is placed on the redistributive effects of such fluctuations between financial intermediaries.
and workers when insurance markets are incomplete. The main contribution of our paper is to fill this gap and show that binding financial constraints lead to significant redistributions that benefit the financial sector at the expense of workers. This effectively rewards risk-taking in the financial sector.

Our paper is also related to a long and growing literature on financial regulation and bailouts (see e.g. Freixas and Rochet, 2008, for a comprehensive review), but puts the distributive implications of such financial policies at the center stage. One recent strand of this literature argues that financial regulation should be designed to internalize pecuniary externalities in the presence of incomplete markets. See e.g. Lorenzoni (2008); Korinek, (2011); Jeanne and Korinek (2010ab, 2012); Gersbach and Rochet (2012) for papers on financial regulation motivated from asset price externalities, or Caballero and Lorenzoni (2010) for a paper on currency intervention based on exchange rate and wage externalities in an emerging economy. Campbell and Hercowitz (2009) study pecuniary externalities on the interest rate that arise in the transition from an equilibrium with low household debt to an equilibrium with high household debt. They show that deregulation that relaxes collateral constraints on borrowers may reduce borrower welfare by increasing the interest rate. Our paper is based on pecuniary externalities from bank capital to wage earners and studies the implications for financial regulation and bailouts. Empirical evidence for the importance of financial sector capital for the broader economy is provided e.g. in Adrian et al. (2010).

A second strand of the literature on financial regulation argues that an important objective of regulation is to limit the risk-shifting of financial institutions that count on government bailouts, which are typically assumed as a given. See e.g. Hall (2010) and Martinez-Miera and Suarez (2012). Our contribution to this literature is twofold: first, we provide an endogenous rationale for why it is in the interest of workers to provide government bailouts. Secondly, we show that bailouts may act as a substitute for missing insurance markets. This is also related to an emerging literature that shows that expansive monetary policy during crises works in part by performing redistributions (see e.g. Brunnermeier and Sannikov, 2012).

In the discussion of optimal capital standards for financial institutions, Admati et al. (2010) and Miles et al. (2012) have pointed out that society at large would most likely benefit from imposing higher capital standards. We provide a formal economic framework to study the externalities from bank capital to other sectors in the economy analytically.

Our paper is also related to a growing literature that focuses on the role of the financial sector in increasing societal inequality over the past decades (see e.g. Kaplan and Rauh, 2010; Philippon and Reshef, 2013) as well as the implications for financial instability and crises (see e.g. Kumhof and Ranciere, 2012). We provide a unified explanation for the increase in inequality and instability based on the notion that the centrality of the financial sector in a modern market economy may allow the sector to extract large rents by increasing its risk-taking.

At a technical level, the exclusive role of bankers in intermediating capital
is related to a literature on “bottlenecks,” which describes how the supplier of an essential productive input can earn rents from restricting supply to her customers (see e.g. Rey and Tirole, 2007, for an overview). In our framework, bankers earn similar rents when risk-taking creates an aggregate scarcity of bank capital.

2 Bank Capital and Workers

We develop an analytical model in which bank capital is critical for workers because bankers intermediate capital to the real economy. When bank capital is low, real capital investment is constrained below the first-best level and production declines. This hurts workers since capital and labor are complements in all standard production functions. In the following, we introduce our model setup and start by analyzing the first-best allocation; then we introduce the financial imperfection that is responsible for the main result of our paper.

2.1 Model Setup

There are three time periods, \( t = 0, 1, 2 \), a single good that serves both as consumption good and capital as well as a unit mass each of two types of agents: bankers and workers.

**Bankers** In period 0, bankers are born with one unit of the consumption good. They invest a fraction \( x \in [0, 1] \) of it in a project that delivers a risky payoff \( \tilde{A} \) in period 1 with a continuously differentiable distribution function \( G(\tilde{A}) \) over the domain \((0, \infty)\), a density function \( g(\tilde{A}) \) and an expected value \( E[\tilde{A}] > 1 \) in our benchmark model. They hold the remainder \((1 - x)\) in a storage technology with gross return 1.5 The resulting equity level of bankers in period 1 is

\[
e = x\tilde{A} + (1 - x)
\]

Consistent with the literature on banking regulation, we will frequently use the term “bank capital” to refer to bank equity \( e \) in the following.

In period 1, bankers raise \( d \) deposits at a gross deposit rate of \( r \) and lend \( k \leq d + e \) to the productive sector of the economy at a gross interest rate \( R \). In period 2, bankers are repaid and value total profits in period 2 according to a linear utility function

\[
\pi = Rk - rd
\]

**Workers** Workers are born in period 1 after the technology shock \( \tilde{A} \) is realized. This timing implies that workers cannot enter into risk-sharing contracts with bankers in period 0 and that all the risk \( x\tilde{A} \) from investing in the risky technology needs to be borne by bankers. This outcome reflects the notion that risk markets

\footnote{From a macroeconomic perspective, the storage technology could be interpreted e.g. as savings that are invested abroad.}
between bankers and workers are incomplete. An alternative microfoundation for this would be that obtaining the distribution function $G(A)$ requires that bankers exert an unobservable private effort, and insuring against fluctuations in $A$ would reduce their incentive to exert this effort. In practice, bank capital is subject to significant fluctuations, as illustrated in Figure 1, and an important fraction of this risk is not shared with the rest of society.6

Workers are born with a large endowment $m$ of consumption goods. They lend an amount $d$ of deposits to bankers and hold the remainder in a storage technology with gross return 1. No arbitrage implies that the gross deposit rate at which workers lend to bankers satisfies $r = 1$.

In period 2, workers inelastically supply one unit of labor $\ell = 1$ at the prevailing market wage $w$. (The main insights of our framework are unchanged if labor supply is elastic.) Worker utility depends only on their total consumption. For notational simplicity we normalize the expression for worker consumption by subtracting the constant $m$ to obtain the utility function

$$u = w\ell$$

Workers collectively own firms, which are neoclassical and competitive and only produce in period 2. Firms rent capital $k$ from bankers at interest rate $R$ at the end of period 1, and hire labor $\ell$ from workers at wage $w$ in period 2. They seek to maximize profits $F(k, \ell) - w\ell - Rk$, where $F(k, \ell) = Ak^\alpha \ell^{1-\alpha}$ with $\alpha \in (0,1)$. For simplicity, we assume that there is no uncertainty in firms’ production. In equilibrium firms earn zero profits, and firm ownership is irrelevant.

The first-order conditions of the firm problem are

$$R = F_k = \alpha Ak^{\alpha-1} \ell^{1-\alpha}$$
$$w = F_\ell = (1-\alpha) Ak^\alpha \ell^{-\alpha}$$

2.2 First-Best Allocation

A planner who implements the first-best maximizes aggregate surplus in the economy subject to the resource constraints of the economy,

$$\max_{x,e,k,\ell} E[F(k, \ell) + e + m - k] \quad \text{s.t.} \quad e = xA + (1-x)$$
$$k \leq e + m$$
$$x \in [0,1], \ell \in [0,1]$$

In period 2, the optimal labor input is $\ell^* = 1$, and that the optimal level of capital investment satisfies $k^* = (\alpha A)^{1-\alpha}$, i.e. it equates the marginal return to

6For example, only 17.9% of US households hold direct stock investments, and another 33.2% hold equity investments indirectly, e.g. via retirement funds or other mutual funds. Furthermore, equity ownership is heavily skewed towards the high end of the income distribution (see Table A2a in Kennickel, 2013).
investment to the return on the storage technology,

\[ R^* = F_k (k^*, 1) = 1 \]

We call the resulting output level \( F(k^*, 1) \) the first-best level of output, or potential output. As we discussed earlier, we assume that \( m \) is large so that the resource constraint \( k \leq e + m \) is lax, i.e. there are always sufficient funds available in the economy to implement the first-best in the absence of market frictions. The marginal product of labor at the first-best level of capital is \( w^* = F_l (k^*, 1) \).

In period 0, the planner chooses the portfolio allocation that maximizes expected bank equity \( E[e] \). As long as \( E[\tilde{A}] > 1 \), she will pick the corner solution \( x = 1 \).

Since a fraction \( \alpha F(k^*, 1) \) of production is spent on investment, the net social surplus generated in the first-best is

\[ S^* = (1 - \alpha) F(k^*, 1) + E[\tilde{A}] \]

### 2.3 Financial Constraint

We assume that bankers are subject to a commitment problem to capture the notion that bank capital matters. Specifically, bankers have access to a technology that allows them to divert a fraction \((1 - \phi)\) of their gross revenue, where \( \phi \in [0, 1] \). By implication depositors can receive repayments on their deposits that constitute at most a fraction \( \phi \) of the gross revenue of bankers. Anticipating this commitment problem, depositors restrict their supply of deposits to satisfy the constraint

\[ rd \leq \phi Rk \]  \hspace{1cm} (1)

An alternative interpretation of this financial constraint follows the spirit of Holmstrom and Tirole (1998): Suppose that bankers in period 1 can shirk in
their monitoring effort, which yields a private benefit of \( B \) per unit of period 2 revenue but creates the risk of a bank failure that may occur with probability \( \Delta \) and that results in a complete loss. Bankers will refrain from shirking as long as the benefits are less than the costs, or \( BRk \leq \Delta (Rk - rd) \). If depositors impose the constraint above for \( \phi = 1 - \frac{B}{B} \), they can ensure that bankers avoid shirking and the associated risk of bankruptcy.\(^7\)

We should note that our benchmark model is not able to account for the procyclicality of financial leverage, which is documented e.g. in Brunnermeier and Pedersen (2009).\(^8\) We could correct for this by making the parameter \( \phi \) vary with the state of the economy, so that \( \phi (\bar{A}) \) is an increasing function. This would not qualitatively affect our main results, since the marginal value of bank capital for a given pair \((e, \phi)\) would be unchanged.

\section{Laissez-Faire Equilibrium}

We define the laissez-faire equilibrium of the economy as a set of prices \( \{r, R, w\} \) and an allocation \( \{x, e, d, k\} \), with all variables except \( x \) contingent on \( \bar{A} \), such that the investment decisions of households and bankers and the production decisions of firms are optimal given their constraints, and the markets for capital, labor and deposits clear.

We solve for the laissez-faire equilibrium in the economy with the financial constraint using backward induction, i.e. we first solve for the optimal period 1 equilibrium of bankers, firms and workers as a function of a given level of bank capital \( e \). Then we analyze the optimal portfolio choice of bankers in period 0, which determines \( e \).

\subsection{Period 1 Equilibrium}

We analyze equilibrium in the economy in period 1 for a given level of bank capital \( e \). Employment is always at its optimum level \( \ell = 1 \). The financial constraint binds if bank equity is below a threshold \( e < e^* = (1 - \phi)k^* \). In this case, households provide deposits up to the constraint \( d = \phi Rk/r \), the deposit rate is \( r = 1 \), and the lending rate is \( R = F_k (k, 1) \). Equilibrium capital investment in the constrained region, denoted by \( k^* (e) \), is implicitly defined by the equation

\[ k = e + \phi kF_k (k, 1) \] (2)

\(^7\)If the equilibrium interest rate is sufficiently large that \( R > \frac{1}{1 - \Delta + B} \), banks would prefer to offer depositors a rate \( r = \frac{1}{1 - \Delta + B} \) and shirk in their monitoring, incurring the default risk \( \Delta \). We will discuss in the following section that such high interest rates are unlikely to be an equilibrium outcome as they would give rise to bailouts.

\(^8\)Since leverage is equal to \( \frac{1}{1 - R} \), and \( R \) increases when \( e \) is low, leverage limits mechanically rise in our model when bank capital is scarce.
which has a unique positive solution for any \( e > 0 \). Overall, capital investment is given by the expression

\[
k(e) = \min \left\{ \hat{k}(e), k^* \right\}
\]

Equilibrium \( k(e) \) is strictly positive, strictly increasing in \( e \) over the domain \( e \in [0, e^*] \) and constant at \( k^* \) for \( e \geq e^* \). The equilibrium lending rate and the wage level satisfy, respectively,

\[
R(e) = \alpha F(k(e), 1)/k(e) = \frac{\alpha}{e - \phi R(e)}\frac{k}{R(e) - 1} \cdot k(e, e)
\]

Let us distinguish aggregate bank equity \( e \), and the equity \( e^i \) of an individual banker indexed by \( i \). Then we can describe the level of capital intermediated by banker \( i \) and the resulting profits by

\[
k(e^i, e) = \min \left\{ k^*, \frac{e^i}{1 - \phi R(e)} \right\}
\]

\[
\pi(e^i, e) = e^i + [R(e) - 1] \cdot k(e^i, e)
\]

In equilibrium, \( e^i = e \) will hold, and we denote the equilibrium profits of the banking sector as a whole as well as the utility of workers by

\[
\pi(e) = e + \alpha F(k(e), 1) - k(e) = (1 - \alpha) F(k(e), 1)
\]

Total surplus in the economy is \( s(e) = u(e) + \pi(e) \).

### 3.2 Marginal Value of Bank Capital

How do changes in bank capital affect the economy? If bankers are financially constrained, then higher bank capital allows for higher deposits. Therefore a marginal increase in bank capital \( e \) will lead to a greater than one-for-one increase in investment \( k \). To find \( k'(e) \), we apply the implicit function theorem to (2), which yields

\[
k'(e) = \frac{1}{1 - \phi \alpha F_k} > 1 \quad \text{for} \quad e < e^*
\]

For \( e \geq e^* \), capital investment is at \( k^* \) and is unaffected by increases in bank capital; therefore \( k'(e) = 0 \) for \( e \geq e^* \).

The increase in total surplus arising from a marginal increase in bank capital is \( 1 + (F_k - 1)k'(e) \). This is divided between bankers and workers, with workers receiving the benefit of increased wages \( (1 - \alpha)F_kk'(e) \), and bankers receiving the remainder \( 1 + (\alpha F_k - 1)k'(e) \) in increased profits. Once bank equity reaches the threshold \( e^* \), capital investment is at the first-best level \( k^* \), and additional increases in equity no longer raise aggregate investment. Beyond this point,
additional equity earns the return of the storage technology and only increases the return of bankers.

Analytically, we determine the marginal value of aggregate bank capital for workers and bankers collectively by using the expression for \( k_0(e) \),

\[
\begin{align*}
    w'(e) &= \begin{cases} 
        \frac{(1-\phi)F_k}{1-\phi R(e)} & \text{for } e < e^* \\
        0 & \text{for } e \geq e^* 
    \end{cases} \\
    \pi'(e) &= \begin{cases} 
        \frac{(1-\phi)F_k}{1-\phi R(e)} & \text{for } e < e^* \\
        1 & \text{for } e \geq e^* 
    \end{cases}
\end{align*}
\]

An individual banker \( i \) takes the interest rate \( R(e) \) as given and perceives the constraint on deposits as a simple leverage limit. Thus she perceives the effect of a marginal increase in bank capital \( e^i \) as increasing her capital investment according to \( k_1(e^i, e) = \frac{1}{1-\phi R(e)} \), which implies an increase in bank profits by

\[
\pi_1(e^i, e) = 1 + \frac{R(e) - 1}{1-\phi R(e)} = \frac{(1-\phi)F_k}{1-\phi F_k}
\]

Panel 1 of Figure 3 depicts the payoffs of bankers and workers as a function of bank capital \( e \).\(^9\) As long as \( e < e^* \), capital investment falls short of the first best level. In this region, the welfare of workers and of bankers are strictly increasing concave functions of bank equity. Once bank capital reaches the threshold \( e^* \), the economy achieves the first-best level of investment. Any bank capital beyond this point is invested in the storage technology and the benefits accrue entirely to bankers. Therefore bank profits increase linearly in \( e \) and

\(^9\)The parameter values used to plot all figures are reported in Appendix B.
workers do not benefit from additional bank capital beyond $e^*$. This generates a non-convexity in the function $\pi(e)$ at $e^*$. Furthermore, the function $s(e)$ captures the total surplus $s(e) = w(e) + \pi(e)$.

Panel 2 of Figure 3 reports the marginal increase in bank profits $\pi'(e)$ and wages $w'(e)$ resulting from an increase in aggregate bank capital. For $e < e^*$, an increase in aggregate bank capital increases financial intermediation, which in turn raises real capital investment. This increases wages but reduces the rate of return on capital $R(e)$. After the threshold $e^*$ has been reached, additional bank capital does not increase financial intermediation or investment in real capital $k$, and so the marginal value of bank capital is 1 for bankers, and 0 for households.

This discontinuity in the marginal benefit of bank capital to bankers and workers reflects two different regimes of the economy: If the financial sector is constrained, bank capital is an important variable for workers since the constraint hurts aggregate investment and depresses their wages. If the financial sector is unconstrained, bank capital is irrelevant for workers and all the benefits of additional bank capital accrue to banks.

Our analytical findings on the value of bank capital are consistent with the empirical regularities that we depicted in Figure 1 on page 2. When bank capital fell during the financial collapse of 2008/09, the wage bill slumped. The prices of other factors that are complementary in production, illustrated by commodity prices, also declined sharply. By contrast, the spread between lending and deposit rates increased. These findings are consistent with empirical evidence across a wide range of banking crises (see Reinhart and Rogoff, 2009).

### 3.3 Scarcity Rents

If bank capital is below the optimum level, banks earn scarcity rents. In the first-best equilibrium or under frictionless financial markets, the market return on real capital investment is $R^* = 1$ since the alternative to capital investment is the safe storage technology. If bank capital is scarce, i.e. $e < e^*$, the financial friction between bankers and workers drives the return to capital investment up to $R(e) = F_k(k(e),1) > 1$ since not all productive investments can obtain loans. Bankers earn the difference between the two, i.e. the lending spread $R(e) - 1$ on all $k$ units of capital intermediated. We capture the total scarcity rent $SR$ earned by banks as

$$SR = k[F_k - 1]$$

The scarcity induced by binding financial constraints has similar distributive effects to scarcity generated by monopolistic behavior: it restricts the supply of credit and raises lending spreads, benefitting bankers at the expense of the rest of the economy, i.e. workers. The labor share remains a constant fraction $1 - \alpha$ of output under Cobb-Douglas production technologies. If capital input $k$ is reduced but labor supply remains constant, wages go down. This constitutes a
pecuniary externality through which workers effectively share the risk of capital shortages with bankers.

The scarcity spread arising from financial constraints also plays a useful social role in allocating risk. It signals to bankers that there are extra returns available for carrying capital into constrained states of nature.

### 3.4 Period 0 Equilibrium

In period 0, bankers decide what fraction $x$ of their endowment to allocate to the risky project. Banker $i$ takes the aggregate levels of $x$ and $e$ as given and chooses $x^i$ to maximize

$$\max_{x^i \in [0,1], e^i} \Pi^i(x^i; x) = E[\pi(e^i, x^i)] \text{ s.t. } e^i = (1 - x^i) + \tilde{A}x^i$$

At an interior optimum, the optimality condition of bankers is

$$E[\pi_1(e^i, e^i) (\tilde{A} - 1)] = 0,$$

i.e. the risk-adjusted return on the stochastic payoff $\tilde{A}$ equals the return of the safe storage technology.

The stochastic discount factor $\pi_1$ in this expression is given by equation (3) and is strictly declining in $e$ as long as $e < e^*$ and constant at 1 otherwise. Observe that each banker $i$ perceives his stochastic discount factor as independent of his choices of $e^i$ and $x^i$. However, in a symmetric equilibrium, $e^i = e$ as well as $x^i = x$ have to hold, and equilibrium is given by the level of $x$ and the resulting realizations $e = \tilde{A}x + (1 - x)$ such that the optimality condition (5) is satisfied. As long as $E[\tilde{A}] > 1$, the optimal allocation to the risky project satisfies $x > 0$ and is uniquely pinned down by condition (5). If the expected return is sufficiently high, equilibrium is given by the corner solution $x = 1$.

We denote by $x^{LF}$ the fraction of their initial assets that bankers allocate to the risky project in the laissez faire equilibrium. The resulting levels of welfare for workers and entrepreneurs are $\Pi^{LF} = E[\pi(1 - x^{LF} + \tilde{A}x^{LF})]$ and $W^{LF} = E[w(1 - x^{LF} + \tilde{A}x^{LF})]$.

We define by $\tilde{A}(x)$ the threshold of $\tilde{A}$ above which production is at its first-best level for a given risky portfolio allocation $x$ and observe that

$$\tilde{A}(x) = 1 + \frac{e^* - 1}{x}$$

If $e^* \leq 1$, then the safe return is sufficient to avoid the financial constraint and the first-best level of capital intermediation $k^*$ would be reached for sure with a perfectly safe portfolio $x = 0$. We can interpret this case as an economy in which the financial sector is sufficiently developed to intermediate the first-best amount of capital in normal times, i.e. without any extra risk-taking. In that case, we can interpret the risky project $\tilde{A}$ as a diversion from the main
intermediation business of banks, e.g. a diversification from retail banking into investment banking, or loans to Latin American governments that offer extra returns at extra risk. If \( e^* \leq 1 \), then bankers find it optimal to choose \( x^{LF} > 1 - e^* \), i.e. they take on sufficient risk so that the financial constraint is binding at least for the very lowest returns so that \( \tilde{A}(x) > 0 \). This is because the expected return on the risky project dominates the safe return, and bankers perceive the cost of being marginally constrained as second-order. We also observe that for \( e^* < 1 \), the function \( \tilde{A}(x) \) is strictly increasing from \( \tilde{A}(1 - e^*) = 0 \) to \( \tilde{A}(1) = e^* \), i.e. more risk-taking makes it more likely that the financial sector becomes constrained.

If \( e^* > 1 \), on the other hand, then the economy would be constrained if bankers invest all their endowment in the safe return. We can interpret this as an economy where banks are systematically undercapitalized and risk-taking helps them to mitigate these constraints. In that case, the function \( \tilde{A}(x) \) is strictly decreasing from \( \lim_{x \to 0} \tilde{A}(x) = \infty \) to \( \tilde{A}(1) = e^* \), i.e. more risk-taking makes it less likely that the financial sector is constrained.

### 3.5 Pareto Frontier

We denote by \( x^B = \arg \max_x E[\pi(\tilde{A}x + 1 - x)] \) the allocation to the risky project that is collectively preferred by bankers, and by \( x^W = \arg \max_x E[u(\tilde{A}x + 1 - x)] \) the choice collectively preferred by workers. If \( e^* \leq 1 \), then \( x^W = 1 - e^* \), i.e. the point on the Pareto frontier that is optimal for workers is such that financial constraints will be just loose in all states of nature. If \( e^* > 1 \), then the optimal risk allocation for workers satisfies \( x^W > 0 \) – workers would like bankers to take a little bit of risk because the safe return produces insufficient bank capital to intermediate the first-best return, and risk-taking increases the expected return.

The Pareto frontier of the economy consists of all pairs of bank profits and worker wages \((\Pi(x), W(x))\) for \( x \in [x^W, x^B] \).

**Proposition 1 (Pareto Frontier)** (i) The risk allocations that are collectively optimal for workers and bankers, respectively, satisfy

\[ x^W \leq x^B \]

with strict inequalities unless they are corner solutions.

(ii) Over the interval \([x^W, x^B]\), the expected utility of workers \( W(x) \) is strictly decreasing in \( x \), and the expected utility of bankers \( \Pi(x) \) is strictly increasing in \( x \).

(iii) We find furthermore that \( x^{LF} \leq x^B \). If \( e^* \leq 1 \) then \( x^W \leq x^{LF} \leq x^B \) with strict inequalities unless they are corner solutions.

**Proof.** We first show that the functions \( \Pi'(x), \Pi_1(x, x), \) and \( W'(x) \) are strictly
Then since have
\[ \Pi''(x) = \int_0^\infty \left( \hat{A} - 1 \right)^2 \frac{(1 - \phi) \alpha F_{kk}}{(1 - \alpha \phi F_k)^3} dG(\hat{A}) < 0 \]
and
\[ \frac{d}{dx} \Pi_1(x^i, x) = \int_0^\infty \left( \hat{A} - 1 \right)^2 \frac{(1 - \phi) F_{kk}}{(1 - \phi F_k)^2} dG(\hat{A}) < 0 \]
Note that if it is indeed the case that \( x^W < x^B \), then part (ii) of the proof follows immediately from this fact.

Next we show that \( x^{LF} < x^B \) at an interior solution. Consider the point \( x^{LF} \). At this point we have \( \Pi_1 = 0 \). Then we have

\[ \Pi'(x^{LF}) = \Pi'(x^{LF}) - \Pi_1(x^{LF}, x^{LF}) = -\int_0^\hat{A} \frac{(1 - \alpha)(1 - \phi)(\hat{A} - 1)F_k}{(1 - \phi F_k)(1 - \phi F_k)} dG(\hat{A}) \]
Observe that the term \( \frac{F_k}{(1 - \phi F_k)} \) is strictly increasing in \( F_k \). Now we define \( \hat{R} \) as follows. If \( \hat{A} \leq 1 \), so that the term \( (\hat{A} - 1) < 0 \) over the entire interval, we let \( \hat{R} \) be the value of \( F_k \) when \( \hat{A} = \hat{A} \). If instead we have \( \hat{A} > 1 \), then let \( \hat{R} \) be the value of \( F_k \) at \( \hat{A} = 1 \). Then since \( F_k \) is decreasing in \( \hat{A} \), we have

\[ -\int_0^\hat{A} \frac{(1 - \alpha)(1 - \phi)(\hat{A} - 1)F_k}{(1 - \phi F_k)(1 - \phi F_k)} dG(\hat{A}) > -\int_0^\hat{A} \frac{(1 - \alpha)(1 - \phi)(\hat{A} - 1)F_k}{(1 - \phi R)(1 - \phi F_k)} dG(\hat{A}) \]
Recall that at \( x^{LF} \) we have \( \Pi_1 = 0 \). We can write this as

\[ \int_0^{\hat{A}} \frac{(1 - \phi) F_k}{1 - \phi F_k} dG(\hat{A}) + \int_0^{\infty} (\hat{A} - 1)dG(\hat{A}) = 0 \]
Then since \( \int_0^{\infty} (\hat{A} - 1)dG(\hat{A}) > 0 \), we must have \( \int_0^{\hat{A}} (\hat{A} - 1)\frac{(1 - \phi) F_k}{1 - \phi F_k} dG(\hat{A}) < 0 \). Thus we have

\[ \Pi'(x^{LF}) > -\frac{(1 - \alpha)(1 - \phi R)}{(1 - \phi R)} \int_0^{\hat{A}} \frac{(1 - \phi) F_k}{1 - \phi F_k} dG(\hat{A}) > 0 \]
Thus we have \( x^{LF} < x^B \). If \( e^* \leq 1 \) then \( x^W = 1 - e^* \) because workers prefer avoiding any constraints whereas \( x^{LF} > 1 - e^* \) because individual bankers would like to expose themselves to at least some constraints; therefore \( x^W < x^{LF} \).

Finally, we show that \( x^W < x^B \) for interior solutions to prove (i). Observe that

\[ \Pi'(x) - \frac{(1 - \phi) \alpha}{1 - \alpha} W'(x) = \int_0^{\infty} (\hat{A} - 1)dG(\hat{A}) > 0 \]
Since at an interior solution we have \( W'(x^W) = 0 \), this implies \( \Pi'(x^W) > 0 \), and so \( x^B > x^W \). ■
Figure 4: Pareto frontier

Figure 4 depicts the Pareto frontier for a typical portfolio allocation problem. The risk allocation that is optimal for workers \( x^W \) is at the bottom right of the figure. As risk-taking \( x \) increases, we move upwards and left along the Pareto frontier, i.e. expected bank profits rise but at the expense of reducing worker welfare. The decentralized equilibrium is indicated by the marker \( x^{LF} \). The top left of the Pareto frontier \( x^B \) represents the maximum level of bank profits and the lowest expected level of worker utility.

Intuitively, risk-taking has asymmetric payoffs for workers and bankers: workers lose during a credit crunch, if \( e \) declines below \( e^* \), but they do not gain if \( e \) rises above \( e^* \) since capital investment is already at its efficient level and there is no reason to push it beyond. By contrast, bankers share only a fraction \( \alpha \) of the pain when bank capital falls below \( e^* \) since the remaining fraction \( (1 - \alpha) \) of the cost of a credit crunch falls on workers, but bankers reap all the benefits if equity rises above \( e^* \). In panel 1 of Figure 3 it can be seen that the payoff function of workers is therefore significantly more concave than that of bankers. In fact, the payoff function of bankers is locally convex around the threshold \( e^* \) where the financial constraint becomes binding.

3.6 Financial Regulation

Financial regulation has the potential to move the economy along the Pareto frontier. The unregulated equilibrium – in the absence of any other market distortions – is represented by the laissez-faire equilibrium \( x^{LF} \) on the frontier. Any point \( \tilde{x} < x^{LF} \) can be implemented by imposing a ceiling on the risk-taking
of individual bankers of $x^i \leq \bar{x}$.

**Corollary 2 (Redistributive Effects of Financial Regulation)** Financial regulation can implement any risk allocation $\bar{x} \leq x^{LF}$ by imposing $\bar{x}$ as a ceiling on risk-taking. Lowering the ceiling $\bar{x}$ increases worker welfare and reduces banker welfare for any $\bar{x} \in [x^W, x^{LF}]$.

Conversely, financial deregulation relaxes the ceiling $\bar{x}$ and redistributes from workers to bankers.

### 3.7 Risk-Taking Incentives

In describing the laissez-faire allocation $x^{LF}$, we assumed that the only distortions present in the economy were financial imperfections, i.e. market incompleteness that prevents insurance between bankers and workers and a financial constraint on borrowing by bankers. However, many academics suggest that there are a number of other important imperfections that induce financial market participants to take on excessive risks (see e.g. Freixas and Rochet, 2008; Acharya et al., 2010), for example market power, agency problems, and safety nets. These distortions are likely to increase risk-taking beyond the described $x^{LF}$ in the absence of regulation.

Our analysis above suggests that such distortions would not only lead to increased risk-taking, but would also redistribute welfare from workers to bankers by increasing the volatility of bank capital, i.e. by increasing bank profits in good times and making financial crises more frequent and more severe, hurting workers. We illustrate this in more detail in the following example on market power as well as in the ensuing section on bailouts.

**Example (Market Power)** Assume that there is a finite number $n$ of identical bankers in the economy who each have mass $\frac{1}{n}$. Banker $i$ internalizes that his risk-taking decision $x^i$ in period 0 affects aggregate bank capital $e = \frac{1}{n} e^i + \frac{n-1}{n} e^{-i}$, where $e^{-i}$ captures the capital of the other bankers. For a given $e$, we assume that bankers charge the competitive market interest rate $R(e)$ in period 1.\(^{10}\)

First consider the optimal level of capital supplied by bankers who partially internalize their effect on interest rates and are not subject to a leverage constraint. Bankers solve

$$
\max_{k^i} \left\{ (F_k (k, 1) - 1) k^i \right\} \quad \text{where} \quad k = \frac{1}{n} k^i + \frac{n-1}{n} k^{-i}
$$

\(^{10}\)By contrast, if bankers interacted in Cournot-style competition in the period 1 market for loans, they would restrict the quantity of loans provided for a given amount of bank equity $e^i$ to $\min \{k(e^i), k^{*n}\}$ where $k^{*n} = k^* \left( \frac{n-1}{n} \right)^{1/n}$ to increase their scarcity rents. We do not consider this effect in order to focus our analysis on the period 0 risk-taking effects of market power.
whose solution is $\frac{1}{n} F_{kk} k^i + F_k = 1$. Assuming a symmetric solution, this will be satisfied at

$$k^{*} = \left(1 - \frac{1}{n} (1 - \alpha) \right) \frac{1}{n} k^*$$

which will be achieved at a level of equity $e^{*} = \left(1 - \frac{\phi}{1 - \frac{1}{n} (1 - \alpha)} \right) k^{*}$. If $e < e^{*}$, the deposit constraint binds and bankers receive the same profits as before.

The marginal valuation of bank capital is now

$$\pi^i (e, e^{-i}) = \begin{cases} \frac{1}{n} \pi' (e) + \frac{n-1}{n} \pi'_i (e, e) & \text{for } e < e^{*} \\ 1 & \text{for } e \geq e^{*} \end{cases}$$

This falls in between the marginal value of bank capital for the sector as a whole and for a competitive banker, i.e. $\pi' < \pi^i < \pi'_1$.

Since we have $\pi^i (e, e) = \pi'_1 + \frac{1}{n} (\pi' - \pi'_1)$, we can write the optimality condition for one of $n$ large firms as

$$\Pi^i_1 = \Pi_1 (x) + \frac{1}{n} (\Pi' - \Pi_1) = 0$$

We immediately see that for $n = 1$, this reduces to $\Pi' = 0$, which has solution $x^B$, and for $n \to \infty$ this reduces to $\Pi_1 = 0$, which has solution $x^{LF} < x^B$.

Now suppose that for a given $n$, we have $x \in (x^{LF}, x^B)$. At $x^n$, we differentiate the optimality condition w.r.t. $n$ and find

$$\frac{d}{dn} \Pi^i_1 = -\frac{1}{n^2} (\Pi' - \Pi_1)$$

Since $\Pi_1$ and $\Pi'$ are both strictly decreasing in $x$, and since they are zero at $x^{LF}$ and $x^B > x^{LF}$ respectively, in the interval $(x^{LF}, x^B)$ we have $\Pi_1 < \Pi'$. Therefore for higher $n$ we have $\frac{d}{dn} \Pi^i_1 < 0$, and so $x^n$ is decreasing in $n$.

In short, bankers with market power take on greater risk than in the laissez-faire equilibrium among atomistic bankers, with the optimal risk allocation $x^n$ being a declining function of $n$. We also observe that $x^1 = x^B \geq x^\infty = x^{LF}$, with strict inequality unless they are corner solutions.

Intuitively, bankers with market power internalize that the benefits of additional equity when they are constrained accrues in part to the rest of the economy by relieving the credit crunch. This reduces their scarcity rents and therefore provides lower incentives for precautionary behavior. Our example illustrates that socially excessive risk-taking is an important dimension of non-competitive behavior by banks, even when banks do not monopolistically restrict loan supply for given bank capital levels.

### 3.8 Financial Innovation

We investigate two ways in which financial innovation may affect our results. First, improvements in contracting and enforceability may enable bankers to take on higher leverage. Secondly, financial innovation may increase the set of risky assets in which bankers can invest.
3.8.1 Higher Leverage

The term $\phi$ in our model determines the maximum leverage in the banking system. In reality, leverage limits depend on both regulation and the financial sector’s ability to commit to repaying funds. We can model financial system deregulation or financial innovation as increases in $\phi$.

Consider the effect of a marginal increase in $\phi$. For a given level of bank equity in which the economy is constrained $e < e^*$, this will cause equilibrium capital to increase

$$\frac{dk}{d\phi} = \frac{F_k k}{1 - \phi \alpha F_k}$$

The level of equity below which the leverage constraint binds fall by $\frac{de}{d\phi} = -k^*$. An increase in $\phi$ will always increase the welfare of workers, since their welfare is strictly increasing in the amount of capital $k$ intermediated, but will only increase the welfare of bankers when capital is below the monopoly level of capital, which satisfies $\pi'(e_m) = 1$ or, equivalently, $\alpha F_k = 1$.

An increase in $\phi$ will also change agents’ marginal valuation of bank equity. At a given level of bank equity $e$, households’ marginal valuation changes according to

$$\frac{d}{d\phi} [w'(e)] = \left( \frac{\alpha}{1 - \alpha} - k'(e) \right) [w'(e)]^2$$

The first term of (6) captures that there are two opposing effects at work. A higher $\phi$ causes the marginal unit of bank equity to be levered up at a higher rate, leading to larger gains in household welfare. Simultaneously, higher $\phi$ increases capital at each level of bank equity, making further increases less valuable.

The marginal value of bank equity perceived by individual bankers changes according to

$$\frac{d}{d\phi} \pi_1(e^i, e) = \left( \frac{1}{1 - \phi} \right) [\pi'(e) - 1] \pi_1(e^i, e)$$

which is positive if and only if equilibrium capital is below the monopoly level that satisfies $\pi'(e_m) = 1$. Thus for low levels of bank equity, individual bankers value bank capital more because they realize that they can lever up a given dollar of bank equity by more; for high levels of bank equity, they value additional bank capital less because higher leverage implies more capital intermediation and lower returns $R(e)$ on each unit intermediated.

The effect on $x^{LF}$ is ambiguous. In general, $x^{LF}$ increases if and only if

$$\frac{d}{d\phi} \Pi_1(x^i, x) = \int_0^{\tilde{A}} \left( \tilde{A} - 1 \right) \frac{d}{d\phi} \left[ \pi_1(e^i, e) \right] dG(\tilde{A}) > 0$$

If we assume that $\tilde{A} (x^{LF}) < 1$, i.e. that bankers are constrained only for realizations of the shock below the safe return, then we find the following results: In an economy in which banks are mostly unconstrained or moderately constrained
such that bank equity is above the monopoly level $e > e^m$, the marginal valuation of bank equity declines and bankers will choose higher risk-taking. In an economy in which banks are tightly constrained and bank equity is mostly below the monopoly level $e < e^m$, the marginal valuation of equity goes up and bankers will choose lower risk-taking.

3.8.2 New Investable Assets

Another manifestation of financial innovation is to allow financial market players to access new investment opportunities, frequently projects that are characterized by both higher risk and higher expected returns. For example, financial innovation may enable bankers to invest in new activities, as made possible e.g. by the 1999 repeal of the 1933 Glass-Steagall Act, or to lend in new areas, to new sectors or to new borrowers, as e.g. during the subprime boom of the 2000s.

Formally we capture this type of financial innovation by expanding the set of risky assets to which bankers have access in period $0$. For a simple example, assume an economy in which bankers can only access the safe investment projects in period $0$ before financial innovation takes place, and assume that financial innovation expands the set of investable projects to include the risky project with stochastic return $\tilde{A}$.

The pre-innovation equilibrium corresponds to $x = 0$ in our benchmark setup. If we assume that $e^* < 1$, i.e. if the safe return in period $0$ is sufficient for bankers to intermediate the first-best level of capital, this choice maximizes worker welfare.

After financial innovation introduces the risky project, bankers allocate a strictly positive fraction of their endowment $x^{LF} > 1 - e^*$ to the risky project and incur the risk of being financially constrained in low states of nature. This is their optimal choice because the expected return $E[\tilde{A}] > 1$ delivers a first-order benefit over the safe return, but bankers perceive the cost of being marginally constrained as second-order since $\pi_1(e^*, e)$ is continuous at $e^*$. Worker welfare, on the other hand, unambiguously declines as a result of the increased risk-taking. Workers have nothing to gain from bank capital that exceeds $e^*$ but they experience first-order losses if bank capital declines below $e^*$, constraining capital investment and reducing wages.

This illustrates that financial innovation that increases the set of investable projects so as to include more high-risk-high-return options may redistribute from workers to bankers, akin to financial deregulation, even though total surplus may be increased. The problem in the described economy is that workers would be happy for bankers to increase risk-taking if they could participate in both the upside and the downside via complete insurance markets. In the absence of such markets, restricting risk-taking activities by banks, e.g. via regulations such as the Volcker rule, may benefit workers by acting as a second-best device to complete financial markets.
4 Bailouts

When aggregate bank capital is low, real capital investment is constrained and output and wages are depressed, as we illustrated in Figure 1 for the case of the 2008/09 financial crisis. In such a situation, the rest of society may benefit from providing additional funds to banks, since this would increase bank credit, raise capital investment in the real economy and lift output and wages. Such actions are commonly referred to as "bailouts."

Bailouts are often distinguished into two broad categories:

**Emergency Lending** A loan $d^{BL}$ that a policymaker provides to constrained bankers on behalf of workers at an interest rate $r^{BL}$ that is frequently subsidized, i.e. below the market interest rate $r^{BL} \leq 1$. Such lending constitutes a transfer of $(r^{BL} - 1) d^{BL}$ in net present value terms\(^{11}\). Assuming that such interventions cannot relax the commitment problem of bankers that we described in section 2.3, they are subject to the constraint

$$rd + r^{BL} d^{BL} \leq \phi Rk \quad (1')$$

**Equity Injections** provide constrained bankers with additional bank equity $q$ in exchange for a dividend distribution $D$, which is frequently expressed as a fraction of bank earnings. The equity injection constitutes a transfer of $q - D$ from workers to bankers in net present value terms. Assuming that the dividend payment is subject to the commitment problem of bankers that we assumed earlier, it has to obey the constraint

$$rd + D \leq \phi Rk \quad (1'')$$

Given our assumptions, both types of bailouts are isomorphic to a lump-sum transfer $t$ from workers to bankers\(^ {12}\). In the following lemma, we will first focus on an optimal lump-sum transfer and then show that the resulting allocations can be implemented either directly or via an optimal package of emergency lending or equity injection.

**Lemma 3 (Optimal Bailout Policy)** (i) If aggregate bank capital in period 1 is below a threshold $0 < \hat{\varepsilon} < e^*$, workers find it collectively optimal to provide lump-sum transfer $t = \hat{\varepsilon} - e$ to bankers. The threshold $\hat{\varepsilon}$ is determined by the expression $w'(\hat{\varepsilon}) = 1$ or

$$\hat{\varepsilon} = (1 - \alpha) \frac{[1 - (1 - \phi)\alpha]^{1-\alpha}}{\alpha} e^* \quad (7)$$

(ii) Both workers and bankers are indifferent between providing the bailout via subsidized emergency loans such that $(1 - r^{BL}) d^{BL} = t$ or via subsidized equity injections such that $q - D = t$.

---

\(^{11}\)In our framework, we assumed that default probabilities are zero in equilibrium. In practice, the interest rate subsidy typically involves not charging for expected default risk.

\(^{12}\)Since labor supply is constant, a tax on labor would be isomorphic to a lump sum transfer.
(iii) Emergency lending and/or equity injections that do not represent a transfer in net present value terms are ineffective.

**Proof.** For part (i) of the lemma, observe that the welfare of workers who collectively provide a transfer \( t \geq 0 \) to bankers is given by \( w(e + t) = 1 \), and we define the resulting equity level as \( \hat{e} = e + t \), which satisfies equation (7). We observe that \( w'(e) \) is strictly declining from \( w'(0) = 1/\phi > 1 \) to \( w'(e^*) = \frac{1-\omega}{1-\phi \alpha} < 1 \) over the interval \([0, e^*]\) so that \( \hat{e} \) is uniquely defined. If aggregate bank capital is below this threshold \( e < \hat{e} \), bankers find it collectively optimal to transfer the shortfall. If \( e \) is above this threshold, it does not pay off for workers to provide a transfer since \( w < 1 \) and the optimal transfer is given by the minimum \( t = 0 \).

For part (ii) of the lemma, let us first focus on an emergency loan package described by a pair \((r^{BL}, d^{BL})\) that is provided to bankers by a policymaker on behalf of workers. Since the opportunity cost of lending is the storage technology, the direct cost of such a loan to workers is \((1 - r^{BL})d^{BL}\). Bankers intermediate \( k = e + d + d^{BL} \) where we substitute \( d \) from constraint (1') to obtain
\[
k = \frac{e + (1 - r^{BL})d^{BL}}{1 - \phi R(k)} = k \left(e + (1 - r^{BL})d^{BL}\right)
\]
Therefore the emergency loan is isomorphic to a lump sum transfer \( t = (1 - r^{BL})d^{BL} \) for bankers, workers and firms. For an equity injection that is described by a pair \((q, D)\), an identical argument can be applied.

These observations directly imply part (iii) of the lemma. More specifically, constraint (1') implies that an emergency loan of \( d^{BL} \) at interest rate \( r^{BL} = 1 \) reduces private deposits by an identical amount \( \Delta d = -d^{BL} \) and therefore does not affect real capital investment \( k \). Similarly, constraint (1'\)) has an equity injection that satisfies \( q = D \) reduces private deposits by \( \Delta d = -D \) and crowds out an identical amount of private deposits.

The intuition of part (i) of the lemma is that increasing bank capital via lump-sum transfers relaxes the financial constraint of bankers and enables them to intermediate more capital, which in turn expands output and wages. As long as \( e < \hat{e} \), the cost of the transfer on workers is less than the collective benefit in the form of higher wages. If workers can coordinate to provide a bailout transfer, or if they are represented by a policymaker who maximizes their welfare and internalizes this effect, they will be collectively better off by providing a transfer that lifts bank capital up to \( \hat{e} \).

Part (ii) of the lemma captures an equivalence result between the two categories of bailouts – what matters for constrained bankers is that they obtain a transfer in net present value terms, but it is irrelevant how this transfer is provided. From the perspective of bankers who are subject to constraint (1), a one dollar repayment on emergency loans or dividends is no different from a one dollar repayment to depositors, and all three forms of repayment tighten the financial constraint of bankers in the same manner. An emergency loan or an equity injection at preferential rates that amounts to a one dollar trans-
fer allows bankers to raise an additional $R_1$ dollars of deposits and expand intermediation by $\frac{1}{1-\phi R}$ dollars in total.

Part (iii) of the lemma observes that emergency loans or equity injections that are provided at ‘fair’ market rates, i.e. that do not constitute a transfer in net present value terms, will therefore not increase financial intermediation. We assumed that the commitment problem of bankers requires that they obtain at least a fraction $(1 - \phi)$ of their gross revenue. If government does not have a superior enforcement technology to relax this constraint, any repayments on emergency lending or dividend payments on public equity injections reduce the share obtained by bankers in precisely the same fashion as repaying bank depositors. Such repayment obligations therefore decrease the amount of deposits that bankers can obtain by an equal amount and do not expand capital intermediation.

Conversely, if government had superior enforcement capabilities to extract repayments or dividends, then those special capabilities would represent an additional reason for government intervention in the instrument(s) that relax the constraint most.

For the remainder of our analysis of bailouts, we impose the following assumption:

**Assumption 1** The parameters $\alpha$ and $A$ are such that $\hat{e} < 1$.

This is a mild assumption that guarantees that the banking sector will not require a bailout if the entire period 0 endowment is invested in the safe project. It also implies that bailouts are not desirable in states of nature in which the risky project yields higher returns than the safe project. This is a reasonable assumption as we typically expect bailouts to occur in bad states of nature.

### 4.1 Period 1 Equilibrium under Bailouts

We analyze the optimal bailout transfer policy of the worker sector in period 1 as a function of the aggregate bank capital position $e$. (We continue to assume that workers’ period 1 wealth $m$ is large so that it does not limit the size of the desired bailout.)

For $e \geq \hat{e}$, the collective welfare of workers $w(e)$ and bankers $\pi(e)$ are unchanged from the expressions in the benchmark model since no bailouts are given. For $e < \hat{e}$, the possibility of bailouts modifies the expressions for welfare as follows:

\[
\begin{align*}
    w^{BL}(e) &= (1 - \alpha) F(e + t(e), 1) - t(e) \\
    \pi^{BL}(e) &= \alpha F(\hat{e}, 1)
\end{align*}
\]

We illustrate our findings in Figure 5. The threshold $\hat{e}$ below which bankers receive bailouts is indicated by the left dotted vertical line. Panel 1 shows bailouts $t(e)$ and welfare of workers and bankers as a function of bank capital.
Figure 5: Welfare and marginal value of bank capital under bailouts.

Bailouts are positive but decrease to zero over the interval \([0, \hat{e}]\). Within this interval, they stabilize the profits of bankers at the level \(\pi(\hat{e})\). The welfare of workers is increasing at slope 1 since each additional dollar of bank capital implies that the bailout is reduced by one dollar. Bailouts therefore make the payoff functions of all agents less concave and, in the case of bankers, locally convex.

### 4.2 Marginal Value of Bank Capital

From the above expressions, we derive the marginal value of bank capital in the bailout region, i.e. for \(e < \hat{e}\). We note that \(1 + t'(e) = 0\) in this region and find that the welfare effects of a marginal increase in bank capital are

\[
\begin{align*}
w^{BL}(e) & = (1 - \alpha) F_k [1 + t'(e)] - t'(e) = 1 \\
\pi^{BL}(e) & = \alpha F_k [1 + t'(e)] = 0
\end{align*}
\]

Panel 2 of Figure 5 depicts the marginal welfare effects of bank equity under bailouts. The marginal benefit for workers \(w^{BL}(e)\) is 1 within the bailout region \(e < \hat{e}\), since each additional dollar of bank equity reduces the size of the required bailout that they inject into bankers by a dollar. (In fact, we can determine the level of \(\hat{e}\) by equating the marginal benefit of bank capital to workers in the absence of bailouts, corresponding to the downward-sloping dotted line \(w^{BL}(e) = (1 - \alpha) F_k\) in the figure, to the marginal cost which is unity. This point is marked by a circle in the figure.)
Figure 6: Total surplus and marginal value of bank capital under bailouts.

4.3 Bailout Rents

If initial bank equity is $e < \hat{e}$, the provision of bailouts generates significant social surplus $F(\hat{e}, 1) - F(e, 1) - (\hat{e} - e) > 0$ from the perspective of period 1. Constrained bankers obtain capital that allows them to expand lending, which increases production and benefits both bankers and workers. Bailouts significantly mitigate the market incompleteness that is created by the financial constraint (1) and that prevents bankers from raising deposit finance and intermediating capital to the productive sector.\footnote{If the revenue required for bailouts had to be raised via distortionary taxation, then the welfare effects would be attenuated.}

Interestingly, this creates a non-monotonicity in the marginal social value of bank capital $s'(e) = w'(e) + \pi'(e)$, illustrated in Figure 6. For low levels of bank capital $e < \hat{e}$, the marginal social value of bank equity equals one, since higher bank equity will just reduce the size of bailouts one-for-one. Intuitively, bailouts are a very effective technology to mitigate severe capital shortages. Within the interval $e \in [\hat{e}, e^*)$, bankers are constrained, but workers are not willing to inject funds since they would benefit less than the cost of a transfer – they receive only a fraction $(1 - \alpha)$ of the additional surplus in the form of wages. Therefore the marginal social benefit of bank equity jumps to $F_k(\hat{e}, 1) = \frac{1}{1 - \alpha}$ at $\hat{e}$ and declines monotonically along with the marginal product of capital $F'_k(e, 1)$ until bank capital reaches the unconstrained point $e^*$. Above $e^*$, the social benefit of additional bank capital is one since the additional capital is simply held in the storage technology.

Redistributive Effects Bailouts have significant redistributive effects since they constitute straight transfers from workers to bankers. At the margin, each
additional unit of bailout generates a surplus $F_k(e, 1) - 1$, of which $w'(e) - 1$ arises to households and $\pi'(e)$ to bankers. For the last marginal unit of the bailout, the benefit to workers is $w'(\hat{e}) - 1 = 0$ - they are indifferent between providing the last unit or not. However, the marginal benefit to bankers for the last unit is strictly positive $\pi'(\hat{e}) = \frac{\alpha}{1-\alpha}$. Bankers capture a significant fraction of the surplus generated by bailouts because of their exclusive capacity to allocate capital to the rest of the economy.

### 4.4 Period 0 Risk-Taking

Next we describe how optimal discretionary bailout transfers in period 1 affect the risk-taking behavior of banks in period 0 and discuss the implications for the distribution of resources in the economy. Optimal discretionary bailouts ensure that aggregate capital investment satisfies $k = e + t(e) \geq \hat{e}$ at all times. Since the return on capital is decreasing in aggregate capital investment, this imposes a ceiling on the market interest rate under bailouts $R_{BL}(e) \leq R(\hat{e}) = \frac{1}{1-\alpha}$.

The incentive effects of bailouts depend critically on whether they are provided conditional on individual bank capital $e^i$ or aggregate bank capital $e$. Bailouts that are conditional on $e^i$ provide bankers with incentives to increase risk-taking so as to increase the expected bailout rents received. By contrast, bailouts that are conditional solely on $e$ look like lump-sum transfers from the perspective of an individual bank and only have wealth effects but no substitution effects.

At a general level, we assume that the bailout received by an individual banker $i$ for a given level of individual and aggregate bank equity $(e^i, e)$ is allocated according to the function

$$t(e^i, e; \gamma) = \begin{cases} 0 & \text{if } e \geq \hat{e} \\ \hat{e} - (1 - \gamma)e - \gamma e^i & \text{if } e < \hat{e} \end{cases}$$

where $\gamma \in [0, 1]$ captures the extent to which the bailout depends on individual bank equity. This specification nests bailouts that are entirely conditional on aggregate bank capital (for $\gamma = 0$) as well as those conditional on individual bank capital (for $\gamma = 1$). Alternatively, if banks are non-atomistic and bailouts are entirely conditional on aggregate bank capital $e$, we can interpret the parameter $\gamma$ as the market share of individual banks, since each bank will internalize that its bank equity makes up a fraction $\gamma$ of aggregate bank equity.

We denote the amount of their endowment that bankers allocate to the risky project in period 0 by $x_{BL}^*(\gamma)$, and we find that bailouts have the following effects:

**Proposition 4 (Risk-Taking Effects of Bailouts)**

(i) Introducing bailout transfers increases period 0 risk-taking $x_{BL}^*(\gamma) > x_{LF}^*$.

(ii) Risk-taking $x_{BL}^*(\gamma)$ is an increasing function of $\gamma$.

(iii) Bailouts increase expected bank profits $\Pi_{BL}$.
Proof. For (i) observe that the welfare maximization problem of bankers under bailouts for a given parameter \( \gamma \) is

\[
\max_{x^{\prime} \in [0,1], e^{\prime}} \Pi^{BL}(x^{\prime}, x; \gamma) = E \left[ \pi^{BL}(e^{\prime} + t(e^{\prime}, e; \gamma), e + t(e)) \right]
\]

where \( e^{\prime} = 1 - x^{\prime} + \tilde{A} x^{\prime} = e \) in equilibrium. Let us define \( \tilde{A} \) as the level of \( \tilde{A} \) that achieves the bailout threshold \( \tilde{e} \) and observe \( \tilde{A} < 1 \) by Assumption 1. The first partial derivative of the function \( \Pi^{BL} \) evaluated at \( x^{LF} \) satisfies

\[
\Pi^{BL}_1(x^{LF}, x^{LF}; \gamma) = E \left[ (\tilde{A} - 1) \pi^{BL}_1(e^{\prime}, e; \gamma) \right] = \\
= (1 - \gamma) \pi_1(\tilde{e}, \tilde{e}) \int_{0}^{\tilde{A}} (\tilde{A} - 1) dG(\tilde{A}) + \int_{\tilde{A}}^{\infty} (\tilde{A} - 1) \pi_1 dG(\tilde{A}) > \\
\int_{0}^{\tilde{A}} (\tilde{A} - 1) \pi_1 dG(\tilde{A}) + \int_{\tilde{A}}^{\infty} (\tilde{A} - 1) \pi_1 dG(\tilde{A}) = \Pi_1(x^{LF}, x^{LF}) = 0
\]

The inequality holds because the second terms in the two expressions with integrals are identical and must be positive for \( \Pi_1(x^{LF}, x^{LF}; \gamma) \) to hold. The first term in \( \Pi^{BL}_1(x^{LF}, x^{LF}; \gamma) \) is either positive or satisfies

\[
(1 - \gamma) \int_{0}^{\tilde{A}} (\tilde{A} - 1) \pi_1(\tilde{e}, \tilde{e}) dG(\tilde{A}) \geq \int_{0}^{\tilde{A}} (\tilde{A} - 1) \pi_1(\tilde{e}, \tilde{e}) dG(\tilde{A}) > \int_{0}^{\tilde{A}} (\tilde{A} - 1) \pi_1(\tilde{e}, \tilde{e}) dG(\tilde{A})
\]

since \( (\tilde{A} - 1) \) is strictly increasing and \( \pi_1(\tilde{e}, \tilde{e}) \) is strictly decreasing over the interval \([0, \tilde{A}]\). Therefore individual bankers will choose to increase \( x^{BL} > x^{LF} \) if there is a positive probability of bailouts, confirming point (i).

For (ii), consider the effect of an increase in \( \gamma \). Differentiating the optimality condition at \( x^{BL} \) for a given \( \gamma \) yields

\[
\frac{d\Pi^{BL}}{d\gamma} = -\pi_1(\tilde{e}, \tilde{e}) \int_{0}^{\tilde{A}} (\tilde{A} - 1) dG(\tilde{A}) > 0
\]

where the inequality holds since \( \tilde{A} < 1 \).

For (iii), observe that \( \Pi^{BL}(x) \geq \Pi(x) \) since bankers obtain additional transfers and \( \pi(e) \) is increasing, and that \( \Pi^{BL}(x) \) is increasing in \( x \). Taking this together with the observation that \( x^{BL} > x^{LF} \) we find that \( \Pi^{BL}(x^{BL}) > \Pi^{BL}(x^{LF}) > \Pi(x^{LF}) \).

Intuitively, point (i) reflects that bailouts reduce the tightness of constraints and therefore the returns on capital \( \pi_1 \) in low states of nature. This reduces the precautionary incentives of bankers and induces them to take on more risk. Observe that this effect is similar to the effect of any countercyclical policy or any improvement in risk-sharing via markets. The effect is also visible in Panel 1 of Figure 5, in which the payoff function of bankers under bailouts is less concave than in the absence of bailouts, inducing them to increase their risk-taking.
For $\gamma > 0$, point (ii) captures that the risk-taking incentives of bankers rise further because they internalize that one more dollar in losses will increase their bailout by $\gamma$ dollars. This captures the standard notion of moral hazard, i.e. that bailouts targeted at individual losses increase risk-taking.

Point (iii) describes that higher risk-taking increases banker welfare at the expense of workers. Bailouts increase banker welfare both directly because of the transfers received from workers and indirectly as a result of the higher risk-taking.

4.5 Effects of Bailouts on Pareto Frontier

Proposition 5 (Pareto Frontier under Bailouts) (i) The Pareto frontier shifts out as a result of bailouts, i.e. for a given choice of $x$ with a positive probability of bailouts, bank profits and worker welfare are strictly higher, $\Pi^{BL}(x) > \Pi(x)$ and $W^{BL}(x) > W(x)$.

(ii) For $e^* \leq 1$, the outward shift in the Pareto frontier is biased towards bankers, i.e. the risk allocation preferred by workers and the corresponding welfare remain constant at $x^W$ and $W(x^W)$, whereas the risk allocation preferred by bankers and the corresponding welfare increase $x^{B, BL} > x^B$ and $\Pi^{BL}(x^{B, BL}) > \Pi(x^B)$ if there is a positive probability of bailouts at $x^B$.

Proof. For point (i), observe that $\pi(e)$ is increasing and bailouts lead to strictly higher bank equity, therefore $\Pi^{BL}(x) > \Pi(x)$ for given $x$. Workers only provide bailouts if it increases their welfare, i.e. if $w'(e) > 1$, therefore their welfare increases as well for given $x$.

Point (ii) holds because when $e^* \leq 1$, then $x^W = 1 - e^*$ and the equilibrium is unconstrained in all states of nature, implying no role for bailouts at $x^W$. The proof that the collectively optimal level of risk-taking and welfare go up for bankers if there is a positive probability of bailouts at $x^B$ follows along the same steps as the proof of point (i) in Proposition 4. □

The proposition reflects that bailouts make the economy more efficient by mitigating the incompleteness of financial markets when financial constraints are severe: given a low realization of bank capital, it is Pareto-improving when workers provide bailouts.

However, the outward shift in the Pareto frontier is generally biased towards bankers since they receive transfers from workers. Point (ii) illustrates that this is especially clear for the case $e^* \leq 1$, i.e. when the return of the safe project in period 0 is sufficient to make the banking sector unconstrained under no risk-taking: in that case, workers prefer keeping $x$ sufficiently low to avoid binding financial constraints altogether; therefore there is no role for bailouts at $x^W$, and the Pareto frontier remains unchanged at $x^W$. Bankers, by contrast, benefit from risk-taking, and collectively prefer to expose the economy to a positive probability of being constrained. If there is a positive probability of bailouts at $x^B$, the Pareto frontier shifts out for bankers.
Corollary 6 (Effects of Bailouts on Worker Welfare) The effect of introducing bailouts on worker welfare can be decomposed into two components,

$$\Delta W = [W^{BL}(x^{BL}) - W(x^{BL})] + [W(x^{BL}) - W(x^{LF})]$$

The first component captures that bailouts improve welfare for a given level of risk-taking and is always positive. The second component captures that bailouts increase risk-taking and is always negative for $e^* < 1$.

We illustrate our findings in Figure 7. The figure shows how the Pareto frontier depicted in Figure 4 is affected by the introduction of bailouts. Given our parameterization, the old Pareto frontier (dotted line) and the new Pareto frontier with bailouts coincide at $x^W$ but diverge for higher values of $x$. Worker welfare at $x^W$ is unchanged, but banker welfare at $x^{BL, BL}$ is increased significantly. In the figure, we assume that $\gamma = 0$, i.e. bailouts are distributed lump sum, but the introduction of bailouts nonetheless increases risk-taking so that banker welfare rises significantly by $\Delta \Pi$ and worker welfare falls by $\Delta W$.

Let us next look at how the portfolio choice of bankers affects the expected bailout rents that they receive.

Corollary 7 (Bailout Rents) (i) Bankers receive an expected bailout rent of

$$BR(x) = E[t(e)]R(\hat{e})$$
from workers, which is the product of the expected bailout transfer times its marginal value \( R(\hat{e}) = \frac{1}{1-\alpha} \). The expected bailout rent is increasing in \( x \).

(ii) Bailout rents are increasing in \( \gamma \).

Proof. For (i), we denote the expected bailout rent in integral notation by

\[
BR(x) = \frac{1}{1-\alpha} \int_{0}^{\hat{A}(x)} \left[ \hat{e} - \left( 1 - x - \hat{A} \right) \right] dG(\hat{A})
\]

Taking the derivative of this function we find

\[
BR'(x) = \frac{1}{1-\alpha} \int_{0}^{\hat{A}(x)} \left( 1 - \hat{A} \right) dG(\hat{A}) \geq 0
\]

If \( G(\hat{A}(x)) = 0 \) for a given \( x \), then \( BR'(x) = 0 \). Otherwise the term under the integral is strictly positive since \( \hat{A} < 1 \) and therefore \( BR'(x) > 0 \) holds strictly.

For (ii), we showed in Proposition 4 that risky investment in the presence of bailouts \( x^{BL}(\gamma) \) is increasing in \( \gamma \). Since bailout rents are increasing in \( x \), the claim follows.

The expected bailout transfer is a rent in the sense that it constitutes income that bankers earn in excess of what they would obtain in competitive markets. In particular, if we were to auction a loan from workers to undercapitalized bankers with \( e < \hat{e} \) in the amount of \( t(\hat{e}) \) under the assumption that they could commit to repay, then bankers would be willing to pay interest of \( R(\hat{e}) \) on this amount.

Bankers are able to capture this rent because we assumed that they are unique in their capacity to intermediate capital to the productive sector of the economy. If bank capital is low, workers are in a situation in which they have to provide a bailout unless they want to suffer the severe wage losses associated with low bank capital.

5 Conclusions

The central focus of our paper is that financial regulation has important redistributive implications if the financial sector has an exclusive role in the process of credit intermediation and if financial markets are imperfect. The majority of the literature on financial regulation focuses on the efficiency implications of financial regulation and disregards redistributive effects. Welfare is typically determined by a planner who picks the most efficient allocation under the assumption that the desired distribution of resources between different agents can be implemented independently.

However, if insurance markets are incomplete and if redistributions cannot be undone via lump-sum transfers – two conditions which seem highly relevant in the real world – maximizing aggregate output is an arbitrary concept.
Weighting one dollar in the hands of workers and one dollar in the hands of bankers equally is just one arbitrary standard among many others. Depending on how much weight a planner places on workers versus bankers, she may find it desirable to engage in more or less regulation of risk-taking in the financial sector. Financial regulation acts as a substitute for missing insurance markets or lump-sum transfers in our framework.

We identify two types of rents that accrue to the financial sector because of its exclusive “bottleneck” role in intermediating capital from savers to the real economy. The first type of rent is a scarcity rent: when the financial sector is constrained, wages for workers decline whereas bankers earn higher spreads on their lending. The reason is that financial constraints reduce capital intermediation, which makes capital relatively scarce and labor relatively abundant. The second type are bailout rents that the financial sector earns because it is cheaper for workers to provide bailouts than to suffer a severe credit crunch. Higher risk-taking in the financial sector increases both rents and shifts surplus from workers to bankers. The degree of financial regulation therefore has first-order redistributive implications.

There are a number of important issues that we leave for future analysis: First, if the regulatory framework of a country covers only part of its financial system, it generates large incentives for the remaining parts to expand since they are in a preferential role to extract rents. In the US, for example, the shadow financial system grew to the point where it became essential. This made the sector a bottleneck for credit intermediation and allowed it to extract significant bailout rents in the aftermath of the 2008 financial crisis.

Second, the framework of our paper rested on the assumption that a given set of agents, bankers, had the exclusive ability to intermediate capital to the rest of the economy. The rents of the financial sector could be reduced if it alternative financial intermediaries can emerge and make up for the lost intermediation capacity of the existing financial sector after a crisis has hit.

Third, if there is sufficient capital in the financial sector to ensure that financial constraints are not binding, we assumed that it was simply paid out to bankers. More generally, excessive bank capital may also lead to inefficient investments and/or bubbles.

References


A Data Sources

Data for Figure 1

Unless otherwise noted, data is taken from the Federal Reserve Bank of St. Louis FRED database (Federal Reserve Economic Data).

Panel 1: Bank equity is calculated as the difference between the series "Total Liabilities and Equity" and "Total Liabilities" in the "Financial Business" category, from the Federal Reserve Flow of Funds data (series FL - 79 - 41900 and 41940).

Panel 2: The real wage bill is "Compensation of employees, received" (FRED series W209RC1) normalized by "Gross Domestic Product: Implicit Price Deflator" (FRED series GDPDEF).

Panel 3: The commodity price index in Panel 3 is the Commodity Metals Price Index from the IMF, i.e. the column "Industrial inputs / metals" of Table 1.a. from the Indices of Primary Commodity Prices publication.

Panel 4: The spread on risky borrowing in Panel 4 is the difference between "Moody’s Seasoned Baa Corporate Bond Yield" (FRED series BAA) and "10-Year Treasury Constant Maturity Rate" (FRED series DGS10).

B Model Parameterization

Figures 3, 5, and 6 depict period 1 welfare and marginal values of bank equity. We use the following parameterization:

\[
\begin{array}{|c|c|}
\hline
\alpha & 1/3 \\
A & 10 \\
\phi & 0.5 \\
\hline
\end{array}
\]

Figures 4 and 7 depict period 0 welfare and equilibrium. We let \(\bar{A}\) be distributed lognormally with mean \(\mu\) and variance \(\sigma^2\), with the range truncated to the interval \([0, 2]\). The chosen parameters are
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<table>
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<tbody>
<tr>
<td>$\alpha$</td>
<td>$1/5$</td>
</tr>
<tr>
<td>$A$</td>
<td>8.1335</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\mu$</td>
<td>1.04</td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Compared to the previous set of figures, we decreased $\alpha$ and chose $A$ so as to leave $e^*$ unchanged from the period 0 figures. The decrease in $\alpha$ raises the bailout threshold $\hat{e}$ so that the effect of bailouts on period 0 risk-taking decisions is more pronounced and better visible.