# The Redistributive Effects of Financial Deregulation*

Anton Korinek
Johns Hopkins University and NBER

Jonathan Kreamer
University of Maryland

October 2013

**Abstract**

Financial regulation is often framed as a question of economic efficiency. This paper, by contrast, puts the distributive implications of financial regulation center stage. We develop a model in which the financial sector benefits from risk-taking by earning greater expected returns. However, risk-taking also increases the incidence of large losses that lead to credit crunches and impose negative externalities on the real economy. Assuming incomplete risk markets between the financial sector and the real economy, we describe a Pareto frontier along which different levels of risk-taking map into different levels of welfare for the two parties. A regulator has to trade off efficiency in the financial sector, which is aided by deregulation, against efficiency in the real economy, which is aided by tighter regulation and a more stable supply of credit. We also show that financial innovation, asymmetric compensation schemes, concentration in the banking system, and bailout expectations enable or encourage greater risk-taking and allocate greater surplus to the financial sector at the expense of the rest of the economy.

**JEL Codes:** G28, E25, E44, H23
**Keywords:** financial regulation, distributive conflict, rent extraction, growth of the financial sector

*The authors thank INET/CIGI for financial support. We would like to acknowledge helpful comments and discussions with George Akerlof, Robert Bichsel, Olivier Blanchard, Claudio Borio, Maya Eden, Bruce Greenwald, Gita Gopinath, Andy Haldane, Oliver Hart, Olivier Jeanne, Bob King, Andrew Levin, Jonathan Ostry, Marco Pagano, Goetz von Peter, Jean-Charles Rochet, Damiano Sandri, Joseph Stiglitz, Elif Ture and Razvan Vlahu, as well as participants at the CEMLA Conference on Macroprudential Policy, the CIGI/INET Conference on False Dichotomies, the 1st CSEF Conference on Finance and Labor, the 2013 FIRS Conference, the 2012 JME-SNB-SCG Conference, the 2013 LASA Conference, the 2013 NBER Summer Institute and at seminars at the BIS, the Boston Fed, the IMF and Sveriges Riksbank. For contact information please visit `http://www.korinek.com`

# 1 Introduction

Financial regulation is often framed as a question of economic efficiency in the economic literature. However, the intense political debate on the topic suggests that redistributive questions are front and center in setting financial regulation. In the aftermath of the financial crisis of 2008/09, for example, consumer organizations, labor unions and political parties championing worker interests have strongly advocated a tightening of financial regulation, whereas financial institutions and their representatives have issued dire warnings of the dangers and high costs of tighter regulation.

Financial regulation matters for the rest of the economy because the financial sector plays a central role in a modern market economy (see e.g. Caballero, 2010). It provides credit to all sectors of the economy and intermediates capital to its most productive use. As long as the financial sector is well capitalized, it can fulfill this role almost seamlessly. During such times, it seems as if the financial system was just a veil and the economy can be well understood without explicitly considering the financial sector.

If the financial sector suffers large losses and finds itself short of capital, however, it imposes large negative externalities on the rest of the economy. It can no longer fulfill its role of intermediating savings to productive investment and spending opportunities, leading to a credit crunch and a decline in output that hurts all other factor owners in the economy: for example, workers experience unemployment and declines in their wages even though their labor could be employed more productively if the financial intermediation process were working well.

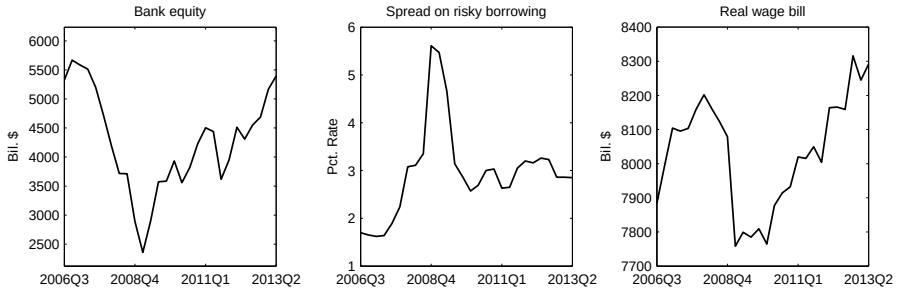


Figure 1: Bank equity, interest rate spread and wage bill.

These observations are consistent with the experience of the US during the 2008/09 financial crisis, as illustrated in Figure 1. The first panel depicts the decline in bank equity during the crisis.[1] The second panel shows the concurrent increase in the spread between interest rates for risky borrowing and safe rates. Although some of this increase is attributable to higher default risk, a significant fraction is due to constraints in the financial system (see e.g. Adrian et al., 2010).

[1] For a detailed description of data sources, see appendix C.

The last panel shows the steep decline in the wage bill over the course of the crisis. The recovery in this variable was somewhat sluggish, possibly because the initial shock to the financial sector was aggravated by aggregate demand problems and constraints on household balance sheets. Similar macroeconomic effects have been observed during financial crises for centuries (see e.g. Reinhart and Rogoff, 2009).

The crisis occurred after decades of financial deregulation had removed the restrictions on financial sector risk-taking that had been imposed after the Great Depression (see e.g. Abiad et al., 2010). This process of deregulation was accompanied by strong growth in the size of the financial sector to levels not seen since the late 1920s (Philippon and Reshef, 2013a). And as the financial crisis of 2008/09 demonstrated vividly, deregulation also led to a more volatile financial system in which the real economy was exposed to an increased risk of credit crunches.

This paper develops a formal model to analyze the distributive conflict inherent in regulating risk-taking in the financial sector. We capture the special role of the financial sector by assuming that it is the only sector that can engage in financial intermediation and 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."

We introduce two types of financial imperfections into our model. First, bankers suffers from a commitment problem and need 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 ensure proper incentives. Secondly, 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. More generally, a sufficient condition is that the holdings of bank equity are not proportionally distributed across the financial elite and the rest of society.[2]

Because of the "skin in the game"-constraint, a well-capitalized financial sector is essential for the rest of the economy. In particular, the financial sector needs to hold a certain minimum level of capital to intermediate the first-best level of credit in the economy and achieve the optimal level of output. If aggregate bank capital declines below this threshold, binding financial constraints force bankers to cut back on credit to the rest of the economy. The resulting credit crunch causes output to contract, wages to decline and lending spreads to increase, capturing the typical effects of financial crises that we illustrated in Figure 1. At a technical level, these price movements constitute pecuniary externalities that hurt the real economy but benefit bankers.

[2] An alternative and complementary assumption would be that bank managers are able to extract a significant fraction of the surplus earned by financial institutions in the form of agency rents. The redistributive implications would be the same as in our framework.

When financial institutions decide how much risk to take on, they trade off the benefits of risk-taking in terms of higher expected return with the risk of being constrained, but they do not internalize the negative externalities on the rest of the economy. Bankers always choose a strictly positive level of risk-taking in our model so as to earn superior returns. By contrast, workers are averse to fluctuations in bank capital and would like to limit the level of risk-taking in the financial sector to ensure a more stable supply of credit to the real economy.

We characterize a Pareto-frontier along which higher levels of risk-taking correspond to higher levels of welfare for bankers and lower levels of welfare for workers. We interpret financial regulation and deregulation as imposing or relaxing regulatory constraints on risk-taking, which moves the economy along this Pareto frontier. In a sense, financial regulators need to trade off efficiency in the financial sector, which is aided by deregulation, against efficiency in the real economy, which is aided by tighter regulation and a more stable supply of credit.

The distributive conflict over risk-taking and regulation is the result of both financial imperfections in our model. If bankers weren't financially constrained, then they could always intermediate the optimal amount of capital and their risk-taking would not affect the real economy. Similarly, if risk markets were complete, then bankers and the rest of the economy would share not only the downside but also the benefits of financial risk-taking. In both cases, the distributive conflict would disappear. By contrast, in our benchmark framework in which both financial frictions are present, the occasionally binding financial constraint on bankers imposes one-sided negative externalities on workers in the form of credit crunches.

Our findings are consistent with the experience of a large number of countries in recent decades: deregulation allowed for record profits in the financial sector, which benefitted largely the financial elite (see e.g. Philippon and Reshef, 2013a). Simultaneously, most countries also experienced a decline in their labor share (Karabarbounis and Neiman, 2013). When crisis struck, e.g. during the financial crisis of 2008/09, economies experienced a sharp decline in financial intermediation and real capital investment, with substantial negative externalities on workers and the rest of the economy. Such occasionally binding financial constraints are also generally viewed as the main driving force behind financial crises in the quantitative macro literature (see e.g. Mendoza, 2010).

Drawing an analogy to more traditional forms of externalities, we can compare financial deregulation to the relaxation of safety rules on nuclear power plants: such a relaxation will reduce costs, which increases the profits of the nuclear industry in most states of nature and may benefit the rest of society via reduced electricity rates. However, it comes at a heightened risk of nuclear meltdowns that impose massive negative externalities on the rest of society. In expectation, relaxing safety rules increases the profits of the nuclear sector at the expense of the rest of society.

We analyze a number of extensions to study how risk-taking in the financial sector interacts with the distribution of resources in our model economy. We in-

vestigate the effects of financial innovation that enables bankers to take on more risk by providing them with access to a wider menu of investment options and find that it always benefits bankers, but it may result in higher volatility and impose greater externalities on workers. We provide an example in which workers are unambiguously worse off from financial innovation. Similarly, if bank managers have asymmetric compensation packages, they will have incentives to take on higher risks and expose the rest of the economy to larger negative externalities.

If bankers have market power, we find that their precautionary incentives are reduced because they internalize that any losses they suffer will lead to a decline in aggregate bank capital and push up lending rates, which mitigates the losses. This increases risk-taking and benefits bankers at the expense of workers. Our finding therefore highlights a new dimension of welfare losses from concentrated banking systems, leading to increased financial instability.

The redistributive effects of deregulation are magnified when we allow for discretionary bailouts: Ex-post, workers find it collectively optimal to provide bailouts to bankers when aggregate bank capital is sufficiently scarce so as to ease the credit crunch and mitigate the decline in wages. This makes it difficult to commit not to provide bailouts. Ex-ante, bailouts reduce the precautionary incentives of bankers and increase risk-taking even if they are provided in lump-sum fashion. If bailouts are contingent on the capital levels of individual financial institutions, the distortive effects on risk-taking are reinforced, corresponding to the traditional moral hazard effect.

We therefore identify a novel channel through which bailouts lead to redistributions between the financial sector and the real economy: they lead to greater risk-taking which boosts expected bank profits but leads to a higher incidence of credit crunches and more severe externalities on workers in bad times. In expectation, the redistribution due to higher risk-taking is typically much larger than the outright transfers that financial institutions receive during bailouts, as we illustrate in an example. Financial deregulation exacerbates both of these effects since it allows for higher risk and increases the probability and magnitude of bailouts.

**Policy Implications** Our paper highlights the distributive conflict inherent in setting financial regulation. Given the two assumed financial market imperfections in our model, financial regulators have to trade off greater efficiency in the financial sector, which relies on risk-taking, versus greater efficiency in the real economy, which requires a stable supply of credit.

If regulators care primarily about the real economy, for example, then their main concern is to ensure that bankers are well-capitalized so they can provide a stable supply of credit. Interpreting our results more broadly, this is aided by (i) separating risky activities, such proprietary trading, from traditional financial intermediation, (ii) imposing higher capital requirements on risky activities, in particular on those that do not directly contribute to lending to the real economy, (iii) limiting payouts if they endanger a sufficient level of capitalization

in the financial sector, (iv) using structural policies that reduce incentives for risk-taking, e.g. by limiting market power, asymmetric managerial incentive contracts, financial innovations that increase risk-taking, and bailout expectations and (v) forcing recapitalizations when necessary, even if they impose private costs on bankers. Opposite conclusions apply if regulators place a larger welfare weight on bankers: they will roll back regulations on risk-taking, reduce capital requirements etc.

A Pareto-improvement could only be achieved if deregulation was coupled with measures that increase risk-sharing between bankers and the rest of the economy so that the upside of risk-taking is shared. Even if formal risk markets for this are absent, redistributive policies such as higher taxes on financial sector profits that are used to strenghten the social safety net for the rest of the economy would constitute such a mechanism.

**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 (see e.g. Gertler and Karadi, 2011). However, little emphasis is placed on the redistributive effects of such fluctuations between financial intermediaries and the rest of the economy. The main contribution of our paper is to fill this gap and show that binding financial constraints lead to significant negative externalities so that risk-taking benefits the financial sector at the expense of the real economy when risk markets are incomplete.

Our paper is also related to a long and growing literature on financial regulation (see e.g. Freixas and Rochet, 2008, for a comprehensive review), but puts the distributive implications of such financial policies 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), Jeanne and Korinek (2010ab, 2012), Bianchi and Mendoza (2010), Korinek (2011) and 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 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 redistributive implications of financial deregulation and bailouts.

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 are subject to government guarantees (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 bailouts once a crisis has occurred. In our model, such transfers lead to a Pareto improvement because they substitute for missing markets. In existing macroeconomic models (see e.g. Bianchi, 2012; Sandri and Valencia, 2013), the desirability of bailouts has only been shown in models in which the transfer is made by a representative agent who also owns the recipient banks so that redistributive effects are by definition avoided. Secondly, we put the redistributive effects of bailout policies center stage. Our findings are also related to an emerging literature that shows that expansive monetary policy during crises works in part by redistributing wealth (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 argued that society at large would benefit from imposing higher capital standards. They focus on the direct social costs of risk-shifting by banks on governments. We focus instead on the indirect social costs caused by credit crunches. Estimates suggest that in most countries, including in the US, the social cost of credit crunches far outweighed the direct monetary costs of bailouts related to the financial crisis of 2008/09 (see e.g. Haldane, 2010).

Our paper is also related to a growing literature that focuses on the role of the growth of the financial sector in increasing societal inequality over the past decades (see e.g. Kaplan and Rauh, 2010; Philippon and Reshef, 2012) 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.

There is also a growing empirical literature that documents the importance of financial sector capital for the broader economy and that underpins our modeling assumptions. Adrian et al. (2010) provide evidence that the capital position of financial intermediaries has strong effects on the real economy. Haldane (2010) estimates that the Great Financial Crisis of 2008/09 imposed social costs on the world economy in the order of magnitude of several trillion dollars. Furceri et al. (2013) provide cross-country evidence on the deleterious effects of capital account liberalization on inequality.

The rest of the paper proceeds as follows: The ensuing section develops an analytical model in which bankers intermediate capital to the real economy. Section 3 analyzes the determination of equilibrium and how changes in bank capital differentially affect the two sectors. Section 4 describes the redistributive

conflict over risk-taking between bankers and the real economy. In section 5, we analyze the impact of factors such as financial innovation, agency problems, market power and discretionary bailouts on this conflict.

# 2 Bank Capital and Workers

## 2.1 Model Setup

We assume an economy with three time periods, $t = 0, 1, 2$, and a unit mass each of two types of agents: bankers and workers. Furthermore, there is a single good that serves both as consumption good and capital.

**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 $E[\tilde{A}] > 1$. They hold the remainder $(1 - x)$ in a storage technology with gross return 1.

After the realization of the risky payoff $\tilde{A}$ in period 1, the resulting equity level of bankers 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 with a large endowment $m$ of consumption goods. They lend an amount $d$ of deposits to bankers at a deposit rate of $r$ and hold the remainder in a storage technology with gross return 1. No arbitrage implies that the deposit rate 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 utility by subtracting the constant $m$ so that

$$u = w\ell$$

*Remark:* In the described framework, risk markets between bankers and workers are incomplete since workers are born in period 1 after the technology shock $\tilde{A}$ is realized and cannot enter into risk-sharing contracts with bankers in period 0. All the risk $x\tilde{A}$ from investing in the risky technology therefore needs to be borne by bankers. An alternative microfoundation for this market incompleteness

would be that obtaining the distribution function $G(\tilde{A})$ requires that bankers exert an unobservable private effort, and insuring against fluctuations in $\tilde{A}$ would destroy their incentives to exert this effort. In practice, bank capital is subject to significant fluctuations, as illustrated in Figure 1, and a large fraction of this risk is not shared with the rest of society.[3] We will investigate the implications of reducing this market incompleteness below in Section 4.1.

**Firms** Workers collectively own firms, which are neoclassical and competitive and 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.

The first-order conditions of the firm problem are

$$\begin{aligned} R &= F_k = \alpha A k^{\alpha-1}\ell^{1-\alpha} \\ w &= F_\ell = (1-\alpha) A k^{\alpha}\ell^{-\alpha} \end{aligned}$$

*Remark 1:* In the described setup, we have separated the risk-taking decision $x$ of bankers from the financial intermediation function $k$ by assuming they occur in separate time periods. This simplifies our analysis, but implies that there is no direct contemporaneous benefit to workers if bankers invest more in the risky payoff with higher expected return. We show in appendix A.2 that our results continue to hold if the risk-taking and financial intermediation functions of bankers are intertwined: we assume that the aggregate production function of the economy in both periods 1 and 2 is $[\tilde{A}_t x_t + 1 - x_t]F(k_t,\ell_t)$ so that workers directly benefit from risk-taking $x_t$ because they receive higher wages in period $t$.[4]

*Remark 2:* Our model setup assumes for simplicity that the endowments of labor and savings as well as the firms are owned by the same set of agents which we called workers. Our results would be unchanged if we assigned these ownership claims to separate types of agents since savers earn zero net returns and firms earn zero profits in equilibrium. For example, there could be an additional type of agent called capital owner who own all the savings and firms of the economy.

[3] For example, Wall Street banks routinely pay out up to half of their revenue as employee compensation in the form of largely performance-dependent bonuses, constituting an implicit equity stake by insiders in their firms. A considerable fraction of remaining explicit bank equity is also held by insiders. Furthermore, 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. And this equity ownership is heavily skewed towards the high end of the income distribution (see Table A2a in Kennickel, 2013).

[4] In a similar vein, it can be argued that risky borrowers (e.g. in the subprime segment) benefitted from greater bank risk-taking because they obtained more and cheaper loans.

| Period 0 | Period 1 | Period 2 |
|---|---|---|
| • Banks enter with initial endowment 1<br>• Banks choose risky investment $x \in [0,1]$ | • Shock $\tilde{A}$ realized<br>• Bank equity $e = (1-x) + \tilde{A}x$<br>• Households enter and deposit $d$ at rate $r$ in banks<br>• Bankers supply capital $k \leq d + e$ to firms | • Households supply labor $\ell = 1$<br>• Firms produce $F(k, \ell)$<br>• Banks receive return $Rk$, households obtain $w\ell$<br>• Banks pay households $rd$ |

Figure 2: Timeline

## 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,

$$\max_{x,e,k,\ell} E\left[F\left(k,\ell\right) + e + m - k\right] \quad \text{s.t.} \quad \begin{aligned} e &= x\tilde{A} + (1-x) \\ k &\leq e + m \\ x &\in [0,1], \ell \in [0,1] \end{aligned}$$

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

$$R^* = F_k\left(k^*, 1\right) = 1$$

We call the resulting output level $F\left(k^*, 1\right)$ 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 invest $k^*$ in the absence of market frictions. The marginal product of labor at the first-best level of capital is $w^* = F_\ell\left(k^*, 1\right)$.

In period 0, the first-best planner chooses the portfolio allocation that maximizes expected bank equity $E\left[e\right]$. Since $E[\tilde{A}] > 1$, she will pick the corner solution $x = 1$.

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

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

## 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

$$rd \leq \phi Rk \tag{1}$$

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 $\phi = 1 - \frac{B}{\Delta}$, they can ensure that bankers avoid shirking and the associated risk of bankruptcy.[5]

Furthermore, our model assumes that all credit is used for production so that binding constraints directly reduce supply in the economy. An alternative and complementary assumption would be that credit is required to finance (durable) consumption so that binding constraints reduce demand. In both setups, binding financial constrainst hurt the real economy, with similar redistributive implications.[6]

# 3 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 $\tilde{A}$, such that the investment decisions of bankers and workers 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 equilibrum 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 $e$.

## 3.1 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 $\ell = 1$ since we assumed

[5] If the equilibrium interest rate is sufficiently large that $R > \frac{1}{1-\Delta+B}$, banks would prefer to offer depositors a rate $r = \frac{1}{1-\Delta}$ and shirk in their monitoring, incurring the default risk $\Delta$. We will discuss in section 5.4 below that such high interest rates are unlikely to be an equilibrium outcome as they would give rise to bailouts.

[6] We should also note that our benchmark model does account for the procyclicality of financial leverage, which is documented e.g. in Brunnermeier and Pedersen (2009). However, this could easily be corrected by making the parameter $\phi$ vary with the state of nature so that $\phi\left(\tilde{A}\right)$ is an increasing function.

wages are flexible. The financial constraint is loose if bank equity is sufficiently high so that bankers can intermediate the first-best amount of capital, $e \geq e^* = (1-\phi)k^*$. In this case, the deposit and lending rates satisfy $r = R = 1$ and bankers earn zero returns on their lending activity. The wage level is $w^* = (1-\alpha) F(k^*, 1)$. We interpret this situation as "normal times."

If bank equity is below the threshold $e < e^*$ then the financial constraint binds and the financial sector cannot intermediate the first-best level of capital. We interpret this situation as a "credit crunch" or "financial crisis" since the binding financial constraints reduce output below its first-best level. Workers 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 $\hat{k}(e)$, is implicitly defined by the equation

$$k = e + \phi k F_k(k, 1) \tag{2}$$

which has a unique positive solution for any $e \geq 0$. 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,

$$\begin{aligned} R(e) &= \alpha F(k(e), 1)/k(e) \\ w(e) &= (1-\alpha) F(k(e), 1) \end{aligned}$$

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[7]

$$\begin{aligned} k\left(e^i, e\right) &= \min\left\{k^*, \frac{e^i}{1-\phi R(e)}\right\} \\ \pi\left(e^i, e\right) &= e^i + [R(e) - 1] \cdot k\left(e^i, e\right) \end{aligned}$$

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

$$\begin{aligned} \pi(e) &= e + \alpha F(k(e), 1) - k(e) \\ w(e) &= (1-\alpha) F(k(e), 1) \end{aligned}$$

Total utilitarian surplus in the economy is

$$s(e) = w(e) + \pi(e) = e + F(k(e), 1) - k(e)$$

Panel 1 of Figure 3 depicts the payoffs of bankers and workers as a function of aggregate bank capital $e$.[8] As long as $e < e^*$, capital investment falls short

[7] Technically, when financial intermediation is unconstrained at the aggregate level because $e > e^*$, there is a continuum of equilibrium allocations of $k^i$ since the lending spread is zero $R(e) - 1 = 0$ and individual bankers are indifferent between intermediating more or less. In the equation, we are reporting the symmetric level of capital intermediation $k^*$ for this case.

[8] The parameter values used to plot all figures are reported in Appendix B.

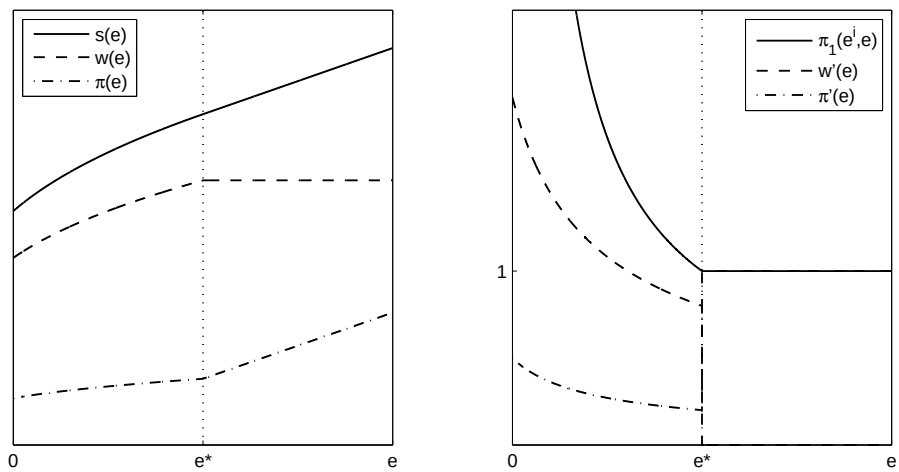


Figure 3: Welfare and marginal value of bank capital $e$

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 just reduces the amount of deposits that bankers need to raise, which increases their final payoff in period 2 but does not benefit workers. Beyond the threshold $e^*$, worker utility therefore remains constant and bank profits increase linearly in $e$. This generates a non-convexity in the function $\pi(e)$ at the threshold $e^*$.

Our analytical findings on the value of bank capital are consistent with the empirical regularities of financial crises that we depicted in Figure 1 on page 2.

## 3.2 Marginal Value of Bank Capital

How do changes in bank capital affect output and the distribution of surplus in the economy? If bankers are financially constrained in aggregate, i.e. if $e < e^*$, then a marginal increase in bank capital $e$ allows bankers to raise more deposits and leads to a greater than one-for-one increase in capital investment $k$. Applying the implicit function theorem to (2) in the constrained region we find

$$k'(e) = \begin{cases} \frac{1}{1-\phi\alpha F_k} > 1 & \text{for } e < e^* \\ 0 & \text{for } e \geq e^* \end{cases}$$

If bankers are unconstrained, $e \geq e^*$, then additional bank equity $e$ leaves capital investment unaffected at the first-best level $k^*$; therefore $k'(e) = 0$.

The marginal effect of additional bank capital on total surplus is $s'(e) = 1+(F_k - 1)\,k'(e)$. The first term captures the consumption value of an additional unit of wealth for bankers. The second term captures that bank capital $e$ raises investment in real capital by $k'(e)$ which earns a marginal return $(F_k - 1)$.

Looking at the distribution of this additional surplus between bankers and workers we find

$$\begin{aligned} w'(e) &= (1-\alpha)F_k k'(e) \\ \pi'(e) &= 1 + (\alpha F_k - 1)\, k'(e) \end{aligned}$$

The effects of changes in bank equity for the two sectors differs dramatically depending on whether the financial constraint is loose or binding. In the unconstrained region $e \geq e^*$, the consumption value for bankers is the only benefit of bank capital since $k'(e) = 0$ and so $w'(e) = 0$ and $\pi'(e) = 1$. Bank capital is irrelevant for workers and the benefits of additional bank capital accrue entirely to bankers.

By contrast, in the constrained region $e < e^*$, additional equity increases capital intermediation $k$ and output $F(k, 1)$. A fraction $(1-\alpha)$ of the additional output $F_k$ accrues to workers via increased wages, and a fraction $\alpha$ of the output net of the additional capital input accrues to bankers. These effects are illustrated in Panel 2 of Figure 3.

Technically, the effects of bank capital on wages $w(e)$ and the return on capital $R(e)$ in the constrained region constitute *pecuniary externalities*. When atomistic bankers choose their optimal equity allocations, they take all prices as given and do not internalize that their collective actions will have general equilibrium effects that move wages and the lending rate. In particular, they do not internalize that equity shortages will hurt workers by pushing down wages and pushing up lending rates.

The decline in wages when $e < e^*$ occurs because labor is a production factor that is complementary to capital in the economy's production technology. The increase in lending rates when $e < e^*$ occurs because the financial constraint drives the return to capital investment up to $R(e) = F_k(k(e), 1) > 1$ since not all productive investments can obtain loans. The difference between the lending rate and the deposit rate $r = 1$ allows bankers to earn a spread $R(e) - 1$ when the constraint is binding. Observe that this spread plays a useful social role in allocating risk because it signals to bankers that there are extra returns available for carrying capital into states of nature when it is scarce. However, it redistributes from workers to bankers by enabling them to earn a scarcity rent on their capital.

**Equity Shortages and Redistribution** It is instructive to observe that small shortages of financial sector capital have first order redistributive effects but only second order efficiency effects. In particular, consider an economy in which bank capital is $e^*$ so that the unconstrained equilibrium can just be implemented. Assume that we engage in a wealth-neutral reallocation of the wealth of bankers across periods 1 and 2: we take away an infinitesimal amount $\varepsilon$ of bank capital from bankers in period 1 so as to tighten their financial constraint and return it to them in period 2. The resulting payoffs for bankers and workers are $\pi(e^* - \varepsilon) + \varepsilon$ and $w(e^* - \varepsilon)$.

**Lemma 1 (Redistributive Effects of Equity Shortages)** *A marginal tightening of the financial constraint around the threshold $e^*$ has first-order redistributive effects but only second-order efficiency costs.*

**Proof.** We take the left-sided limit of the derivative of the payoff functions of bankers and workers to find

$$\begin{aligned} \lim_{\varepsilon \to 0} \pi'(e^* - \varepsilon) + 1 &= (1-\alpha) k'(e^*) \\ \lim_{\varepsilon \to 0} w'(e^* - \varepsilon) &= -(1-\alpha) k'(e^*) \end{aligned}$$

The effect on total surplus consists of the sum of the two $s' = \pi' + w'$ and is zero at a first-order approximation. ■

Interestingly, a marginal tightening of the constraint imposes losses on workers from lower wages that precisely equal the gains to bankers from higher lending spreads, i.e. the redistribution between workers and bankers occurs at a rate of one-to-one. Conceptually, this is because pecuniary externalities are by their very nature redistributions driven by changes in prices. In our model, when financial constraints reduce the amount of capital intermediated and push down wages, the losses of workers equal the gains to firms. Similarly, when the lending rate rises, the losses to firms equal the gains to bankers. Since firms make zero profits, we can conclude that the losses to workers have to equal the gains to bankers. Intuitively, since bankers are the bottleneck in the economy when the financial constraint binds, they extract surplus from workers in the form of scarcity rents.

## 3.3 Determination of Period 0 Risk Allocation

An individual banker $i$ takes the lending rate $R$ as given and perceives the constraint on deposits $d \leq \phi R k$ as a simple leverage limit. When a banker is constrained, she perceives the effect of a marginal increase in bank capital $e^i$ as increasing her intermediation activity by $k_1\left(e^i, e\right) = \frac{1}{1-\phi R}$, which implies an increase in bank profits by

$$\pi_1\left(e^i, e\right) = 1 + \left[R(e) - 1\right] k_1\left(e^i, e\right) \tag{3}$$

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

$$\max_{x^i \in [0,1], e^i} \Pi^i\left(x^i; x\right) = E\left[\pi\left(e^i, e\right)\right] \quad \text{s.t.} \quad e^i = \left(1 - x^i\right) + \tilde{A} x^i \tag{4}$$

At an interior optimum, the optimality condition of bankers is

$$E\left[\pi_1\left(e^i, e\right)\left(\tilde{A} - 1\right)\right] = 0, \tag{5}$$

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 $x > 0$. If the expected return is sufficiently high, equilibrium is given by the corner solution $x = 1$. Otherwise it is uniquely pinned down by the optimality condition (5).

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 $\Pi^{LF} = E\left[\pi\left(1 - x^{LF} + \tilde{A}x^{LF}\right)\right]$ and $W^{LF} = E\left[w\left(1 - x^{LF} + \tilde{A}x^{LF}\right)\right]$.

For a given risky portfolio allocation $x$, we define by $\bar{A}(x)$ the threshold of $\tilde{A}$ above which bank capital $e$ is sufficiently high to support the first-best level of production. We can express this function as

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

**Well-Capitalized Banking System** 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 capitalized to intermediate the first-best amount of capital 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 by US banks to Latin American governments that offer extra returns at extra risk.

For the case of $e^* \leq 1$, 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 low realizations of the risky return so that $\bar{A}(x) > 0$. 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 $\bar{A}(x)$ is strictly increasing from $\bar{A}(1 - e^*) = 0$ to $\bar{A}(1) = e^*$, i.e. more risk-taking makes it more likely that the financial sector becomes constrained.

**Under-Capitalized Banking System** If $e^* > 1$, 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 $\bar{A}(x)$ is strictly decreasing from $\lim_{x\to 0}\bar{A}(x) = \infty$ to $\bar{A}(1) = e^*$, i.e. more risk-taking makes it more likely that the financial sector becomes *un*constrained.

# 4 Pareto Frontier

We describe the redistributive effects of financial deregulation by characterizing the Pareto frontier of the economy, which maps different levels of financial risk-taking into different levels of welfare for the financial sector and the real economy. Financial regulation/deregulation moves the economy along this Pareto frontier.

We denote the period 0 allocation to the risky project that is collectively preferred by bankers by

$$x^B = \arg\max_{x\in[0,1]} E[\pi(\tilde{A}x + 1 - x)]$$

Similarly, we denote the choice of $x$ collectively preferred by workers by

$$x^W = \max\left\{\arg\max_{x\in[0,1]} E\left[w(\tilde{A}x + 1 - x)\right]\right\}$$

In a well-capitalized banking system, i.e. for $e^* \leq 1$, workers prefer that risk-taking in the financial sector is limited to the point where financial constraints will be loose in all states of nature so that the first-best level of capital investment $k^*$ can be implemented. This is guaranteed for any $x \in [0, 1 - e^*]$. Since workers are indifferent between all $x$ within this interval but bankers benefit from risk-taking, the only point from this interval that is on the Pareto-frontier is $x^W = 1 - e^*$. In an under-capitalized banking sytem, i.e. for $e^* > 1$, the optimal risk allocation for workers involves a positive level of risk-taking $x^W > 0$ – workers benefit from a little bit of risk because the safe return produces insufficient bank capital to intermediate the first-best amount of capital $k^*$, and risk-taking in period 0 increases the expected availability of finance in period 1.

**Definition 2 (Pareto Frontier)** *The Pareto frontier of the economy consists of all pairs of bank profits and worker wages* $(\Pi(x), W(x))$ *for* $x \in \left[x^W, x^B\right]$.

To ensure that the Pareto frontier is non-degenerate, we assume that the optimal levels of risk-taking for workers and in the decentralized equilibrium are interior and satisfy $x^W < 1$ and $x^{LF} < 1$. This is a weak assumption that holds whenever the risk-reward trade-off associated with $\tilde{A}$ is sufficiently steep.

**Proposition 3 (Characterization of Pareto Frontier)** *(i) The risk allocations that are collectively preferred by workers and bankers, respectively, satisfy*

$$x^W < x^B$$

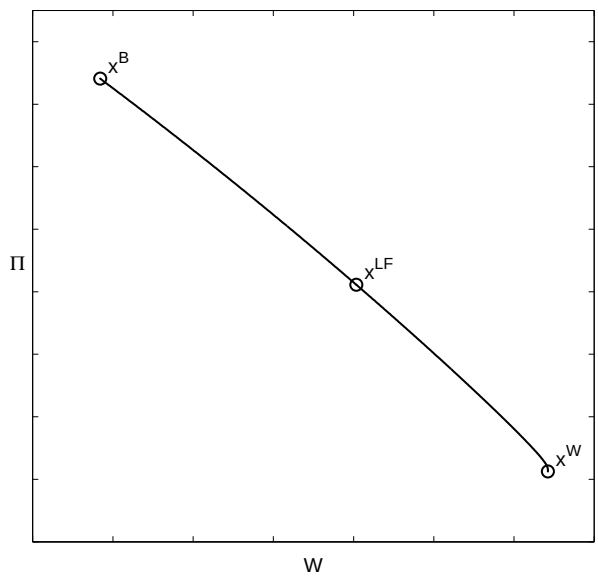


Figure 4: Pareto frontier

*(ii) Over the interval* $\left[x^W, x^B\right]$*, 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* $x^{LF} < x^B$*. If* $e^* \leq 1$ *then* $x^W < x^{LF} < x^B$*.*

**Proof.** See appendix A.1. ■

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, and the allocation preferred by bankers is at the top left. The laissez faire equilibrium is indicated by the marker $x^{LF}$. As risk-taking $x$ increases, we move upwards and left along the Pareto frontier. Along the way, expected bank profits rise for two reasons: first, because the risky technology offers higher returns; secondly because binding financial constraints redistribute from workers towards bankers, as we emphasized in lemma 1. The welfare of workers declines because they are more and more hurt by binding financial constraints.

## 4.1 Market Incompleteness and the Distributive Conflict

To pinpoint why there is a distributive conflict over the level of risk-taking, it is instructive to analyze the role of the two financial market imperfections in our results. First, assume that we remove the financial constraint on bankers in period 1. In that case, the profits/losses of bankers do not affect how much capital can be intermediated to the real economy and workers are indifferent

about the level of risk-taking – bank capital does not generate any pecuniary externalities. In such an economy, financial risk-taking and financial intermediation are two orthogonal activities and we find that $x^W = x^B = x^{FB} = 1$, i.e. the distributive conflict disappears.

Secondly, assume that we introduce a complete insurance market in period 0 in which bankers and workers can share the risk associated with the technology $\tilde{A}$, but we keep the financial constraint in period 1. In that case, workers will insure bankers against any capital shortfalls so that bankers can invest in the risky technology without imposing negative externalities on the real economy. By implication all agents are happy to invest the first-best amount $x^W = x^B = x^{FB} = 1$ in the risky techology, and the distributive conflict again disappears.

More generally, introducing a risk market in period 0 puts a formal price on risk-taking and, if both sets of agents can participate in this market, it implies that bankers and workers will agree on a common price of risk. Loosely speaking, this provides workers with a channel through which they can transmit their risk preferences to bankers.

An interesting special case in which financial markets in period 0 are effectively complete is a 'Marxist' two sector framework in which bankers/capitalists own all the capital and households/workers own all the labor in the economy (i.e. there are no desposits $d = 0$ and no storage). By implication, bankers invest all their equity into real capital $k = e$. Given a Cobb-Douglas production technology, the two sectors earn constant fractions of aggregate output so that $\pi(e) = \alpha F(e, 1)$ and $w(e) = (1 - \alpha) F(e, 1)$ for $e = \tilde{A}x + (1 - x)$. As long as the two sectors have preferences with identical relative risk aversion (in our benchmark model both have zero risk-aversion), the optimal level of risk-taking for capitalists simultaneously maximizes total surplus and worker welfare:

$$\arg\max_x E[\pi(e)] = \arg\max_x E[F(e, 1)] = \arg\max_x E[w(e)]$$

Bank capital still imposes pecuniary externalities on wages in this 'Marxist' setting, but the pecuniary externalities under a Cobb-Douglas technology guarantee that both sets of agents obtain constant fractions of output, replicating the allocation under perfect risk-sharing. (Analytically, the constant capital and labor shares drop out of the optimization problem.) Again, there is no distributive conflict.

By contrast, in our benchmark framework with the two market imperfections reintroduced, the negative pecuniary externalities only occur on the downside. Once bank capital exceeds the threshold where financial constraints are loose, it is irrelevant and has no further effects on workers. The distributive conflict is therefore generated by the combination of the occasionally binding financial constraints and the lack of risk-sharing between bankers and workers.

## 4.2 Financial Regulation

We interpret financial regulation in our framework as policy measures that affect risk-taking $x$ and therefore move the economy along the Pareto frontier.[9] The unregulated equilibrium – in the absence of any other market distortions – is represented by the laissez-faire equilibrium $x^{LF}$ on the frontier.

The two simplest forms of financial regulation of risk-taking are:

1. Regulators may impose a ceiling on the risk-taking of individual bankers such that $x^i \leq \bar{x}$. Such a ceiling will be binding if $\bar{x} < x^{LF}$. This type of regulation closely corresponds to capital adequacy regulations as it limits the amount of risk-taking per dollar of bank equity.

2. Regulators may impose a tax $\tau^x$ on risk-taking $x^i$ so as to modify the optimality condition for the risk-return tradeoff of bankers to $E[\pi_1 \cdot (\tilde{A} - \tau^x - 1)] = 0$. Such a tax can implement any level of risk-taking $x \in [0, 1]$. For simplicity, we assume that the tax revenue is rebated to bankers in lump-sum fashion.

Financial regulators can implement any risk allocation $\bar{x} \leq x^{LF}$ by imposing $\bar{x}$ as a ceiling on risk-taking or by imposing an equivalent tax on risk-taking $\tau^x \geq 0$. The distributive implications are straightforward:

**Corollary 4 (Redistributive Effects of Financial Regulation)** *Tightening regulation by lowering $\bar{x}$ or raising $\tau^x$ increases worker welfare and reduces banker welfare for any $\bar{x} \in \left[x^W, x^{LF}\right]$.*

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

**Scope for Pareto-Improving Deregulation** An interesting question is whether there exists a mechanism for Pareto-improving deregulation if we add further instruments to the toolkit of policymakers in addition to the regulatory measures on $x$ that we described in Corollary 4. Such a mechanism would need to use some of the gains from deregulation obtained by bankers to compensate workers for the losses they suffer during credit crunches.

Consider first a planner who provides an uncontingent lump-sum transfer from bankers to compensate workers for the losses from deregulation. The marginal benefit to workers is $1 - E\left[w'(e)\right]$ if the transfer is given in period 1 or $1 - \phi E\left[w'(e)\right]$ if it is given in period 2, i.e. workers would obtain a direct marginal benefit of 1 in all states of nature, but in constrained states they would be hurt by a tightening of the financial constraint which reduces their wages by $w'(e)$ if given in period 1 or a fraction $\phi$ therefore if it is given in

[9] Observe that a financial regulator would not find it optimal to change the leverage parameter $\phi$ in our setup. The parameter cannot be reduced because it stems from an underlying moral hazard problem and banks would default or deviate from their optimal behavior. Similarly, it is not optimal to increase $\phi$ because this would tighten the constraint on financial intermediation without any corresponding benefit.

period 2, since the transfer reduces the capital or the pledgeable income of bankers in period 2. Both types of uncontingent transfers entail efficiency costs from tightening the constraints on bankers. Compensating workers with an uncontingent payment without imposing these efficiency costs would require that the planner has superior enforcement capabilities to extract payments in excess of the financial constraint (1).

Alternatively, consider a planner who provides compensatory transfers to workers contingent on states of nature in which bankers are unconstrained, i.e. in states in which they make high profits from the risky technology $\tilde{A}$. This would not impose any efficiency costs but would require that the planner can engage in state-contingent transactions that are not available via private markets in our model. (It can be argued that this type of transfer corresponds to proportional or progressive profit taxation.)

In short, the planner only has efficient compensation mechanisms if she can get around at least one of the two financial market imperfections in our framework, i.e. if she can mitigate either the financial constraint (1) or the incompleteness of risk markets.

If the planner cannot improve on these market imperfections and/or if transfers require distortionary taxation, then the scope for Pareto-improving deregulation is more limited as the redistributive benefit of any transfer has to be weighed against the cost of the distortion introduced. In general, this creates a constrained Pareto frontier along which the trade-off between the welfare of the two agents is significantly less favorable, i.e. a Pareto frontier that is enveloped by the frontier depicted in Figure 4.

# 5 Risk-Taking and Redistribution

Factors that affect risk-taking in the economy will also have first-order redistributive implications as they move the economy along its Pareto frontier. 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. Following our analysis, these distortions can be expected to redistribute welfare from workers to bankers by increasing the volatility of bank capital.

In the following, we illustrate this in more detail for the case of financial institutions with market power, managerial agency problems that lead to asymmetric payoffs for managers, and financial innovation that creates new risk-taking opportunities. In the ensuing section we will examine how safety nets create additional redistributions by inducing bankers to take on more risk.

## 5.1 Financial Innovation

An important 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 that financial innovation expands the set of investable projects to include the risky project with stochastic return $\tilde{A}$. Furthermore, assume that $e^* < 1$, i.e. the safe return in period 0 generates sufficient period 1 equity for bankers to intermediate the first-best level of capital. The pre-innovation equilibrium corresponds to $x = 0$ in our benchmark setup and this maximizes worker welfare.

**Example 1 (Distributive Effects of Financial Innovation)** *In the described economy, expanding the set of investment projects to include $\tilde{A}$ increases banker welfare but reduces 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 $\pi_1\left(e^i, e\right)$ 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.

Restrictions on the risk-taking activities of banks, e.g. via regulations such as the Volcker rule, may benefit workers by acting as a second-best device to complete financial markets. In the example described above this would be the case.

## 5.2 Asymmetric Compensation Schemes

It is frequently argued that managers of financial institutions may have incentives to increase risk-taking because of asymmetric compensation schemes that reward them them for higher risk and that this may have played an important role in the build-up of risk before the financial crisis of 2008/09. We illustrate

this mechanism using a stylized model of an incentive problem between bank owners and bank managers and analyze the distributive implications.

Let us extend our benchmark model by assuming that bank owners have to hire a new set of agents called bank managers to conduct their business. Bank managers choose an unobservable level of risk-taking $x$ in period 0. Bank owners are able to observe the realization of bank capital $e$ in period 1 and to instruct managers to allocate any bank capital up to $e^*$ in financial intermediation, and managers carry any excess $\max\{0, e - e^*\}$ in a storage technology. We can view financial intermediation versus storage as representative of lending to real projects versus financial investments, or commercial banking versus investment banking.

Suppose that bank managers do not have the ability to commit to exert effort in period 1 and can threaten to withdraw their monitoring effort for both bank loans and storage in period 1. If they do not monitor, the returns on intermediation and storage (real projects and financial investments) are diminished by a fraction $\varepsilon$ and $\delta\varepsilon$ respectively, where $\delta > 1$. In other words, the returns to financial investments are more sensitive to managerial effort than real investments. An alternative interpretation would be along the lines of Jensen (1986) that free cash provides managers with greater scope to abuse the resources under their control.

Assuming that managers have all the bargaining power and that we are in a symmetric equilibrium, the threat to withdraw their effort allows them to negotiate an incentive payment from bank owners of

$$p\left(e^i, e\right) = \varepsilon \min\left\{\pi\left(e^i, e\right), \pi\left(e^*, e^*\right)\right\} + \delta\varepsilon \max\left\{0, e^i - e^*\right\}$$

The marginal benefit of bank equity for an individual manager is $p_1(e, e) = \varepsilon\pi_1(e, e)$ for $e < e^*$ and $p_1(e, e) = \delta\varepsilon\pi_1(e, e) = \delta\varepsilon$ for $e \geq e^*$. Since financial investments require a greater incentive payment, the payoff of managers is relatively more convex than the payoff of banks $\pi(e, e)$ and managers benefit disproportionately from high realizations of bank capital. Comparing this extension to our benchmark setup, we can view $\Pi(x)$ as the joint surplus of bank owners and managers, and the two functions $\Pi(x)$ and $W(x)$ remain unchanged compared to our earlier framework – the only thing that changes is the level of $x$ that will be chosen by bank managers.

Managers internalize the asymmetric payoff profile when they choose the level of risk-taking in period 0. They maximize $E[p\left(e^i, e\right)]$ where $e^i = \tilde{A}x^i + 1 - x^i$ and their optimality condition is

$$E\left[\left(\tilde{A} - 1\right) p_1(e, e)\right] = 0$$

It is then straightforward to obtain the following result:

**Proposition 5 (Agency Problems and Risk-Taking)** *(i) The optimal choice of risk-taking of bank managers exceeds the optimal choice $x^{LF}$ in our benchmark model if the payoff function of managers is asymmetric $\delta > 1$.*

*(ii) The expected welfare of workers is a declining function of $\delta$.*

**Proof.** For (i), observe that we can write

$$p(e^i, e) = \epsilon\pi(e^i, e) + \epsilon\left(\delta - 1\right)\left(e^i - e\right)\mathbb{I}_{e^i \geq e^*}$$

where $\mathbb{I}_{e^i \geq e^*}$ is an indicator variable that is equal to 1 when $e^i \geq e^*$ and 0 otherwise. The preferred choice of $x$ by managers, call it $x^A$, satisfies $P_1(x) = E\left[(\tilde{A} - 1)p_1(e^i, e)\right] \geq 0$. We can write this as

$$P_1(x) = \epsilon\Pi_1(x) + \epsilon\left(\delta - 1\right)E\left[(\tilde{A} - 1)\mathbb{I}_{e^i \geq e^*}\right]$$

where $\Pi_1(x) = E\left[(\tilde{A} - 1)\pi_1(e^i, e)\right]$ is the owner's first-order condition. Now we argue that the second term is strictly positive. Note that we can write this term as

$$E\left[(\tilde{A} - 1)\mathbb{I}_{e^i \geq e^*}\right] = \int_{A^*}^{\infty}(\tilde{A} - 1)dG(\tilde{A})$$

Since we have $E[\tilde{A} - 1] > 0$ by assumption, and since $(\tilde{A} - 1)$ is an increasing function of $\tilde{A}$, it follows that the integral over the upper half of the range must also be strictly positive. Therefore for all $x$, we have $P_1(x) > \Pi_1(x)$, and in particular $\Pi_1(x^{LF} > 0$, and so $x^A > x^{LF}$.

To prove (ii), we begin by showing that $x^A$ is strictly increasing in $\delta$. Differentiating $P_1(x)$ with respect to $\delta$ yields $\epsilon E\left[(\tilde{A} - 1)\mathbb{I}_{e^i \geq e^*}\right]$, which is strictly positive. At the old preferred level of $x$, we now have $P_1(x) > 0$, and so $x^A$ will increase. Now we observe that increasing $x$ for $x > x^W$ will always make workers worse off. Given that $x^W < x^{LF} < x^A$, this implies that increasing $\delta$ will make workers worse off. ■

## 5.3 Financial Institutions with 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 $R\left(e\right)$ 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

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

[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 $\min\left\{k\left(e^i\right), k^{*n}\right\}$ where $k^{*n} = k^*\left(\frac{n-(1-\alpha)}{n}\right)^{\frac{1}{1-\alpha}}$ 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

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

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

The marginal valuation of bank capital is now

$$\pi_1^{i,n}\left(e^i, e^{-i}\right) = \begin{cases} \frac{1}{n}\pi'(e) + \frac{n-1}{n}\pi_1^i\left(e^i, e\right) & \text{for } e < e^{*,n} \\ 1 & \text{for } e \geq e^{*,n} \end{cases}$$

This falls in between the marginal value of bank capital for the sector as a whole and for a competitive banker, i.e. $\pi' < \pi_1^{i,n} < \pi_1^i$.

Since we have $\pi_1^{i,n}\left(e^i, e\right) = \pi_1^i + \frac{1}{n}\left(\pi' - \pi_1^i\right)$, we can write the optimality condition for one of $n$ large firms as

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

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 $x^n \in \left(x^{LF}, x^B\right)$. At $x^n$, we differentiate the optimality condition w.r.t. $n$ and find

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

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 $\frac{d}{dn}\Pi_1^{i,n} < 0$, and so $x^n$ is decreasing in $n$. We summarize these results as follows:

**Proposition 6** *The optimal risk allocation $x^n$ of bankers is a declining function of the number $n$ of banks in the market. In particular, we 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 accrue 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.

## 5.4 Bailouts

Bailouts have perhaps raised more redistributive concerns than any other form of public financial intervention, presumably because they involve redistributions in

the form of explicit transfers that are much more transparent than other implicit forms of redistributions.

However, the redistributive effects of bailouts are both more subtle and potentially more pernicious than this simple view suggests. Ex post, i.e. once bankers have suffered large losses and the economy experiences a credit crunch, bailouts may actually lead to a Pareto improvement and workers may be better off by providing a transfer. However, ex-ante, bailout expectations increase risk-taking. This redistributes surplus from workers to the financial sector in a less explicit and therefore more subtle way, as we have emphasized throughout this paper.

**Model of Endogenous Bailouts** Since bank capital is essential for the real economy, workers in our model find it optimal to coordinate to provide bailouts to bankers during episodes of severe capital shortages in order to mitigate the adverse effects of credit crunches on the real economy. Such bailouts typically come in two broad categories, emergency lending, frequently at a subsidized interest rate, and equity injections, frequently at a subsidized (or even zero) price. We show in Appendix A.3 that no matter how exactly a bailout is provided, what matters in our model is the total amount of resources (subsidies) given to bankers to relax their binding financial constraints. For the remainder of this section, we focus for simplicity on bailouts in the form of direct transfers. The appendix generalizes our results.

**Lemma 7 (Optimal Bailout Policy)** *If aggregate bank capital in period* 1 *is below a threshold* $0 < \hat{e} < e^*$*, workers find it collectively optimal to provide lump-sum transfer* $t = \hat{e} - e$ *to bankers. The threshold* $\hat{e}$ *is determined by the expression* $w'(\hat{e}) = 1$ *or*

$$\hat{e} = (1-\alpha)\left[1-(1-\phi)\alpha\right]^{\frac{\alpha}{1-\alpha}} e^* \tag{6}$$

**Proof.** The welfare of workers who collectively provide a transfer $t \geq 0$ to bankers is given by $w(e+t)-t$. An interior optimum satisfies $w'(e+t) = 1$. We define the resulting equity level as $\hat{e} = e+t$, which satisfies equation (6). Observe that $w'(e)$ is strictly declining from $w'(0) = 1/\phi > 1$ to $w'(e^*) = \frac{1-\alpha}{1-\phi\alpha} < 1$ 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 $t = 0$.

■

The intuition stems from the pecuniary externalities of bank capital on wages: 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 increases wages. As long as $e < \hat{e}$, the cost of a transfer on workers is less than the collective benefit in the form of higher wages. If workers can coordinate, they will be collectively better off by providing a transfer that lifts bank capital to $\hat{e}$.

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

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

This guarantees that the banking sector will not require a bailout if the 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 mild assumption as we typically expect bailouts to occur in bad states of nature.

**Period 1 Equilibrium** 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:

$$\begin{aligned} w^{BL}(e) &= (1-\alpha) F(e + t(e), 1) - t(e) \\ \pi^{BL}(e) &= \alpha F(\hat{e}, 1) \end{aligned}$$

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. 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.

**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

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

Panel 2 of Figure 5 depicts the marginal welfare effects of bank equity under bailouts. The marginal benefit for workers $w^{BL\prime}(e)$ 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

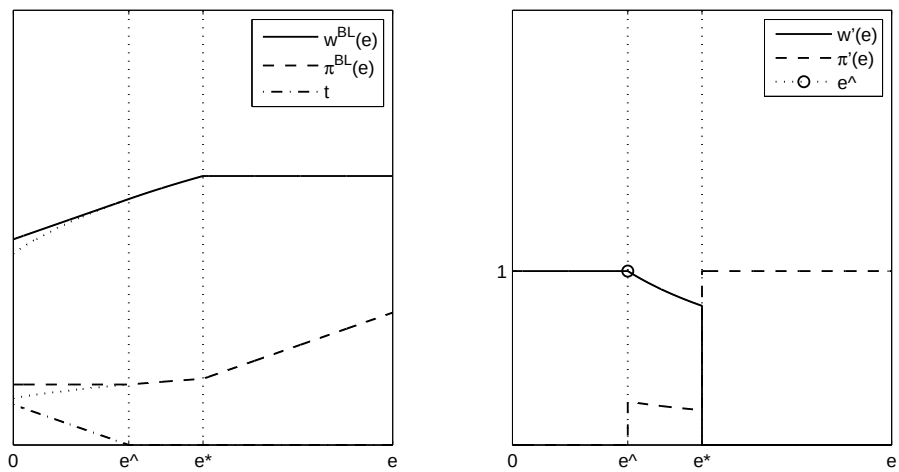


Figure 5: Welfare and marginal value of bank capital under bailouts.

to workers in the absence of bailouts, corresponding to the downward-sloping dotted line $w^{BL\prime}(e) = (1-\alpha) F_k$ in the figure, to the marginal cost which is unity. This point is marked by a circle in the figure.)

Bailouts constitute straight transfers from workers to bankers, but in our model, they nonetheless generate a Pareto improvement for a given $e < \hat{e}$ in period 1 because they 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. At the margin, each additional unit of bailout generates a surplus $F_k(e,1) - 1$, of which $w'(e) - 1$ arises to workers 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 $\pi'(\hat{e}) = \frac{\alpha}{1-\alpha}$. One interpretation of this is that bankers are able to extract "bailout rents" from workers because of their bottleneck role in financial intermediation.

**Period 0 Risk-Taking** Optimal discretionary bailouts impose a ceiling on the market interest rate $R^{BL}(e) \leq R(\hat{e}) = \frac{1}{1-\alpha}$ since they ensure that aggregate capital investment is greater than the threshold $k \geq \hat{e}$ at all times. This mitigates the precautionary incentives of bankers and increases their optimal risk-taking, corresponding to a "wealth effect" of bailouts. This effect exists even if bailouts are conditional on aggregate bank capital $e$ and are provided in the form of lump-sum transfers.

In addition, the adverse incentive effects of bailouts are aggravated if they are conditional on individual bank capital $e^i$, which provide bankers with incentives to increase risk-taking so as to increase the expected bailout rents received, corresponding to a "substitution effect" of bailouts.

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

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

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 solely on individual bank capital (for $\gamma = 1$). Alternatively, if banks are non-atomistic and bailouts are 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 8 (Risk-Taking Effects of Bailouts)** *(i) Introducing bailout transfers increases period 0 risk-taking $x^{BL}(\gamma) > x^{LF}$ for any $\gamma = 0$.*

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

**Proof.** See appendix A.1. ■

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 lowers the precautionary incentives of bankers and induces them to take on more risk, even if the bailouts are provided in a lump-sum fashion. Observe that this effect is similar to the effects 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 more convex 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.

**Redistributive Effects** The welfare effects of introducing bailouts on bankers and workers can be decomposed into two parts, the change in expected welfare from introducing bailouts for a given level of risk-taking $x^{BL}$, corresponding to the market completion effect of bailouts, and the change in the level of risk-taking, corresponding to the incentive effects of bailouts, :

$$\begin{aligned} \Delta\Pi &= \left[\Pi^{BL}(x^{BL}) - \Pi(x^{BL})\right] + \left[\Pi(x^{BL}) - \Pi(x^{LF})\right] \\ \Delta W &= \underbrace{\left[W^{BL}(x^{BL}) - W(x^{BL})\right]}_{\text{market completion}} + \underbrace{\left[W(x^{BL}) - W(x^{LF})\right]}_{\text{incentive effect}} \end{aligned}$$

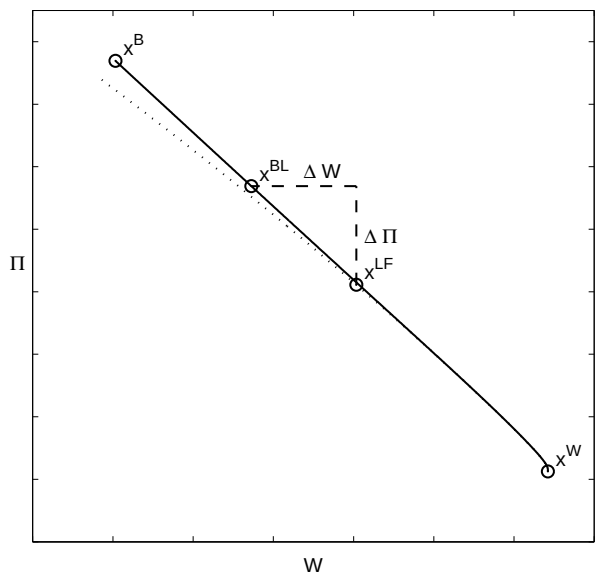


Figure 6: Pareto frontier under bailouts

**Corollary 9 (Distributive Effects of Bailouts)** *(i) Bankers always benefit from introducing bailouts and their expected profits* $\Pi^{BL}(\gamma)$ *are an increasing function of* $\gamma$*.*

*(ii) Workers benefit from the market completion effect of bailouts but are hurt by the incentive effects of bailouts if* $e^* < 1$*. The absolute magnitude of both effects is an increasing function of* $\gamma$*.*

**Proof.** The first term is positive for both sets of agents because, for given $x$, bailouts generate a Pareto improvement.[11] The second term is always positive for bankers because $\Pi'(x) > 0$ and is always negative for workers for $e^* < 1$ because $W'(x) < 0$. Higher $\gamma$ increases risk-taking and therefore leads to more bailouts, increasing the absolute magnitude of all four terms. ■

Although the market completion effect is positive for both sets of agents, the increase in risk-taking benefits bankers 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.

We illustrate our findings in Figure 6. The figure shows how the Pareto frontier depicted in Figure 4 is affected by the introduction of bailouts under the assumption that $\gamma = 0$, i.e. bailouts are distributed lump sum. The new Pareto frontier (solid line) is shifted out compared to the old frontier (dotted line) at

[11] We could further disentangle the first term for workers into a negative term corresponding to the transfers that they make and a larger positive term corresponding to the resulting increase in wages for given $x$.

its left end, i.e. $\Pi^{BL}(x) > \Pi(x)$ and $W^{BL}(x) > W(x)$ for all $x > x^W$ but is unchanged at $x = x^W$ as long as $e^* < 1$ (which holds in our parameterization). The shift in the frontier is thus biased towards bankers and the introduction of bailouts constitutes banker-biased technological change. In our figure, risk-taking increases significantly even though $\gamma = 0$. Banker welfare rises by $\Delta\Pi$ whereas worker welfare falls by $\Delta W$.

# 6 Conclusions

The central finding 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 the welfare weights that 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.

We find that deregulation benefits the financial sector by allowing for greater risk-taking and higher expected profits. However, the downside is that greater risk-taking leads to a greater incidence of losses that are sufficiently large to trigger a credit crunch. If the financial sector is constrained in its intermediation activity, the real economy obtains less credit and invests less, lowering output and the marginal product of labor, which imposes negative externalities on wage earners. The degree of financial regulation therefore has first-order redistributive implications.

More generally, we show that many other factors that increase risk-taking in the financial sector lead to a redistribution of expected welfare from workers to bankers. These factors include financial innovation that enhances risk-taking opportunities, agency problems, market power and bailouts.

There are a number of issues that we leave for future analysis: First, since risk-taking is profitable, financial regulation generates large incentives for circumvention. If the regulatory framework of a country covers only one part of its financial system, the remaining parts will expand. In the US, for example, the shadow financial system grew to the point where it constituted a significant part of the financial sector. 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 (see e.g. Korinek, 2013).

Second, 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 alternative financial intermediaries can emerge and make up for the lost intermediation capacity of the financial sector when a crisis hits.

# References


Abiad, Abdul, Enrica Detragiache and Thierry Tressel, 2010. "A New Database of Financial Reforms," *IMF Staff Papers* 57(2), pp. 281-302.

Acharya, Viral V. and Tanju Yorulmazer, 2008, "Cash-in-the-Market Pricing and Optimal Resolution of Bank Failures," *Review of Financial Studies* 21(6), pp. 2705-2742.

Acharya, Viral V., Thomas Cooley, Matthew Richardson and Ingo Walter, 2010, "Manufacturing Tail Risk: A Perspective on the Financial Crisis of 2007-2009," *Foundations and Trends in Finance* 4(4), pp. 247-325.

Admati, Anat R., Peter M. DeMarzo, Martin F. Hellwig, Paul Pfleiderer, 2010, "Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is Not Expensive," *Stanford GSB Research Paper No.* 2065.

Adrian, Tobias, Emanuel Moench and Hyun Song Shin, 2010, "Macro Risk Premium and Intermediary Balance Sheet Quantities," *IMF Economic Review* 58(1), pp. 179-207.

Benigno, Gianluca, Huigang Chen, Christopher Otrok, Alessandro Rebucci, and Eric R. Young, 2012, "Optimal Policy for Macro-Financial Stability," *manuscript, LSE.*

Bernanke, Ben and Mark Gertler, 1989, "Agency Costs, Net Worth and Business Fluctuations," *American Economic Review* 79(1), pp. 14-31.

Bianchi, Javier, 2012, "Efficient Bailouts?" *NBER Working Paper* w18587.

Bianchi, Javier, and Enrique Mendoza, 2010, "Overborrowing, Financial Crises, and 'Macroprudential' Taxes," *NBER Working Paper* w16091.

Brunnermeier, Markus K., and Lasse Heje Pedersen, 2009, "Market liquidity and funding liquidity," *Review of Financial Studies* 22(6), pp. 2201-2238.

Brunnermeier, Markus K. and Yuliy Sannikov, 2012, "Redistributive Monetary Policy," Jackson Hole Symposium, 1 September 2012.

Caballero, Ricardo J., 2010, "Sudden financial arrest," *IMF Economic Review* 58, pp. 6-36.

Caballero, Ricardo J. and Guido Lorenzoni, 2009, "Persistent Appreciations and Overshooting: A Normative Analysis," MIT, mimeo.

Calvo, Guillermo A., Fabrizio Coricelli, Pablo Ottonello, 2012, "The Labor Market Consequences of Financial Crises With or Without Inflation: Jobless and Wageless Recoveries," NBER Working Paper 18480.

Campbell, Jeffrey R, and Zvi Hercowitz, 2009, "Welfare Implications of the Transition to High Household Debt," *Journal of Monetary Economics* 56(1), pp. 1-16.

Del Negro, Marco, Gauti Eggertsson, Andrea Ferrero and Nobuhiro Kiyotaki, 2010, "The Great Escape? A Quantitative Evaluation of the Fed's Non-standard Policies," unpublished manuscript, Federal Reserve Bank of New York.

Freixas, Xavier and Jean-Charles Rochet, 2008, *Microeconomics of Banking*, 2nd edition, Cambridge, MA: MIT Press.

Furceri, Davide, Florence Jaumotte and Prakash Loungani, 2013, "The distributional consequences of capital account liberalization," *IMF Working Paper*.

Geanakoplos, John and Heraklis Polemarchakis, 1986, "Existence, regularity, and constrained suboptimality of competitive allocations when the asset market is incomplete," *Cowles Foundation Paper* 652.

Gertler, Mark, and Peter Karadi, 2011, "A model of unconventional monetary policy," *Journal of Monetary Economics* 58, pp. 17-34.

Gertler, Mark, and Nobuhiro Kiyotaki, 2010, "Financial intermediation and credit policy in business cycle analysis," *Handbook of Monetary Economics* 3, pp. 547-599.

Gersbach and Rochet, 2012, "Aggregate Investment Externalities and Macroprudential Regulation," Swiss Finance Institute Research Paper No. 12-03.

Haldane, Andrew, 2010, "The $100 Billion Question," Bank of England.

Hall, Robert E., 2010, "Financial Stability with Government-Guaranteed Debt," Ch. 7 in *Forward-Looking Decision Making*, Princeton University Press.

Jeanne, Olivier and Anton Korinek, 2010a, "Excessive Volatility in Capital Flows: A Pigouvian Taxation Approach," *American Economic Review*, pp. 403–407.

Jeanne, Olivier and Anton Korinek, 2010b, "Managing Credit Booms and Busts: A Pigouvian Taxation Approach," *NBER Working Paper* 16377.

Jeanne, Olivier and Anton Korinek, 2012, "Macroprudential Regulation versus Mopping Up After the Crash," *NBER Working Paper 18675*.

Jensen, Michael C., 1986, "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review* 76(2), pp. 323-329.

Kaplan, Steven N. and Joshua Rauh, 2010, "Wall Street and Main Street: What Contributes to the Rise in the Highest Incomes?" *Review of Financial Studies* 23(3), 2010, 1004-1050.

Karabarbounis, Loukas and Brent Neiman, 2013, "The Global Decline of the Labor Share," *NBER Working Paper 19136*.

Kennickell, Arthur B., 2013, "Ponds and Streams: Wealth and Income in the U.S., 1989 to 2007", *Finance and Economics Discussion Series,* Federal Reserve Board, Washington, D.C.

Kiyotaki, Nobuhiro and John H. Moore, 1997, "Credit Cycles," *Journal of Political Economy* 105(2), pp. 211-248.

Korinek, Anton, 2011, "Systemic Risk-Taking: Amplification Effects, Externalities, and Regulatory Responses", *ECB Working Paper* 1345.

Korinek, Anton, 2013, "Financial Innovation for Rent Extraction," *manuscript*.

Lorenzoni, Guido, 2008, "Inefficient Credit Booms," *Review of Economic Studies* 75(3), 809-833.

Martinez-Miera, David and Javier Suarez, 2012, "A Macroeconomic Model of Endogenous Systemic Risk Taking," *CEPR Discussion Paper* DP9134.

Mian, Atif and Amir Sufi, 2010, "Household Leverage and the Recession of 2007–09," *IMF Economic Review* 58(1), pp. 74-117.

Miles, David, Jing Yang and Gilberto Marcheggiano, 2012, "Optimal Bank Capital," *Economic Journal* 123(567), pp. 1-37.

Philippon, Thomas and Ariell Reshef, 2012, "Wages and Human Capital in the U.S. Financial Industry: 1909-2006," *Quarterly Journal of Economics* 127(4), pp. 1551-1609.

Philippon, Thomas and Ariell Reshef, 2013, "An International Look at the Growth of Modern Finance," *Journal of Economic Perspectives* 27(2), pp. 73-96.

Reinhart, Carmen and Kenneth Rogoff, 2009, *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press.

Rey, Patrick and Jean Tirole, 2007, "A Primer on Foreclosure," in Mark Armstrong and Robert Porter (eds.), *Handbook of Industrial Organization* 1(3), Elsevier.

Sandri, Damiano and Fabian Valencia, 2013, "Financial Crises and Recapitalizations," *forthcoming, Journal of Money, Credit and Banking.*

Stiglitz, Joseph E., 1982, "The Inefficiency of the Stock Market Equilibrium," *Review of Economic Studies* 49(2), pp. 241-261.

# A Technical Appendix

## A.1 Proofs

**Proof of Proposition 3.** We first show that the marginal functions $\Pi'(x)$, $\Pi_1(x^i, x)$, and $W'(x)$ are strictly decreasing in $x$ by differentiating each with respect to $x$,

$$\begin{aligned}
\Pi''(x) &= \int_0^\infty \left(\tilde{A}-1\right)^2 \frac{(1-\phi)\alpha F_{kk}}{(1-\alpha\phi F_k)^3} dG(\tilde{A}) < 0 \\
\frac{d}{dx}\Pi_1(x^i, x) &= \int_0^\infty \left(\tilde{A}-1\right)^2 \frac{(1-\phi)F_{kk}}{(1-\phi F_k)^2 (1-\alpha\phi F_k)} dG(\tilde{A}) < 0 \\
W''(x) &= \left[\frac{(1-\alpha)}{(1-\phi)\alpha}\right] \Pi''(x) < 0
\end{aligned}$$

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. At the point $x^{LF}$ we have $\Pi_1 = 0$. Then we find

$$\Pi'(x^{LF}) = \Pi'(x^{LF}) - \Pi_1(x^{LF}, x^{LF}) = -\int_0^{\bar{A}} \frac{(1-\alpha)(1-\phi)(\tilde{A}-1)F_k}{(1-\phi\alpha F_k)(1-\phi F_k)} dG(\tilde{A})$$

Observe that the term $\frac{F_k}{(1-\phi\alpha F_k)(1-\phi F_k)}$ is strictly increasing in $F_k$. Now we define $\bar{R}$ as follows. If $\bar{A} \leq 1$, so that the term $(\tilde{A}-1) < 0$ over the entire interval, we let $\bar{R}$ be the value of $F_k$ when $\tilde{A} = \bar{A}$. If instead we have $\bar{A} > 1$, then let $\bar{R}$ be the value of $F_k$ at $\tilde{A} = 1$. Then since $F_k$ is decreasing in $\tilde{A}$, we have

$$-\int_0^{\bar{A}} \frac{(1-\alpha)(1-\phi)(\tilde{A}-1)F_k}{(1-\phi\alpha F_k)(1-\phi F_k)} dG(\tilde{A}) > -\int_0^{\bar{A}} \frac{(1-\alpha)(1-\phi)(\tilde{A}-1)F_k}{\left(1-\phi\alpha\bar{R}\right)(1-\phi F_k)} dG(\tilde{A})$$

Recall that at $x^{LF}$ we have $\Pi_1 = 0$. We can write this as

$$\int_0^{\bar{A}} (\tilde{A}-1)\frac{(1-\phi)F_k}{1-\phi F_k} dG(\tilde{A}) + \int_{\bar{A}}^\infty (\tilde{A}-1) dG(\tilde{A}) = 0$$

Then since $\int_{\bar{A}}^\infty (\tilde{A}-1)dG(\tilde{A}) > 0$, we must have $\int_0^{\bar{A}} (\tilde{A}-1)\frac{(1-\phi)F_k}{1-\phi F_k} dG(\tilde{A}) < 0$. Thus we have

$$\Pi'(x^{LF}) > -\frac{(1-\alpha)}{\left(1-\phi\alpha\bar{R}\right)} \int_0^{\bar{A}} \left(\tilde{A}-1\right) \frac{(1-\phi)F_k}{(1-\phi F_k)} dG(\tilde{A}) > 0$$

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

$$\Pi'(x) - \frac{(1-\phi)\alpha}{1-\alpha} W'(x) = \int_{\bar{A}}^\infty \left(\tilde{A}-1\right) dG(\tilde{A}) > 0$$

Since at an interior solution we have $W'(x^W) = 0$, this implies $\Pi'(x^W) > 0$, and so $x^B > x^W$. ■

**Proof of Proposition 8.** For (i) observe that the welfare maximization problem of bankers under bailouts for a given parameter $\gamma$ is

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

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

$$\begin{aligned}
\Pi_1^{BL}\left(x^{LF}, x^{LF}; \gamma\right) &= E\left[\left(\tilde{A} - 1\right)\pi_1^{BL}\left(e^i, e; \gamma\right)\right] = \\
&= (1-\gamma)\pi_1(\hat{e}, \hat{e})\int_0^{\hat{A}} (\tilde{A} - 1)dG(\tilde{A}) + \int_{\hat{A}}^{\infty} (\tilde{A} - 1)\pi_1 dG(\tilde{A}) > \\
&> \int_0^{\hat{A}} (\tilde{A} - 1)\pi_1 dG(\tilde{A}) + \int_{\hat{A}}^{\infty} (\tilde{A} - 1)\pi_1 dG(\tilde{A}) = \Pi_1\left(x^{LF}, x^{LF}\right) = 0
\end{aligned}$$

The inequality holds because the second terms in the two expressions with integrals are identical and must be positive for $\Pi_1\left(x^{LF}, x^{LF}\right) = 0$ to hold. The first term in $\Pi_1^{BL}\left(x^{LF}, x^{LF}; \gamma\right)$ is either positive or satisfies

$$(1-\gamma)\int_0^{\hat{A}} (\tilde{A}-1)\pi_1\left(\hat{e}, \hat{e}\right) dG(\tilde{A}) \geq \int_0^{\hat{A}} (\tilde{A}-1)\pi_1\left(\hat{e}, \hat{e}\right) dG(\tilde{A}) > \int_0^{\hat{A}} (\tilde{A}-1)\pi_1(e, e)dG(\tilde{A})$$

since $(\tilde{A} - 1)$ is strictly increasing and $\pi_1(e, e)$ is strictly decreasing over the interval $[0, \hat{A})$. 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

$$\frac{d\Pi_1^{BL}}{d\gamma} = -\pi_1(\hat{e}, \hat{e})\int_0^{\hat{A}} (\tilde{A} - 1)dG(\tilde{A}) > 0$$

where the inequality holds since $\hat{A} < 1$. ■

## A.2 Period 0 Production Function

This appendix generalizes our setup to a symmetric Cobb-Douglas production function across periods $t = 1$ and 2 of the form

$$\left[\tilde{A}_t x_t + 1 - x_t\right] F(k_t, \ell_t)$$

This allows us to account for the notion that the higher returns from risk-taking in the initial period are shared between workers and bankers.

We continue to assume that bankers choose the fraction $x_t$ allocated to risky projects and firms choose the amount of capital invested $k_t$ before the productivity shock $\tilde{A}_t$ is realized, i.e. in period $t - 1$.

In period 0, bankers supply their initial equity $e_0$ to firms for capital investment so that $k_0 = e_0$. In period 1, the productivity shock $\tilde{A}_1$ is realized and firms hire

$\ell = 1$ units of labor to produce output $\tilde{A}_1 F(e_0, 1)$. Bankers and workers share the productive output according to their factor shares,

$$e_1 = \alpha \left[\tilde{A}_1 x_1 + 1 - x\right] F(e_0, 1) \tag{7}$$

$$w_1 = (1-\alpha) \left[\tilde{A}_1 x_1 + 1 - x\right] F(e_0, 1) \tag{8}$$

where equation (7) represents the law-of-motion of bank equity from period 0 to period 1. Given the period 1 equity level $e_1$, the economy behaves as we have analyzed in Section 3.1 in the main body of the paper, i.e. bankers and workers obtain profits and wages of $\pi(e_1)$ and $w(e_1)$. Observe that all agents are risk-averse with respect to period 2 consumption; therefore the optimal $x_2 \equiv 1$ and we can solve for all allocations as if the productivity parameter in period 2 was the constant $A = E[\tilde{A}_2]$, as in our earlier analysis.

We express aggregate welfare of bankers and workers as a function of period 0 risk-taking $x_1$ as

$$\Pi(x_1) = E\{\pi(e_1)\}$$
$$W(x_1) = E\{w_1 + w(e_1)\}$$

where $e_1$ and $w_1$ are determined by risk-taking and the output shock, as given by equation (7).

Observe that in addition to the effects of risk-taking on period 2 wages $w(e_1)$ that we investigated earlier, period 1 wages now depend positively on risk-taking $x_1$ because wages are a constant fraction $(1-\alpha)$ of output and greater risk leads to higher period 1 output since $E[\tilde{A}_1] > 1$. Bankers do not internalize either of the two externalities on period 1 and period 2 wages.

Assuming an interior solution for $x_1$ and noting that $\pi'(e_1) - 1 = (\alpha F_k - 1)k'(e_1)$, the optimal level of risk-taking for the banking sector $x_1^B$ satisfies

$$\Pi'(x_1^B) = E\left[\left(\tilde{A}_1 - 1\right)\pi'(e_1)\right] =$$
$$= E\left[\tilde{A}_1 - 1\right] + \int_0^{\hat{A}_1} \left(\tilde{A}_1 - 1\right)(\alpha F_k - 1)\, k'(e_1) dG(\tilde{A}_1) = 0$$

The banking sector prefers more risk than workers if $W'(x_1^B) < 0$:

$$\begin{aligned} W'\left(x^B\right) &= E\left\{\left[(1-\alpha)F(e_0,1) + w'(e)\right]\left(\tilde{A} - 1\right)\right\} \\ &= \int_0^{\hat{A}} \left[w'(e) - (1-\alpha)F(e_0,1)(\alpha F_k - 1)\, k'(e_1)\right]\left(\tilde{A} - 1\right) dG(\tilde{A}_1) \end{aligned}$$

where we subtracted the expression $(1-\alpha)F(e_0,1)\,\Pi'(x_1^B) = 0$ in the second line, which is zero by the optimality condition of bankers.

Let us impose two weak assumptions that allow us to sign this expression. First, assume $\phi > \alpha$, i.e. leverage is above a minimum level that is typically satisfied in all modern financial systems (1.5 for the standard value of $\alpha = 1/3$), and secondly, that $\hat{A} < 1$, i.e. only low realizations of the productivity shock lead to credit crunches. Note that these two assumptions are sufficient but not necessary conditions.

Now observe that the first term under the integral, $w'(e)$, is always positive. To sign the second term, notice that $F_k(k,1) \leq F_k(k(0),1) = 1/\phi \;\forall\; e \geq 0$ and so the assumption $\phi > \alpha$ implies that $-(\alpha F_k - 1) < 0$. Furthermore, by the second assumption,

the term $(\tilde{A} - 1)$ is negative since the integral is over the interval $[0, \hat{A}]$. As a result, the two conditions are sufficient to ensure that the expression is always negative and that workers continue to prefer less risk-taking than the banking sector.

Intuitively, our distributive results continue to hold when we account for production and wage earnings in both time periods because the distributive conflict stems from the asymmetric effects of binding financial constraints on bankers and workers, which are still present: workers are hurt from binding constraints but do not benefit from over-abundant bank capital; by contrast bankers benefit from extra capital via increased dividend payments. Therefore workers prefer less risk-taking than bankers.

## A.3 Variants of Bailouts

This appendix considers bailouts that come in the form of emergency lending and equity injections and shows that both matter only to the extent that they provide a subsidy (outright transfer in expected value) to constrained bankers that relaxes their financial constraint.

**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 $\left(r^{BL} - 1\right) d^{BL}$ in net present value terms.[12] Assuming that such interventions cannot relax the commitment problem of bankers that we described in section 2.3, they are subject to the constraint

$$rd + r^{BL} d^{BL} \leq \phi R k \tag{1'}$$

**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

$$rd + D \leq \phi R k \tag{1''}$$

Given our assumptions, both types of bailouts are isomorphic to a lump-sum transfer $t$ from workers to bankers.[13]

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 10 (Variants of Bailouts)** *Both workers and bankers are indifferent between providing the bailout via subsidized emergency loans such that* $\left(1 - r^{BL}\right) d^{BL} = t$ *or via subsidized equity injections such that* $q - D = t$*. Conversely, emergency lending and/or equity injections that do not represent a transfer in net present value terms are ineffective in our model.*

**Proof.** 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

[12] 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.

[13] Since labor supply is constant, a tax on labor would be isomorphic to a lump sum transfer.

is $(1 - r^{BL})d^{BL}$. Bankers intermediate $k = e + d + d^{BL}$ where we substitute $d$ from constraint (1') to obtain

$$k = \frac{e + \left(1 - r^{BL}\right) d^{BL}}{1 - \phi R(k)} = k\left(e + \left(1 - r^{BL}\right) d^{BL}\right)$$

Therefore the emergency loan is isomorphic to a lump sum transfer $t = \left(1 - r^{BL}\right) d^{BL}$ 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 the second part of the lemma. More specifically, constraint (1') implies that an emergency loan of $d^{BL}$ at an unsubsidized 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") implies that an equity injection which satisfies $q = D$ reduces private deposits by $\Delta d = -D$ and crowds out an identical amount of private deposits. ■

This 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 transfer allows bankers to raise an additional $\frac{\phi R}{1-\phi R}$ dollars of deposits and expand intermediation by $\frac{1}{1-\phi R}$ dollars in total.

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.

# B Model Parameterization

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

| | |
|---|---|
| $\alpha$ | 1/3 |
| $A$ | 10 |
| $\phi$ | 0.5 |

Figures 4 and 6 depict period 0 welfare and equilibrium. We let $\tilde{A}$ be distributed lognormally with mean $\mu$ and variance $\sigma^2$, with the range truncated to the interval $[0, 2]$. The chosen parameters are

| | |
|---|---|
| $\alpha$ | 1/5 |
| $A$ | 8.1335 |
| $\phi$ | 0.5 |
| $\mu$ | 1.04 |
| $\sigma^2$ | 0.5 |

For illustrative purposes, we decreased $\alpha$ and chose $A$ so as to leave $e^*$ unchanged compared to the previous set of 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.

# C 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). The market value of equity is used since book values do not reflect the losses incurred during the financial crisis in real time. The resulting series is deflated by "Gross Domestic Product: Implicit Price Deflator" (FRED series GDPDEF).

**Panel 2:** 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).

**Panel 3:** The real wage bill is "Compensation of employees, received" (FRED series W209RC1) deflated by "Gross Domestic Product: Implicit Price Deflator" (FRED series GDPDEF).