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Financial policy in an exuberant world

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Abstract

This paper studies optimal financial policy in a world where the financial sector can become excessively optimistic. I decompose the welfare effects of bank capital regulation to demonstrate the effects of exuberance and its interaction with incentive problems in banking. The optimal policy depends not only on the extent, but also on the type of optimism. For example, it is markedly different when the exuberance of banks focuses on neglected downside risk, as opposed to overstated upside opportunities. A central normative conclusion is that "leaning against the wind", by tightening capital requirements in exuberant times, can be counterproductive. I show that two natural metrics, describing the distortion in perceived upside and downside risk, are sufficient statistics for the policy implications of exuberance. My results shed light on the diverse empirical evidence on the relationship between bank capital and risk-taking. Finally, I investigate the sensitivity of these insights under different assumptions about government rationality and paternalism.

JEL Codes: G01, G21, G40.

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Non-technical summary

Modern financial policy is motivated by the concern that banks might generate too much risk for society. There are two commonly cited reasons why risk-taking in the financial sector can be excessive.

One narrative is that banks are *aware* of the risks they are taking, but decide to take them anyway because they do not bear the full, society-wide cost of their actions. For example, banks' incentives become distorted when they are too big to fail, and can expect bailouts whenever they are troubled. This view goes back at least to Walter Bagehot, who hypothesized in 1873 that "any aid to a present bad bank is the surest mode of preventing the establishment of a future good bank".

A second narrative is that, at the peak of a typical credit boom, financial institutions are not even *aware* of the risks they are taking. A growing body of empirical evidence suggests that many people, including finance professionals, are predictably too optimistic in times of rapid growth. As Hyman Minsky put it, "success breeds a disregard of the possibility of failure". This gives a different rationale for regulating the financial sector, namely, to limit the risks created by bouts of irrational exuberance.

Despite the popularity of both views, virtually all economic models that are used to guide financial policy assume that banks are rational. A standard prescription is that, when policy-makers are worried about risk-taking, they should increase the required level of bank capital (e.g., via countercyclical capital buffers under Basel III).

In this paper, I analyze of bank regulation in a world where banks are not only too big to fail, but can also become irrationally exuberant. A central result is that the standard policy of leaning against the wind, with capital-based tools, is not guaranteed to work well in an exuberant boom.

Should financial policy lean against the wind? Does exuberance make strict capital regulation more or less desirable? To address these questions, it is very useful to disentangle the different effects of capital-based financial policy. Conceptually speaking, any increase in required bank capital has two effects. The *mechanical* effect is that more capital increases the bank's resilience by providing a buffer against losses. An additional, *behavioral* effect is that forcing banks to invest their own capital gives them skin in the game, which then reduces their incentive to engage in risky investments. Clearly, both effects need to be taken into account when making policy decisions (a useful analogy is from tax policy: an increase in income taxes mechanically increases revenue, but also has a behavioral effect because people adjust their labor supply; most fiscal authorities take both effects seriously when assessing tax reforms). If either the mechanical (buffer) effect or the behavioral effect (incentives) is muted, then tight capital regulation becomes less attractive.

My analysis shows that irrational exuberance strengthens the mechanical effect, but at the same time weakens the behavioral effect. Intuitively, buffers are needed precisely when banks are investing heavily in risky assets, which is what they choose to do when they have exuberant beliefs. By contrast, exuberant banks do not respond to the incentives provided by capital: They already believe that the probability of failure (and, therefore, of receiving a bailout) is negligible.

The key result I derive from these insights is that capital requirements – while effective *on average* – will lose their effectiveness in the most exuberant credit booms. Whether this happens depends on the nature, as well as the extent, of exuberance. If markets are mainly exuberant about upside risk (e.g., the potential returns from a new technology), then capital requirements become more effective because capital buffers are more socially valuable. If markets are mainly neglectful about downside risk (e.g., the potential for default in the senior tranches of asset-backed securities), then capital requirements become less effective because of the weakened incentives. In addition to providing guidance for policy during credit booms, my framework helps us to reconcile the recent empirical literature, which shows mixed evidence on the historical effectiveness of capital requirements.

1 Introduction

A large part of financial policy is motivated by the concern that banking systems might generate excessive levels of systematic risk during credit booms. The most common narrative is that financial institutions are aware of the risks they are taking, but decide to take them anyway because of bad incentives, that is, because they do not bear the full, society-wide downside of their actions. This can be because banks enjoy implicit government support (Farhi and Tirole, 2012), or because they fail to internalize the full macroeconomic costs of financial crises (Lorenzoni, 2008; Korinek and Simsek, 2016; Farhi and Werning, 2016). This insight underpins most of the literature which analyzes and calibrates optimal capital requirements, leverage taxes and liquidity requirements (e.g. Van den Heuvel, 2008; Corbae and D'Erasmo, 2014; Bianchi and Mendoza, 2017; Bahaj and Malherbe, 2019).

In this paper, I propose a theory of financial policy where, in addition to incentive problems, banks are subject to *irrational exuberance*. Some recent evidence suggests that, at the peak of a typical credit boom, financial investors might not be aware of the risks they are taking. Cheng et al. (2014) demonstrate that Wall Street insiders, even when trading on their personal account, did not act as if they knew of the risk of the 2008 housing crash. In credit markets more widely, Lopez-Salido et al. (2017) show that indicators of bond market sentiment predict subsequent increases in credit spreads. Baron and Xiong (2017) show that indicators of credit booms can be used to predict significant *negative* returns on bank equity. This evidence is consistent with models of exuberant beliefs during credit booms (Gennaioli et al., 2012; Bordalo et al., 2017), and arguably more difficult to reconcile with rational expectations.

In this context, the motivation for this paper is twofold. First, although irrational exuberance during credit booms appears to be a viable hypothesis, very little rigorous analysis is available to guide policy-makers in an exuberant world. Second, the available empirical evidence on the effectiveness of capital regulation is mixed. On one hand, there is evidence that better capitalized banks are less likely, on average, to engage in risk shifting (e.g., Jiménez et al., 2014). On the other hand, Jorda et al. (2017) show that, historically, more bank capital has a very limited effect on the probability of severe credit crises.

How, in principle, should financial policy deal with exuberance? Are the standard leverage-based policies still effective in an exuberant credit boom? How do the problems created by excessive optimism interact with those created by bad incentives? I consider a model that provides concrete insights on these questions. In particular, my analysis suggests that it is not necessarily effective to "lean against the wind" by tightening capital requirements in exuberant booms. This insight also sheds light on the mixed empirical track record of capital regulation.

The model features a single, large bank who is "too big to fail" because the social costs of its bankruptcy would be prohibitive. If the bank fails, the government raises distortionary taxes to bail it out. The bank borrows from households to invest in risky capital, anticipating its bailout subsidy. I allow the bank's beliefs about the returns to investment to differ from the truth, which captures exuberance. For example, banks may overstate the expected value of investment returns, understate their variance, or downplay the likelihood of rare shocks.[1]

This environment is designed to capture the twin problems of incentives and exuberance in the clearest manner. Before describing the results, I briefly discuss its relationship to the wider literature on macro-prudential policy: My model reflects a very simple macroeconomic rationale for policy, because the health of the entire economy hinges on a single bank. The setup in this paper is modular and builds upon the canonical "Tobin's q" theory of risky investment. It could, in principle, be integrated into richer models of banks' incentives, with fire sales (Lorenzoni, 2008), nominal rigidities (Farhi and Werning, 2016), or heterogeneous banks (Davila and Walther, 2019). All of these environments would share the same key ingredient, namely, that banks do not internalize the social downside of their actions.

The government in my model is able to constrain banks' leverage by imposing equity capital requirements. This is a second-best policy problem: While the government can

[1] The same model can be used, in principle, to analyze the effects of banks who are excessively pessimistic.

require that some cents of every dollar invested must be the bank's own money, it cannot dictate the *scale* of the bank's investment.[2] I consider optimal policy under various objective functions: The economics are clearest in a paternalist mode of government, where the government knows the true distribution of investment returns and also knows the distortions in the private sector's beliefs (see Dávila (2014) and Farhi and Gabaix (2017) for similar treatments). Paternalism obviously places a heavy burden of rationality on the public sector. For this reason, I also consider alternative setups where the government knows of potential exuberance but cannot spot it in real time (this, arguably, is where the psychological and econometric evidence leaves us at the moment), or where the government itself is exuberant.

To analyze optimal policy in this model, I take an approach inspired by the canonical treatment of second-best policy in public finance. If the government raises capital requirements, the effect on welfare can be decomposed into two terms, which reflect to common arguments for capital regulation in practice. The first is the mechanical effect of more capital, which creates a *buffer* that shields society from the costs of bank distress (as in optimal tax analysis, this term simplifies considerably due to an envelope condition). The second is the behavioral effect, which arises because the level of capital changes the bank's *incentives* to engage in risky investments, by forcing the bank to have "skin in the game". The behavioral effect, in turn, hinges on the *sensitivity* of the bank's risky portfolio choices to its capital requirements.

I first derive this decomposition in a benchmark rational model, and then adjust the associated expressions for behavioral "wedges" that capture the gap between the bank's beliefs and rational expectations. The main insights of this paper come from the comparative statics of this decomposition in an exuberant world. I derive four further results.

First, I show that the sensitivity of portfolios to capital is muted when banks are exu-

[2] Regulating the scale of individual banks is not a policy proposal that has been seriously considered in practice. Indeed, most regulatory tools in the Basel Accords – as in my model – constrain ratios and leave scale as a free variable. At a more formal level, "nationalization" policies that control every one of the bank's decisions can be shown to be suboptimal in a world where private agents have real-time signals about investment opportunities that the government does not have (e.g., Walther, 2015).

berant. This is because an optimistic bank does not perceive a large probability of receiving a bailout in the first place and, therefore, makes investment decisions that are close to what an unlevered firm would choose.

Second, I study the welfare effects of raising capital requirements when the bank is exuberant. An important intuition is that distorted beliefs can either weaken or strengthen the case for capital regulation. The type – not just the extent – of exuberance is crucial. This is because bailouts introduce an asymmetry into the bank's incentives. For example, in a "neglected tail risk" scenario, where banks understate the likelihood of making huge losses relative to small ones, the sensitivity of the bank's portfolio choices to capital requirements is muted. Increased optimism in this sense weakens the case for tough capital regulation. By contrast, in a "technology boom" scenario, where banks overstate the likelihood of huge positive returns relative to normal ones, the behavioral wedge associated with the overvalued equity tranche increases, and the case for tough capital regulation becomes stronger.

My formal results generalize these insights using a characterization of asymmetric optimism. In particular, I reduce the normative implication of exuberance to two sufficient statistics, which are (i) the perceived overvaluation of the bank's equity tranche (or equivalently, the distortion to Tobin's q), and (ii) the understatement of the probability of bank failure. The first statistic is a measure of upside optimism, while the second measures downside optimism. Exuberance makes capital regulation more attractive if and only if upside optimism is relatively large. An interesting connection is to Simsek (2013), where a similar type of asymmetry matters. However, the implications in my analysis are quite different. In Simsek's work, which does not feature bailouts, private creditors price bonds from the perspective of relatively pessimistic beliefs, and do not discipline upside optimism. In my setup, by contrast, a relatively pessimistic public sector tries to discipline a credit boom, and its policy is actually *more* effective if upside risk is the main concern.

Third, I apply this logic in order to study the welfare effects of exuberance in the sense of overstated returns (first-order stochastic dominance). Consistent with the intuition above, capital regulation does not necessarily become more attractive when the bank becomes exuberant in this sense. Indeed, it may become less attractive in the neglected tail risk scenario, where optimism focuses on relatively bad states of the world.

Fourth, as a complementary exercise, I characterize the same welfare effects when the bank is exuberant about investment returns in the sense of understated risk (second-order stochastic dominance). Perhaps surprisingly, the welfare implications are much clearer in this case. A decrease in perceived risk (in a reasonable parametric region) always weakens the case for capital regulation.

These results stand in contrast to the simple argument that banks should be regulated more stringently in boom times, or when they perceive the world to be safe. Once the mechanical and behavioral effects are taken into consideration, the welfare effects of raising capital requirements are much more nuanced.

My results do not change materially when I relax the assumption of paternalism. When I assume that the government cannot measure banks' beliefs in real time, the effectiveness of capital regulation is weakened further. The welfare effect of raising capital requirements now contains the covariance between the government's *desire* to control banks' incentives and the *effectiveness* of the tools it has available (i.e., capital requirements). In an exuberant world, and in contrast to a model with rational expectations, this covariance tends to be negative: The government is keen to provide high powered incentives in exuberant booms. However, these are precisely the states of the world where the impact of capital on the bank's incentives is muted, because the bank does not consider failure a likely scenario.

Another important implication of these results is that even optimal capital requirements in an exuberant world are unlikely to curb the most severe credit cycles. These insights go some way towards reconciling the empirical evidence cited above: Capital requirements are effective for incentives on average (e.g., Jiménez et al., 2014), but to not smooth out the largest booms and busts (e.g., Jorda et al., 2017).

The structure of the paper is as follows: Section 2 contains the model environment.

Section 3 derives the central welfare effects and their decomposition in a benchmark model where the bank has rational expectations. Section 4 highlights the impact of exuberance on banks' portfolio choices, and Section 5 derives welfare effects with exuberance. Section 6 contains extensions, and Section 7 concludes.

2 Model

There are two dates $t \in \{0, 1\}$, two consumption goods (dollars and capital), and three types of agents: A single bank, a population of identical households, and a benevolent government.

Preferences. Everybody is risk-neutral. Households' lifetime utility is the sum $u_H = c_0 + c_1$ of their consumption. The bank is less patient, discounts the future at rate r, and has utility $u_B = c_0 + \frac{1}{1+r}c_1$. This generates gains from trade: It is better for households to finance up front investments because they are more patient. The government wants to maximize the utilitarian social welfare function $W = u_H + u_B$.

Endowments and taxation. The bank and households have an endowment of consumption at date 0. Households have a further endowment at date 1, and can therefore be subjected to taxation. The government can raise fiscal revenue t at date 1 by levying a tax of $(1 + \kappa)t$ units of consumption on households, where $\kappa > 0$ is the deadweight cost of taxation. I assume that households' endowments are large enough so that their consumption never becomes negative.

Investment technology. The bank can make investments at date 0 to create $i \geq 0$ units of productive capital. This capital can be used in production at date 1 and yields θi dollars at that time. The return on investment $\theta \geq 0$ is a random variable, with cumulative distribution $F(\theta)$, density $f(\theta)$, and full support on the interval $[0, \theta_{max}]$. As in canonical "Tobin's q" models of optimal investment, I assume that investment at date 0 costs $pi + c(i)$ dollars, where p is the replacement cost of capital, and $c(i)$ is a strictly convex adjustment cost.

Beliefs and exuberance. I will allow for misperceptions of this distribution in various scenarios to capture situation where beliefs are distorted. In particular, the bank evaluates the distribution to of returns as $\hat{F}(\theta)$. I will say that the bank is "exuberant" if $\hat{F}(\theta)$ is either more optimistic than $F(\theta)$ in the sense of first-order stochastic dominance, or less risky than $F(\theta)$ in the sense of second-order stochastic dominance. Hence, exuberant beliefs represent a view that the risk-return trade-off for investment is more favorable than it actually is.

Financial contracts. The bank finances itself by issuing bonds with face value b per unit of investment (i.e., the total stock of debt issued is bi, and the bank's leverage ratio is simply b). Any remaining financing is obtained with an equity contribution from its own endowment.

"Too big to fail" problem. The bank is too big to fail: The bank is unable to repay its debt bi, and faces default, whenever the returns to investment $\theta \leq b$. In this situation, the government always steps in and provides a bailout $t = \max\{b - \theta, 0\}$ per unit of capital to save the bank. This bailout policy captures a situation where it is prohibitively costly to allow the financial sector to close down.

The social costs of letting banks fail are the subject of a long literature, which traces them to the social cost of credit crunches or bank runs from date 1 onwards (e.g., Holmstrom and Tirole, 1997), the danger of lost output or harmful fire sales if bank assets are liquidated by non-expert agents (e.g., Gromb and Vayanos, 2002; Lorenzoni, 2008; Shleifer and Vishny, 2010), or demand-driven recessions when prices are sticky (e.g., Korinek and Simsek, 2016; Farhi and Werning, 2016). A related literature studies the issue that government are not generally able to make credible commitments that prevent bailouts (e.g., Freixas, 1999; Acharya and Yorulmazer, 2007; Keister, 2016). For the sake of clarity, I do not introduce additional notation to replicate these insights. I focus on the clearest case where bailouts are comprehensive, and where the government has no commitment.

In anticipation of this bailout, households know that their debt is safe. This implies that the bank can issue bonds at par at date 0, raising bi dollars for investment. However, at date 1, bailouts impose a total fiscal burden of $(1+\kappa)(b-\theta)i$ on households, whenever $\theta < b$. I define the (state-contingent) fiscal burden on households at date 1 as:

$$\phi(b) = (1+\kappa)\max\{b-\theta, 0\} \tag{1}$$

Financial policy. To combat the distortion in incentives that arises from bailouts, the government is able to impose a standard capital ratio requirement on the bank at date 1. This requirement constrains the bank to set $b \leq \bar{b}$, where $1-\bar{b}$ is the minimal permitted ratio of bank equity to investment. This constraint imposes a debt limit per unit of risky investment, or equivalently, a minimal equity contribution. However, I assume that the government cannot impose direct controls on the magnitude i of risky investment. This restriction means that bank regulation is a *second-best* policy problem.

Equilibrium. Given a regulatory debt limit $\bar{b}$, a (subgame perfect Nash) *equilibrium* in this economy is defined by an investment scale $i \geq 0$ and a leverage choice $b \leq \bar{b}$ that maximize the bank's expected utility, anticipating that the government will provide a bailout $t = \max\{b-\theta, 0\}$ per unit of investment at date 1.

3 The rational benchmarks

To set a benchmark, I analyze the equilibrium of an economy where the bank has rational beliefs $F(\theta)$ about investment returns. It is easy to see that, in order to maximize its lifetime utility, a rational bank would make its choices to maximize the expected present value of its profits:

$$\max_{b\leq\bar{b}, i\geq 0} \pi(b,i) \equiv \frac{1}{1+r}\int_{\theta\geq b}(\theta-b)idF(\theta) - pi - c(i) + bi \tag{2}$$

3.1 Optimal leverage

A simple consequence of the bank's maximization problem in (2) is that the regulatory capital constraint $b \leq \bar{b}$ always binds:

Lemma 1. *If there is a capital requirement, then the bank's privately optimal choice of debt b is always the largest permitted value $b = \bar{b}$. If there is no capital requirement, then the privately optimal choice is $b = \infty$.*

Proof. We have

$$\frac{\partial \pi}{\partial b}/i = 1 - \frac{1}{1+r}(1 - F(b)) > 0.$$

$\square$

Intuitively, the bank always wishes to further exploit the bailout subsidy, and does not bear any costs of financial distress. Hence, there is no reason to choose leverage below the permitted limit.

Since the capital requirement is always binding, I will now treat bank leverage b as an effective policy choice variable for the government. In other words, I will evaluate the welfare effects of the government choosing different levels of bank leverage b directly, since this is equivalent to choosing different levels of the binding debt limit $\bar{b}$ (and it is easier to write b without the bar).

Two features of the model are worth discussing in brief: First, capital requirements in the model are always binding, while in reality, banks tend to voluntarily operate above the legal minimum capital ratio. This discrepancy arises because, in this simple model, the bank's problem is static and bailouts are comprehensive. In a dynamic world, banks would clearly have an incentive to keep higher-than-required capital so as to avoid violating future constraints. Another special property of this simple model is that the bank's objective function is convex in b. This implies that, unlike in many macroeconomic models with leverage, Pigouvian taxes would not work in this economy. If the government imposed a linear tax $t_b \cdot b$ on leverage, the bank's objective would remain convex, and the solution would be either $b = 0$ or $b = \infty$. However, one should not view this as a robust prediction of the theory. In a richer model where, for example, the bank bears some of the costs of bankruptcy with some positive probability, its problem would have an interior solution given enough regularity (see, for example, the regularity conditions in Davila and Walther (2019)).

3.2 Optimal investment

Next, I consider the bank's optimal investment problem. The optimality condition for bank investment i, for a given value of leverage b (i.e., a given level of leverage that has been imposed by the government) is

$$c'(i) = q(b) - p + b \tag{3}$$

where we define

$$q(b) = \frac{1}{1+r} \int_{\theta \geq b} (\theta - b) dF(\theta) \tag{4}$$

This is a levered version of Tobin's marginal q: It measures the private value to equity-holders of owning an additional unit of productive capital at date 1, holding constant their leverage b. The optimality condition differs from standard investment theory because of b on the right-hand side. When some leverage is permitted, debt presents a subsidized form of finance, which in turn lowers the bank's weighted average cost of capital (WACC), and makes investment more attractive. Hence, investment is positive whenever Tobin's q is above the replacement cost p, adjusted for the leverage subsidy b.

3.3 Social welfare

Social welfare differs from the bank's objective due to the fiscal burden on households. Let $i(b)$ be the bank's optimal investment choice, which solves (3). Then the bank's maximized utility is proportional to its profits $\pi(b, i(b))$, which are defined in (2). Households do not extract any surplus from their financial contracts with the bank, since their debt is safe and valued at par. However, they suffer the fiscal burden of $\phi(b)$ per unit of investment, defined as in (1), when the government provides bailouts to the bank at date 1.

Hence, if the government imposes that the bank's leverage is b (or, equivalently, if it imposes a binding leverage requirement $b = \bar{b}$), then utilitarian social welfare function in this economy is

$$\begin{aligned} W(b) &\equiv \pi(b, i(b)) - E[\phi(b)i(b)] \\ &= \pi(b, i(b)) - (1+\kappa)\int_{\theta<b}(b-\theta)i(b)dF(\theta) \end{aligned} \tag{5}$$

3.4 Decomposition of local welfare effects

In the rest of the paper, I will focus on the *local welfare effect* $\frac{dW}{db}$ of raising permitted bank leverage by $db > 0$. Of course, one can read each result in two directions: Either in terms raising the maximal permitted leverage by db, or in terms of reducing minimum capital ratios by db. I will use both interpretations, depending on which one is more intuitive, when discussing the results.

In principle, one can take this analysis further by studying under what conditions the welfare function is quasiconcave in b; this is not necessarily the case, neither in this problem nor in most other second-best analyses. Under such conditions, one would be able to translate all of my results into explicit comparative statics on the optimal policy $b^\star$, which would be the solution to $\frac{dW}{db} = 0$.

I choose to focus on local effects for three reasons. First, local effects contain all of the relevant economic effects. Second, it is highly unlikely in reality that regulators will ever calculate and impose truly optimal capital requirements, both due to political constraints and due to the limits of computational feasibility. Capital reform over the past three decades has been decidedly incremental. Therefore, my view is that the most useful quantity to measure is the value of a small change to current policy. Third, local effects allow me to take steps towards isolate the key sufficient statistics that one would need to observe to conduct this measurement (see Chetty, 2009).

As in second-best tax theory, the marginal impact of permitting more leverage db is the sum of two terms:

Proposition 1. *When the bank is rational, the welfare effect of permitting more leverage satisfies*

$$\frac{dW}{db} = \underbrace{\left[\frac{r}{1+r}(1-F(b)) - \kappa F(b)\right] i(b)}_{\text{mechanical effect ("buffer")}}$$
$$- \underbrace{E[\phi]\frac{\partial i}{\partial b}}_{\text{behavioral effect ("incentives")}} \tag{6}$$

where ϕ is the fiscal burden imposed on households, per unit of investment, due to government bailouts at date 1.

Proof. By the envelope theorem, we have

$$\frac{d\pi(b,i(b))}{db} = \frac{\partial \pi(b,i(b))}{\partial b} = 1 - \frac{1-F(b)}{1+r}$$

and therefore, totally differentiating (5) gives

$$\frac{dW}{db} = 1 - \frac{1-F(b)}{1+r} - (1+\kappa)\left[F(b)i(b) + \int_{\theta<b}(b-\theta)dF(\theta)\frac{\partial i}{\partial b}\right]$$

which simplifies to the expression in the proposition. □

The mechanical effect of leverage on welfare consists of two terms. The first term captures excess costs of equity finance, or equivalently, the gains from trade that are realized when patient agents (households) rather than impatient ones (the bank) finance investments. When the impatience parameter $r = 0$, then there are no gains from trade and equity finance is socially free. The second term captures the costs of financial distress. In this model, distress manifests itself through the deadweight cost κ of fiscal support. A useful intuition is to think of the mechanical effect, which trades off the costs of equity finance against the social costs of distress, as a society-wide instance of the "trade off" theory in classical corporate finance (Kraus and Litzenberger, 1973; Myers, 1984).

The behavioral effect comes from the fact that leverage changes the bank's optimal investment. As we will see, leverage encourages more investment, with $\frac{\partial i}{\partial b} > 0$. An envelope argument implies that the effect of this change on bank profits is second-order. The first order change in welfare arises due to the expected social costs of bailouts $E[\phi]$, which scale with i.

These two effects not only mirror the standard decomposition in tax theory, but also reflect two common practical rationales for bank capital. On one hand, the mechanical effect captures the view that bank capital is a "buffer": More leverage mechanically increases the likelihood of failure and, in turn, the social costs of bank distress. On the other hand, the behavioral effect gives an "incentives" or "skin in the game" rationale for bank capital: Due to bailouts, the social costs of investment exceed the private, and an increase in leverage only widens the wedge. Conversely, a stricter capital requirement (i.e., a decrease in b) aligns incentives because it encourages the bank to internalize the downside of its actions.

4 Exuberance

A bank who has distorted beliefs $\hat{F}(\theta)$ about investment returns sets

$$c'(i) = \hat{q}(b) - p + b \tag{7}$$

where

$$\hat{q}(b) = \frac{1}{1+r} \int_{\theta \geq b} (\theta - b) d\hat{F}(\theta) \tag{8}$$

is a behavioral version of Tobin's q. As in Farhi and Gabaix (2017), we can define the behavioral "wedge" induced by exuberance as

$$\tau(b) \equiv \hat{q}(b) - q(b) \tag{9}$$

This wedge measures the distortion to Tobin's q that is brought about by exuberance. Equivalently, it is the overvaluation that the bank attaches to its equity tranche, per unit of investment.

4.1 The level and sensitivity of exuberant investment

With a binding capital requirement b, the exuberant bank's optimal investment is

$$i(b) = A\left(\hat{q}(b) - p + b\right) \tag{10}$$

where the function $A(.)$ denotes the inverse of the marginal investment cost c'. I write $a = A' = \frac{1}{c''} > 0$ for its first derivative (I sometimes omit the dependence of a on its argument to avoid clutter, but this dependence remains implicit).

The sensitivity of investment with respect to leverage b is therefore

$$\frac{\partial i}{\partial b} = a \times \left[\frac{\partial \hat{q}}{\partial b} + 1\right] = a \times \frac{\hat{F}(b) + r}{1 + r} \tag{11}$$

It follows that:

Proposition 2. *The sensitivity of risky investment to leverage is an increasing function of the perceived probability $\hat{F}(b)$ of receiving a bailout at date 1. Therefore, the sensitivity of investment to leverage is smaller when banks are exuberant than in a rational model if and only if $\hat{F}(b) < F(b)$.*

Leverage, combined with limited liability, implies that the bank ignores the downside of its risky investments. A capital requirement has bite and affects behavior because it forces banks to internalize some of this downside. Indeed, this is the classic "skin in the game" motive for capital regulation. However, if an exuberant bank believes that the tail risk $\hat{F}(b)$ of failure is small, then it considers itself to have plenty of skin in the game already. As a result, a marginal increase in capital has a muted effect on its choice of risky investment. Notice that, in the limit $\hat{F}(b) \to 0$, the sensitivity becomes smaller but does not go to zero. This is because, even for an exuberant bank who does not expect to fail or receive a bailout, debt is a cheaper source of finance than equity, so that an increase in permitted leverage lowers the cost of capital and encourages investment.

An important point to note is that only exuberance about *downside risk* blunts the impact of capital requirements in this manner. For example, one can imagine a "technology bubble", where exuberant agents overstate the possibility of abnormally large positive returns relative to average-sized positive returns. The distribution $\hat{F}(\theta)$ in this case differs from the true distribution $F(\theta)$ only in its right tail, and as long as bank default is a left-tail event, the probability of default $\hat{F}(b)$ and, hence, the sensitivity $\frac{\partial i}{\partial b}$ of investment to leverage, are unaffected by exuberance.

5 Optimal regulation with paternalism

Assume that the government knows the true distribution $F(\theta)$ of investment returns. Assume further that the government is aware that the bank is exuberant and perceives the wrong distribution $\hat{F}(\theta)$. We can now consider an optimal paternalist policy, which takes into account the fact that the bank makes decisions given wrong beliefs, but evaluates the consequences of these decisions using correct ones. This environment clearly places a high burden of foresight on the government, but has the advantage of bringing out the underlying economic effects most cleanly. I consider alternative assumptions in the next section.

The description of the welfare effects of bank leverage in Proposition 1 relies heavily on the envelope theorem. In particular, if the bank chooses the rationally optimal investment

$i(b)$, then its true expected profits satisfy $\frac{\partial\pi(b,i(b))}{\partial i} = 0$. With a behavioral bank, however, the envelope argument breaks down and we have

$$\frac{\partial\pi(b,i(b))}{\partial i} = -\tau(b) \tag{12}$$

The welfare effect in the eyes of the paternalist government now contains an additional term:

Proposition 3. *When the bank is exuberant, the effect on welfare of permitting more leverage satisfies*

$$\begin{aligned}\frac{dW}{db} = & \underbrace{\left[\frac{r}{1+r}(1-F(b)) - \kappa F(b)\right] i(b)}_{\text{mechanical effect ("buffer")}} \\ & - \underbrace{[\tau(b) + E[\phi(b)]]\,\frac{\partial i}{\partial b}}_{\text{behavioral effect ("biased incentives")}}\end{aligned} \tag{13}$$

where $\phi(b) = (1+\kappa)\max\{b-\theta, 0\}$ *is the fiscal burden imposed on households, per unit of investment, due to government bailouts at date* 1*.*

The behavioral wedge $\tau(b)$ strengthens the case for providing the bank with incentives to scale down its investment. This is in contrast to the rational case in Proposition 1, where the only reason to incentivize lower investment was the expected fiscal cost $E[\phi]$ of bailouts. In the paternalist mode of government, there is a new case for strengthening these incentives, namely, to "nudge" the bank towards more rational behavior.

This discussion also highlights how the twin problems of incentives and exuberance *interact* in the model. Consider the decomposition of the welfare effects of leverage in Proposition 1. The incentive-based buffer term $-\kappa F(b)$ is multiplied by the scale $i(b)$ of investment, which grows when an exuberant bank has an inflated perception of Tobin's q. In this sense, incentives become more important. However, the fiscal burden term $-E[\phi]$ is multiplied by the sensitivity of investment to leverage, which shrinks when banks are optimistic. Hence, it is unclear whether incentive effects become, on balance, more or less important when banks are exuberant. This ambiguity is at the core of the results in the next section, which paint a mixed picture of the optimal policy responses to exuberance.

5.1 How should regulation react to exuberance?

Proposition 3 permits a clear analysis of how, and why, optimal capital regulation changes when the bank becomes exuberant. There are three terms in the welfare decomposition in (13) that depend on banks' beliefs. First, the mechanical effect of capital regulation (the first term in (13)) scales with the level $i(b)$ of the bank's investment. This satisfies $i(b) = A\left(\hat{q}(b) - p + b\right)$, and therefore increases whenever the bank's exuberant valuation $\hat{q}(b)$ of its equity tranche increases.

Second, the incentive effect of capital (the second term in (13)) depends on the behavioral wedge $\tau(b)$, which we can write as

$$\begin{aligned}\tau(b) &= \hat{q}(b) - q(b) \\ &= \int_{\theta \geq b} (\theta - b)\left(\hat{f}(\theta) - f(\theta)\right) d\theta \\ &= \int_{\theta \geq b} \left(F(\theta) - \hat{F}(\theta)\right) d\theta \qquad (14)\end{aligned}$$

This expression makes clear that $\tau(b)$ is positive related to the difference $F(\theta) - \hat{F}(\theta)$ of probability assessments. This difference grows whenever the bank's beliefs become more optimistic in the sense of first-order stochastic dominance. Moreover, the difference in assessments matters only in relatively good states of the world where the bank is solvent, with $\theta \geq b$. This is because decisions by the private sector (i.e., the bank and its creditors) are affected only by assessments about *upside* risk, since all downside risk is borne by the public sector.

Finally, recall that the sensitivity of optimal investment to leverage features in the welfare effect of in Proposition 3, and satisfies (from Equation (12)):

$$\frac{\partial i}{\partial b} = a\frac{\hat{F}(b)+r}{1+r}$$

As argued in the previous section, the magnitude of the impact of capital on the bank's incentives depends only on the perceived probability $\hat{F}(b)$ of receiving a bailout, and decreases whenever the bank becomes more optimistic. In contrast to the behavioral wedge, the sensitivity of optimal investment responds only to perceived *downside* risk. This term also depends on beliefs indirectly through the inverse curvature $a = \frac{1}{c''(i(b))}$ of the cost function, which is evaluated at the bank's optimal investment $i(b)$. In the propositions that follow, I abstract from this dependence by focusing on quadratic cost functions, for which a is a constant.

5.2 Sufficient statistics for exuberance

Combining the insights above, I now derive the normative consequences of exuberance. In addition to the behavioral wedge $\tau(b)$, it is clearly important to what extent banks' beliefs understate the downside risk, as measured by the probability of receiving a bailout. I denote this understatement as

$$\delta(b) \equiv F(b) - \hat{F}(b) \tag{15}$$

Using this definition, I characterize the effect of exuberance on the effectiveness of capital regulation:

Proposition 4. *Suppose that adjustment costs are quadratic with $c(i) = \frac{i^2}{2a}$. Then capital regulation is more desirable with exuberance (i.e., the marginal welfare benefit $\frac{dW}{db}$ of permitting more leverage is smaller with exuberance than in the rational benchmark) if and only if*

$$E[\phi]\,\delta(b) \leq [(1+r)(1+\kappa)\,F(b) - \delta(b)]\,\tau(b) \tag{16}$$

This proposition completely characterizes the circumstances under which exuberance renders capital regulation more desirable.

This characterization is particularly useful because it highlights two *sufficient statistics* for the normative implication of exuberance. These statistics are the behavioral wedge $\tau(b)$, along with the understatement $\delta(b)$ of downside risk. Indeed, suppose we hold constant all parameters of the model except for the bank's perceived distribution $\hat{F}(\theta)$ of investment returns. Therefore, condition (16) shows that the distribution $\hat{F}(\theta)$ enters into welfare considerations only via the two statistics $\delta(b)$ and $\tau(b)$. No other properties or moments of the distorted distribution are relevant for local welfare effects.

In terms of economic effects, Proposition 4 delineates two kinds of optimism that are important for financial policy. Notice that the term in square brackets on the right-hand side of (16) is always positive.[3] Hence, Condition (16) shows that the marginal benefit of capital regulation is greater under exuberance when the upside wedge $\tau(b)$ is large, and when the downside distortion $\delta(b)$ is small. Intuitively, optimism about downside risk (i.e., an understatement of the likelihood of catastrophic states of the world compared to merely bad ones) weakens the effectiveness of capital requirements. The reason is that the sensitivity $\frac{\partial i}{\partial b}$ of investments to leverage falls with downside optimism. Downside-optimistic banks do not consider default or bailouts to be salient, and therefore do not respond to leverage based incentives in the usual way. By contrast, optimism about upside risk (i.e., an overstatement of the possibility of very good returns) increases the social case for having capital requirements. This is because upside optimism leads the bank to grossly overvalue its equity tranche, which drives the perceived Tobin's q further away from its true value, leading to overinvestment.

It is worth discussing in more detail what happens when condition (16) fails. Suppose that a regulator thinks that banks are rational, and picks the associated optimal capital requirement (where $\frac{dW}{db} = 0$). Suppose that banks become exuberant, and that condition

[3] Using (15), we have

$$(1+r)(1+\kappa)F(b) - \delta(b) \geq rF(b) + \hat{F}(b) > 0.$$

(16) is not satisfied. Proposition 4 implies that the regulator can now locally improve welfare by *relaxing* capital regulation. The intuition is as follows: When banks become exuberant, they will invest too much, which lowers the level of welfare. However, the regulator realizes that she cannot undo this welfare loss by tightening capital requirements, because banks are no longer sensitive enough to this policy. Moreover, the same lack of sensitivity generates a case for relaxing capital requirements. Under rationality, a relaxation of capital regulation was an unattractive policy because it would have worsened the bank's incentives Under exuberance, by contrast, incentives are insensitive to policy, so that it is worthwhile to allows slightly more leverage in order to exploit gains from trade.

The sufficient statistics in Proposition 4 permit a clean analysis of how particular types of optimism affect welfare. In the remainder of this section, I explore exuberance in the sense of overstated returns (first-order stochastic dominance) and understated risk (second-order stochastic dominance).

5.3 Exuberance in the sense of overstated returns (first-order stochastic dominance)

The analysis so far implies that, for a policy-maker deciding whether capital requirements should be lowered or raised, it is not enough merely to know that beliefs have become more optimistic. The type, as well as the extent, of optimism is crucial. One way to appreciate this distinction is to study the consequences of exuberance in the sense of first-order shifts in banks' beliefs:

Proposition 5. *Fix a true distribution $F(\theta)$ of investment returns, and suppose that the perceived distribution $\hat{F}(\theta)$ is more optimistic in the sense of first-order stochastic dominance (i.e., $\hat{F}(\theta) \leq F(\theta)$ for all θ, with strict inequality for some θ). Suppose further that adjustment costs are quadratic with $c(i) = \frac{i^2}{2a}$. Then, for any level b of leverage:*

1. *If the optimism in $\hat{F}(\theta)$ is concentrated on the upside (i.e., if $\tau(b)$ is sufficiently large,*

holding $\delta(b)$ constant), then the marginal social benefit of permitting leverage is smaller than in a rational world. Hence, capital regulation becomes more valuable with exuberance.

2. *If the optimism in $\hat{F}(\theta)$ is concentrated on the downside (i.e., if $\tau(b)$ is sufficiently small, holding $\delta(b)$ constant), then the marginal social benefit of permitting leverage is larger than in a rational world. Hence, capital regulation becomes less valuable with exuberance.*

This proposition characterizes the effect of overstated returns in the sense of first-order stochastic dominance. Using the sufficient statistics derived above, I show that the impact of overstated returns on the desirability of capital regulation is, in principle, ambiguous.

On one hand (case 1 in the proposition), if the bank mainly overstates the likelihood of very good states relative to average ones (e.g., a "tech bubble" in which investors perceive a huge upside from a new technology), then its optimism is concentrated on the upside. Now it is more desirable to conduct tough capital regulation in order to "nudge" the bank towards more sensible levels of investment.

On the other hand (case 2 in the proposition), suppose that the bank understates the likelihood of disastrous states relative to merely bad ones (e.g., a "credit bubble" in which investors neglect the possibility of correlated defaults – see Gennaioli et al., 2012 for a related analysis). In this case, the bank's optimism is concentrated on the downside. It is now less desirable to tighten capital requirements because the sensitivity of bank behavior to capital regulation has been diminished.

5.4 Exuberance in the sense of understated risk (second-order stochastic dominance)

Next, I consider the idea that, in addition to optimism about the level of investment returns, exuberant times may coincide with an understatement of the risk contained in those returns.

For example, in models of overconfidence, investors overreact to good signals and also overstate the precisions of those signals, leading their posterior beliefs to be tighter than they should be. In this case, the policy implications are much clearer:

Proposition 6. *Suppose that the distribution $\hat{F}(\theta)$ is less risky than $F(\theta)$ in the sense of second-order stochastic dominance (i.e., $F(\theta)$ is a mean-preserving spread of $\hat{F}(\theta)$). Suppose further that adjustment costs are quadratic with $c(i) = \frac{i^2}{2a}$. Then, for an interval of leverage levels $b \in [0, \hat{b}]$, for some upper bound $\hat{b}$, the marginal social benefit of permitting more leverage is larger than in a rational world. Hence, capital regulation becomes less valuable with exuberance.*

If the bank perceives less risk in investment returns, then it generally affects both terms in the welfare decomposition in (3) in the same direction: Capital requirements become less desirable. On one hand, the behavioral wedge $\tau(b)$, which represents the overvaluation of the bank's equity, decreases when perceived risk is low, because of the convexity of the equity claim. This lowers the marginal social benefit of giving the banks incentives to reduce its risky investment. On the other hand, the perceived tail probability $\hat{F}(b)$ with which the bank defaults also decreases when perceived risk is low, as long as b is not too large. In this case, the sensitivity $\frac{\partial i}{\partial b}$ increases, which renders capital requirements even more effective. Intuitively, because a smaller bailout subsidy lowers the private net present value of investment, this change counteracts the bank's optimism and reduces the need for capital regulation.

The upper bound on b in this proposition a weak requirement: For example, in the case of symmetric distributions with a single-crossing property (e.g., Gaussian),[4] the default probability $\hat{F}(b)$ is guaranteed to increase with a mean-preserving spread as long as the default boundary $\theta = b$ is a left-tail event, i.e., as long as the probability of a bailout is below 50%. This is likely to be the empirically relevant region: See, for example, the historical frequency of financial crises and fiscal support reported by Reinhart and Rogoff

[4]The single-crossing property of cumulative distributions, along with equality of means, implies and is stronger than second-order stochastic dominance; see Diamond and Stiglitz (1974).

(2009) or Laeven and Valencia (2013), which suggests a crisis about once every 20 years in developed economies.

Notice that Propositions 5 and 6 paint a similar picture about situations where banks neglect downside risk, either in the sense of understating the likelihood of catastrophic states (part 1 of Proposition 5) or in the sense of second-order stochastic dominance (Proposition 6).

In summary, the results in this section paint a nuanced picture about the normative implications of exuberance. On one hand, I have shown that these effects are complex, and that the type of optimism (i.e., optimism about upside and downside risk) is crucial. On the other hand, I have shown that the reasoning can be simplified by boiling the relevant welfare effects down to two sufficient statistics.

So far, I have assumed perfect paternalism: the government in the baseline model knows the true distribution of investment returns, and also knows precisely how the bank's beliefs are distorted. The next section relaxes this assumption.

6 Optimal regulation without paternalism

This section considers two new variants of the model. First, in a setup that I call "semi-paternalism", the government understands the true joint distribution of θ and s, and anticipates the distortion in the banks' beliefs due to sentiment, but still cannot make capital requirements contingent on the realization of sentiment. Second, in a model with a "behavioral government", the government itself evaluates investment returns according to a distorted distribution.

6.1 Semi-paternalism

To reflect the idea that the government cannot always detect banks' exuberance in real time, I study an extension of the model with a random variable $s \in [\underline{s}, \bar{s}]$, which indexes the bank's sentiment about investment returns. Sentiment s is observed only by the bank. Consider a version of the model above where the timing of events is as follows: First, the government imposes a capital requirement without observing sentiment. Second, the bank observes s and makes its investment decision. Thereafter, the game unfolds as in the previous sections.

With sentiment s, the bank perceives investment returns to have the distribution $\hat{F}(\theta|s)$, while the true conditional distribution is $F(\theta|s)$. For example, in the case where the true distribution $F(\theta|s)$ does not depend on s, sentiment contains no real information. Otherwise, s is a genuinely informative signal of returns, although banks' reactions to it may be too strong or too weak. I assume that an increase in sentiment s induces a perceived distribution, as well as a true distribution, that are more optimistic about θ in the sense of first-order stochastic dominance: $\hat{F}(\theta|s)$ and $F(\theta|s)$ are both decreasing in s. I write $G(s)$ for the true marginal distribution of sentiment, and $F(\theta) = \int F(\theta|s)dG(s)$ and $\hat{F}(\theta) = \int \hat{F}(\theta|s)dG(s)$ for the average probabilities *ex ante* (by the law of iterated expectation, $F(\theta)$ is also the true unconditional distribution of θ).

The goal of this exercise is to isolate the effect of the government's uncertainty about sentiment, which distinguishes this case from the paternalist one I have already analyzed. For this reason, I compare the expected welfare effect of allowing more leverage under semi-paternalism to a benchmark scenario where the bank holds the average exuberant beliefs $\hat{F}(\theta)$ with probability one. Let $W(b)$ continue to denote welfare in this benchmark without uncertainty, and with a small abuse of notation, let $W(b|s)$ be realized welfare in case the bank is permitted leverage b and has sentiment s. Similarly, I write $i(b)$, $\hat{q}(b)$ and $\tau(b)$ for investment, Tobin's q and the behavioral wedge in the benchmark, and their counterparts conditional on sentiments are denoted $i(b|s)$, $q(b|s)$ and $\tau(b|s)$ (with formal definitions in the appendix).

The welfare effect of permitting more leverage under semi-paternalism is distinguished from the benchmark by two covariance terms:

Lemma 2. *Compared to a benchmark where the bank holds the average beliefs $\hat{F}(\theta)$ with* *certainty (and which has welfare function $W(b)$), the effect on expected welfare of permitting more leverage under semi-paternalism satisfies*

$$E\left[\frac{dW(b|s)}{db}\right] = \frac{dW(b)}{db} + Cov\left[\frac{r}{1+r}(1-F(b|s)) - \kappa F(b|s), i(b|s)\right] - Cov\left[\tau(b|s) + E[\phi|s], \frac{\partial i(b|s)}{\partial b}\right] + \xi, \tag{17}$$

where ξ is an approximation error, and is proportional to the deviation of investment costs from a quadratic function.

This has an intuitive interpretation. The first covariance is between the marginal benefit of leverage, which trades off gains from trade against a buffer stock of bank equity, and the scale of the bank's investment. If this is positive, then the social benefit of leverage per unit of investment are particularly large in states of the world where investment is booming. This weakens the case for capital requirements. The second covariance is between the total incentive wedge $\tau(b|s) + E[\phi|s]$, which measures the deviation of the bank's incentives from the planner's, and the sensitivity of the bank's investment to leverage. Intuitively, it measures the co-movements between the government's *desire* to control incentives, and the *effectiveness* of the tool (i.e., capital requirements) at its disposal. If this is negative, then in states of the world where it would be good to discourage investment, the bank does not respond strongly. This further weakens the case for capital regulation.

Next, I derive conditions under which I can determine the sign of these covariances:

Proposition 7. *Consider the semi-paternalist model where the government cannot make capital requirement contingent on the bank's sentiment. Let*

$$\eta(s,\theta) = \frac{\partial \hat{F}(\theta|s)/\partial s}{\partial F(\theta|s)/\partial s}$$

denote the responsiveness the bank's beliefs to sentiment, relative to the true conditional *distribution of investment returns θ. If this sensitivity is bounded from below by $\eta(s,\theta) \geq \eta_0 > 1$, and if η_0 is large enough, then the two welfare effects in Lemma 2 satisfy:*

$$E\left[\frac{dW(b|s)}{db}\right] > \frac{dW(b)}{db},$$

so that permitting more leverage is more beneficial when the regulator is uncertain about sentiment.

The economic interpretation is as follows: In an exuberant world, where we cannot fine-tune capital requirements in real time, it is ineffective to impose high capital requirements ex ante. There are two reasons for this, which correspond to the two covariances in (17), and once again reflect the decomposition of welfare effects into the "buffer" and "incentive" rationales. First, the social cost of capital regulation is amplified by uncertainty, because bank leverage is particularly socially valuable in states of the world where the bank operates at a large scale. Second, in states where it is socially beneficial to control incentives, i.e. when exuberance is strong (large s), the bank's investments choices are actually insensitive to capital requirements. The government's desire to regulate is negatively correlated with the effectiveness of its tools. This effect partially defeats the point of capital regulation.

In addition to this simple argument, the proposition needs to impose a bound on the sensitivity of beliefs to sentiment. To see this, it is useful to discuss the mathematics of the proof. The first (easier) half of the proof shows that the first covariance term in (17) is always positive (with strict inequality whenever sentiment s contains some true information). This is because the "buffer" argument for preventing leverage is less relevant in good times (i.e., high s), which is exactly when the bank chooses larger investment scales and hence creates larger gains from trade. The second half shows that the second covariance in (17) is negative as long as the bank's beliefs are sufficiently responsive – relative to the true ones – to sentiment. There are two competing forces. On one hand, the bank's behavioral wedge $\tau(b|s)$, which measures the deviation of its equity valuation from the truth, is larger in good times as long as $\eta(s,\theta) > 1$. Its slope with respect to s is proportional to the relative responsiveness of the bank's beliefs to sentiment. On the other hand, the expected bailout $E[\phi|s]$ is larger in bad times, but its slope with respect to s is proportional to the responsiveness of *true* beliefs to sentiment. If the bank's relative responsiveness is large enough, the former effect dominates, which implies that the first term in the covariance is increasing in s and, hence, correlates negatively with the sensitivity $\frac{\partial i(b|s)}{\partial b}$ of optimal investments to leverage.

Another interesting feature to note is that the sufficient conditions in the proposition have no bite in a rational world. The proposition focuses on cases where the bank's beliefs are more responsive to sentiment than the true ones, i.e., $\eta(s,\theta) > 1$. In a rational world, by contrast, we have $\eta(s,\theta) \equiv 1$. In other words, the bank reacts to the true information contained in sentiment s, then the behavioral wedge $\tau(b|s) = 0$, and the government's desire to control incentives is dominated by the expected bailout $E[\phi|s]$. This term is large in bad states of the world, when the sensitivity $\frac{\partial i(b|s)}{\partial b}$ is also large. Hence, in a rational world, uncertainty can generate a *stronger* case for capital regulation, because there is no trade-off between desire to regulate and policy effectiveness. The new result, in the context of this paper, is that concerns about exuberance can reverse this argument force and, hence, make capital requirements less attractive.

6.2 Exuberant government

Now I return to the baseline model of exuberance from Section 4, where banks hold fixed and distorted beliefs $\hat{F}(\theta)$,[5] but assume that the government itself agrees with these beliefs and calculates welfare accordingly. Also assume that both the government and the bank are exuberant, that is, that $\hat{F}(\theta)$ is more optimistic than the true distribution $F(\theta)$ in the sense of first-order stochastic dominance.

Write $\hat{W}(b)$ for the behavioral government's perception of welfare. By a similar argument

[5] It is also easy to analyze the case with uncertain sentiments s, as in the last subsection, with an exuberant government. This analysis is available on request, but not many new insights emerge from it.

to Proposition 1, the expected welfare effect of permitting more leverage in this world is

$$\frac{d\hat{W}}{db} = \left[\frac{r}{1+r}(1-\hat{F}(b)) - \kappa\hat{F}(b)\right] i(b) - \hat{E}[\phi]\frac{\partial i}{\partial b}, \tag{18}$$

Comparing this to the welfare effect perceived by a rational government in (13), there are three main differences. First, the governments beliefs $\hat{F}(b)$ affect the perceived mechanical welfare effect of more leverage (the first term in (18)). Second, the incentive effect of more leverage (the second term in (18)) no longer contains the behavioral wedge $\tau(b)$. Since the government agrees with the bank's probability assessment, the only reason to push the bank towards lower investment is to reduce the expected bailout. Third, the expected bailout itself is evaluated according to the government's distorted beliefs, written $\hat{E}[\phi]$.

Since the behavioral government is more optimistic than the rational one, it is easy to see that all three effects go in the same direction:

Proposition 8. *If both the bank and the government are exuberant, the perceived welfare effect of increasing leverage is always smaller than in the paternalist model where the government is rational.*

The intuition is straightforward: All the costs of permitting leverage arise in bad states of the world. Hence, an exuberant government who discounts these states has greater incentives to permit leverage than a more cautious government who evaluates welfare according to the true distribution of investment returns.

To summarize, the lessons from this section are twofold: First, in the semi-paternalist world where the government is rational but cannot spot exuberance in real time, capital regulation is less effective, on average, than in the fully paternalist benchmark. This is because capital requirements are especially ineffective in states of the world where steep incentives are needed. Second, as would be expected, the case for capital requirements is weaker when the government itself becomes exuberant.

7 Conclusion

To conclude, this paper provides a formal analysis of optimal financial policy in a world where the private financial sector may be subject to bouts of irrational exuberance. Based on recent evidence, this seems to be an important case to consider alongside the standard, incentive-based rationale for financial regulation. I have taken a price-theoretic approach to give insights into the welfare effects of bank capital regulation in an exuberant world. At a high level, my results yield two sets of conclusions – one normative and one positive – and associated directions for future research.

On the normative side, it is not clear that "leaning against the wind" is the optimal policy when the private financial sector is exuberant and optimistic about the future returns to investment. Indeed, the rationale for this policy is very nuanced and depends on the *nature* as well as the *extent* of optimism. If optimism focuses on neglected downside risk, or if banks understate the variability of returns, capital requirements actually become less desirable in exuberant times. There ought to be a debate, and future research, about what other policy tools may be effective in this situation.

The positive implication of my analysis is that we should expect capital requirements to reduce bank risk taking, and to smooth out credit cycles at the margin. However, we should not expect them to be effective in terms of curbing the most exuberant credit booms, or in terms of preventing the crises that tend to follow such booms. This testable prediction could be *used* to compare and reconcile different results in the existing empirical literature.

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A Proofs

A.1 Proof of Proposition 4

Let $\bar{W}(b)$ denote welfare in the rational benchmark, as characterized in Proposition 1; and let $W(b)$ denote welfare in a behavioral model, as in Proposition 3. Similarly, let $\bar{i}(b)$ and $i(b)$ denote rational and exuberant optimal levels of investment. Define

$$\Delta(b) \equiv \frac{dW(b)}{db} - \frac{d\bar{W}(b)}{db}$$

From Propositions 1 and 3, we have

$$\begin{aligned}\Delta(b) = &\left[\frac{r}{1+r}(1-F(b)) - \kappa F(b)\right]\left[i(b) - \bar{i}(b)\right] \\ &- E\left[\phi\right]\left[\frac{\partial i}{\partial b} - \frac{\partial \bar{i}}{\partial b}\right] - \tau(b)\frac{\partial i}{\partial b}\end{aligned}$$

With quadratic adjustment costs,

$$i(b) - \bar{i}(b) = a(\hat{q}(b) - q(b)) = a\tau(b)$$

and

$$\frac{\partial i}{\partial b} = a\frac{\hat{F}(b) + r}{1+r}, \quad \frac{\partial \bar{i}}{\partial b} = a\frac{F(b) + r}{1+r}$$

Simplifying yields

$$\Delta(b) = a\left\{\frac{E\left[\phi\right]}{1+r}\delta(b) - \left[(1+\kappa)\, F(b) - \frac{1}{1+r}\delta(b)\right]\tau(b)\right\} \tag{19}$$

and, hence, $\Delta(b) \leq 0$ if and only if (16) holds, as required.

A.2 Proof of Proposition 5

Fix a level of leverage b and a true distribution $F(\theta)$. Then the right-hand side of condition (16) is a positive constant. Consider any sequence of exuberant distributions $\hat{F}(\theta)$ for which $\delta(b) > 0$ is a constant, and either $\tau(b) \to \infty$ or $\tau(b) \to 0$. Recall that the factor on $\tau(b)$ on the right-hand side is strictly positive. When $\tau(b) \to \infty$, the right-hand side of condition (16) diverges to $+\infty$, so the condition holds. When $\tau(b) \to 0$, the left-hand side of (16) converges to 0, and the condition does not hold. Combining with Lemma 4 establishes the claims in the proposition.

A.3 Proof of Proposition 6

With second order stochastic dominance, we have $\delta(b) \geq 0$ for small enough b; let $\bar{b} = \inf\{b : \delta(b) < 0\}$. Moreover, noting that $\hat{q}(b)$ is the expectation of the convex function $(\theta - b)^+$ under $\hat{F}(\theta)$, we have $\tau(b) \leq 0$. Hence, the left-hand side of condition (16) is positive, while the right-hand side is negative, so the condition holds. Combining with Lemma 4 establishes the claim in the proposition.

A.4 Proof of Lemma 2

Proof. In the benchmark where the bank has beliefs $\hat{F}(\theta)$ with probability 1, the welfare effect $\frac{dW}{db}$ is given by (13). Conditional on sentiment s, by a parallel argument, we get

$$\begin{aligned}\frac{dW(b|s)}{db} &= \left[\frac{r}{1+r}(1-F(b|s)) - \kappa F(b|s)\right] i(b|s) \\ &- [\tau(b|s) + E[\phi|s]] \frac{\partial i(b|s)}{\partial b}\end{aligned}$$

where

$$i(b|s) = A(\hat{q}(b|s) - p + b)$$

and

$$\tau(b|s) = \int_{\theta \geq b} \left(F(\theta|s) - \hat{F}(\theta|s)\right) d\theta$$

with

$$\hat{q}(b|s) = \frac{1}{1+r}\int_{\theta \geq b} (\theta - b) d\hat{F}(\theta|s)$$

Taking expectations across $s \in [\underline{s}, \bar{s}]$,

$$\begin{aligned}E\left[\frac{dW(b|s)}{db}\right] &= E\left[\frac{r}{1+r}(1-F(b|s)) - \kappa F(b|s)\right] E\left[i(b|s)\right] \\ &+ Cov\left[\frac{r}{1+r}(1-F(b|s)) - \kappa F(b|s), i(b|s)\right] \\ &- E\left[\tau(b|s) + E[\phi|s]\right] E\left[\frac{\partial i(b|s)}{\partial b}\right] \\ &- Cov\left[\tau(b|s) + E[\phi|s], \frac{\partial i(b|s)}{\partial b}\right]\end{aligned}$$

By the law of iterated expectations,

$$E\left[\frac{r}{1+r}(1-F(b|s)) - \kappa F(b|s)\right] = \frac{r}{1+r}(1-F(b)) - \kappa F(b)$$

and

$$
\begin{aligned}
E\left[\tau(b|s) + E[\phi|s]\right] &= \int_s \int_{\theta \geq b} \left(F(\theta|s) - \hat{F}(\theta|s)\right) d\theta dG(s) + E[\phi] \\
&= \int_{\theta \geq b} \left[\int_s F(\theta|s) dG(s) - \int_s \hat{F}(\theta|s) dG(s)\right] d\theta + E[\phi] \\
&= \tau(b) + E\left[\phi\right]
\end{aligned}
$$

With quadratic costs, $A(x) = ax$, and

$$
\begin{aligned}
E[i(b|s)] &= a \\
E\left[\frac{\partial i(b|s)}{\partial s}\right] &= aE\left[\frac{\hat{F}(b|s) + r}{1 + r}\right] = a\frac{\hat{F}(b) + r}{1 + r} \\
&= E\left[\frac{\partial i(b)}{\partial s}\right]
\end{aligned}
$$

Combining the above, we obtain Equation (17). □

A.5 Proof of Proposition 7

Proof. By Lemma 2, it is sufficient to show that, under the proposed condition we have:

$$
Cov\left[\frac{r}{1+r}(1 - F(b|s)) - \kappa F(b|s), i(b|s)\right] > 0 \tag{20}
$$

$$
Cov\left[\tau(b|s) + E[\phi|s], \frac{\partial i(b|s)}{\partial b}\right] \leq 0 \tag{21}
$$

By first-order stochastic dominance, both variables in the first covariance in (20) are strictly increasing in s and, hence, the covariance is strictly positive.

For the covariance in (21), the second argument $\frac{\partial i(b|s)}{\partial b}$ is decreasing in s, using first-order stochastic dominance and (11). Recalling the definition of ϕ, we can write

$$\begin{aligned} E[\phi|s] &= (1+\kappa)\int_{\theta\leq b}(b-\theta)f(\theta|s)d\theta \\ &= (1+\kappa)\int_{\theta\leq b}F(\theta|s)d\theta \end{aligned}$$

We can therefore write the first argument of the covariance as

$$\xi(s) \equiv \tau(b|s) + E[\phi|s] = \int_{\theta\geq b}\left(F(\theta|s) - \hat{F}(\theta|s)\right)d\theta + (1+\kappa)\int_{\theta\leq b}F(\theta|s)d\theta$$

Differentiating, and imposing the proposed condition on $\eta(s,\theta)$, we get

$$\begin{aligned} \xi'(s) &= \int_{\theta\geq b}(\eta(s,\theta)-1)\left|\frac{\partial F(\theta|s)}{\partial s}\right|d\theta - (1+\kappa)\int_{\theta\leq b}\left|\frac{\partial F(\theta|s)}{\partial s}\right|d\theta \\ &\geq (\eta_0-1)\int_{\theta\geq b}\left|\frac{\partial F(\theta|s)}{\partial s}\right|d\theta - (1+\kappa)\int_{\theta\leq b}\left|\frac{\partial F(\theta|s)}{\partial s}\right|d\theta \end{aligned}$$

For any given family of true conditional distributions $F(\theta|s)$, it follows that $\xi'(s)$ is strictly positive for large enough η_0, which completes the proof. $\square$

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