Macroeconomic Shocks and Banking Regulation*

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Abstract

The recent crisis has brought to the fore the cyclical properties of banking regulation. Countercyclical buffers and enhanced capital requirements meant to stabilize banks' balance sheets across the cycle are not costless, and a delicate balance needs to be reached between providing incentives to generate value and discouraging excessive risk-taking.

The paper develops a model in which, in contrast with Modigliani-Miller, outside equity and capital requirements matter. It analyses banking regulation in the presence of macroeconomic shocks and studies the desirability of self-insurance mechanisms such as countercyclical capital buffers or dynamic provisioning, as well as "macro-hedges" such as CoCos and capital insurance.

Keywords: Banking regulation, macroeconomic shocks, countercyclical capital requirements.

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1 Introduction and motivation

It is commonly agreed that microprudential banking regulations, Basel I and (even more so) Basel II, amplify the impact of the economic cycle on balance sheets and make banks more vulnerable to downturns. To reduce this procyclicality and to strengthen banking stability, Basel III requires more capital and introduces countercyclical capital buffers. More generally, banking recapitalization has been high on policymakers' agenda despite concerns about deleveraging and a potential credit crunch. Moreover, many scholars, most notably Admati et al. (2010), have called for much higher capital ratios than required even under Basel III, arguing that equity is not really costly.

Admati et al's theoretical point goes as follows: existing models of capital adequacy in banking and corporate finance emphasize the need for inside equity, i.e. equity brought by those, such as managers and large monitors (venture capitalists, block shareholders), who can destroy value and therefore must be given skin in the game. But the legal and regulatory concepts of equity include outside equity, i.e., equity held by passive shareholders who do not necessarily impact the corporate strategy. Admati et al's reasoning is that, while inside equity is, as is widely acknowledged, costly/ scarce, outside equity is not. The cushion created by equity could be reinforced by adding, say, money market funds as an extra line of defense to protect depositors. Put differently, while inside equity is relevant, outside equity and debt obey the assumptions of Modigliani-Miller (1958) and so the social cost of outside equity equals that of debt. Implications of this line of reasoning for capital adequacy requirements are then unclear; indeed, existing capital adequacy requirements and current attempts at reinforcing bank capital cannot be rationalized without addressing the very relevance of outside equity.

While its theoretical, uncalibrated nature precludes any judgment about the desirability of Basel III reforms, this paper argues against the view that the social cost of substantially heightened capital requirements are negligible. It extends Dewatripont-Tirole (1994 a, b)'s theory of outside capital structure to allow for the presence of macroeconomic shocks. It investigates the consequences of such shocks for existing regulation and reform proposals.

The theory is based on the idea that managerial incentives depend on how broader corporate choices are affected by performance. Policies that validate managerial choices following good performance, and constrain/downsize/liquidate after a bad one serve as a powerful incentive for managerial compliance. While forward-looking profit maximization implies that bygones are bygones and poor (good) performance remains unpunished (unrewarded), shareholder control in good times and a shift in control from shareholders to debtholders after poor performance by contrast rewards (penalizes) managers for their good (poor) performance. Thus the paradigm belongs to the family of models that view debt as a disciplining device (Townsend 1979, Gale-Hellwig 1985, Aghion-Bolton 1992, Hart-Moore 1994); like in this literature, debt can operate through downsizing or liquidation after low profits. The implications of debt control are broader (including all actions that are not aligned with managerial preferences). And especially, the model predicts a role for outside equity, unlike the rest of the literature.

The desirability of toughening corporate policies after poor performance however applies only to that part of the performance that is under managerial control. From Holmström (1979)'s insulation principle, the fate of economic agents should a priori not be conditioned on events, such as macroeconomic shocks, that lie outside their control. Investigating the consequences of this basic principle leads to the following conclusions:

- The Basel I and II policy of ignoring macroeconomic shocks in the determination of capital adequacy requirements leads to too much intervention in recessions and too much leniency in booms (the regulation rewards the "lucky dollar").

- Forbearance, a commonly adopted supervisory policy of de facto lowering capital adequacy requirements during a recession (in conflict with Basel rules), does a better job at insulating managers from macroeconomic shocks; but it creates sizable incentives for gambling by then-undercapitalized banks.

- Optimal regulation requires that macroeconomic shocks be automatically neutralized, so as to keep the incentives of the investor in control unchanged. This neutralization can take the form of dynamic provisioning or a (Basel III) countercyclical capital buffer provided self-insurance is feasible; if it is not, macro-hedging such as capital insurance or CoCos can achieve this goal.

- General equilibrium properties of these alternative instruments are an important topic for research.

The paper is organized as follows: Section 2 sets up the basic model. Section 3 introduces macroeconomic shocks. Section 4 briefly discusses general equilibrium aspects and section 5 concludes.

Finally, the existing literature on macroprudential regulation has a rather different focus. Our paper focuses on how prudential regulation should deal with macro shocks, not on other reasons that have been invoked as "externality-based" rationales for macroprudential regulation, such as interconnectedness (e.g., Allen-Gale 2000, Caballero-Simsek

2010, Rochet-Tirole 1996), fire sales (e.g., Lorenzoni 2008), surveillance of asset bubbles, or widespread maturity mismatches (e.g., Farhi-Tirole 2012).

2 A simple setting

In the spirit of the branch of the security design literature initiated by Aghion and Bolton (1992), who argued that securities are characterized not only by income rights but also by control rights, we analyzed in Dewatripont and Tirole (1994a) a managerial moral hazard problem in which it is optimal to discipline the manager at least in part through performance-contingent corporate choices.

We argued that, if the corporate actions meant to discipline the manager are not contractible, and if, as is generally the case, optimal corporate choices are time-inconsistent, investors in control of corporate choices must face an incentive that differs from firm-value maximization, in order to be induced to take the ex-ante optimal action. This “double moral hazard problem” in turn calls for the presence of at least a second group of outside investors who receive the remainder of the revenue of the firm. This second group of investors is similar to the "budget breaker" introduced by Holmström (1982) to address moral hazard in teams.

Suppose that the action the manager prefers (call it C for "continuation") is riskier than the action she likes less (call it L for "liquidation"); the efficient provision of managerial incentives calls for allocating control to investors with a concave, i.e., "debt-like", return after bad performance, and a convex, i.e., "equity-like", return after good performance. This suggests that the second-best optimum can be implemented with standard debt and (outside) equity, with contingent control: equity control after good performance, and debt control after bad performance. The model thus predicts securities which consist of realistic bundles of control and income rights.

This section describes the objective functions, the timing, the second-best optimal performance-contingent action choice, and finally the latter’s implementation through an appropriate debt-equity ratio.

2.1 Timing

As discussed above, the model involves both managerial and corporate choices. A banking manager/entrepreneur has no financial resources to cover an investment cost, and turns to investors for financing. The capital structure- that is, the allocation among investors of contingent cash-flow and control rights- is designed at this financing stage. The manager then exerts either a high or low effort. This effort results in a good or bad short-term performance. This short-term profit is verifiable, and so conditions the allocation of control. After observing a signal about future prospects, the group of investors put in control by the realization of the short-term profit then chooses a corporate action or strategy; it can liquidate or more generally take a conservative policy (action L), continue (action C), or gamble for resurrection (action G). Finally, the verifiable long-term profit is realized.

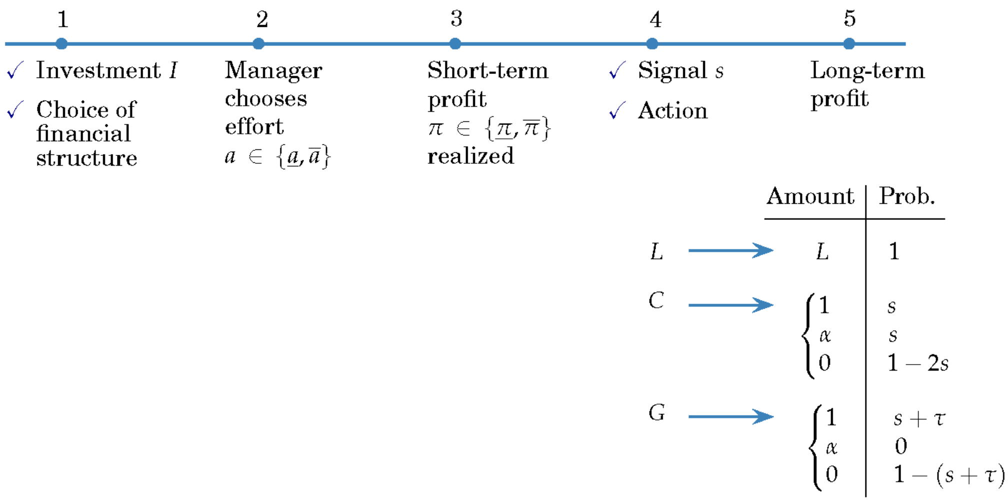

Figure 1: Timing

More precisely, the timing, depicted in Figure 1, goes as follows:

1. *Financing.* The manager/entrepreneur raises an amount I for investment from outside investors. The capital structure concomitantly designed specifies the incentive scheme of the investor in control at stage 4 below.

2. *Moral hazard.* Manager chooses unobservable effort $\mathsf{a} \in \{\underline{\mathsf{a}}, \overline{\mathsf{a}}\}$. The high effort costs her Ψ, the low effort costs her nothing. We assume the bank has a positive NPV only if $\overline{\mathsf{a}}$ is chosen.

3. *Short-term profit realization.* The verifiable short-term profit $\pi \in \{\underline{\pi}, \overline{\pi}\}$ is realized. A high effort increases the probability of a high short-term profit: $\Pr(\overline{\pi}|\overline{\mathsf{a}}) = \overline{\mathsf{p}} > \Pr(\overline{\pi}|\underline{\mathsf{a}}) = \underline{\mathsf{p}}$. We assume that $\underline{\pi} < 0 < \overline{\pi}$. We interpret a negative profit as a shortfall

of income to honor some liabilities to workers or suppliers, liabilities that are senior to investor claims on the firm; such liabilities have to be paid at stage 4, either out of liquidation proceeds, or by investors if they choose to avoid liquidation.

4. *Exercise of corporate control.* An unverifiable signal $s \in [\underline{s}, \overline{s}]$ (with $\overline{s} < 1/2$), independent of π, is observed. After observing this signal, investors in control (as specified at stage 1) select (unverifiable) action $A \in \{L, C, G\}$. Action L ("liquidation") generates ℓ for sure. The other two actions generate a random "long-term profit" later on, at stage 5.

5. *Long-term profit realization.* The long-term profit is verifiable and independent of previous managerial effort. Its probability distribution thus depends only on the choice of corporate strategy A:

   - Action C ("continuation") generates 1 with probability s, α with probability s and 0 with probability $1 - 2s$.
   - Action G ("gambling") generates 1 with probability $s+\tau$ and 0 with probability $1 - s - \tau$.

We assume that $\ell + \underline{\pi} > 0$, so that, if at stage 3, $\underline{\pi} < 0$ is realized, the liabilities it represents can be repaid at stage 4 out of ℓ if action L is chosen. On the other hand, an investor who wishes to choose another action has to first pay up $-\underline{\pi}$ since the other actions may not deliver any income.

For expositional convenience, all players are risk-neutral and do not discount the future. The problem is interesting only if it is optimal to induce the high managerial effort, which we will posit. More importantly, we assume that monetary incentives do not perfectly align managerial and investor incentives; for simplicity, we capture this through an assumption of extreme risk aversion: The manager does not respond at all to monetary incentives; that is, she demands a given wage, normalized to 0, and does not enjoy money beyond that level (as shown in Dewatripont-Tirole 1994a, the results extend to the case in which the manager responds to monetary incentives, as long as the moral hazard problem is inconsistent with the realization of the first best). By contrast, the manager cares about the corporate action choice: She receives private benefit B unless the liquidation action L is selected. We assume that $B > \Psi/(\overline{p} - \underline{p})$.

The manager's utility function is therefore:

$$-\Psi \mathbf{1}_{(a=\overline{a})} + B\mathbf{1}_{(A \neq L)},$$

where $\mathbf{1}_{(.)}$ denotes the indicator function.

For conciseness, we also assume that action C is not only the action preferred by the manager, but also the ex-post efficient one. In particular, it yields a higher expected long-term profit than action L even after the worst possible signal. In turn, we assume that action L generates in expectation more long-term profit than action G, even for the most favorable signal. These two assumptions can be concisely expressed by the following condition:

$$\bar{s} + \tau < \ell < \underline{s}(1 + \alpha). \tag{1}$$

The ex-post efficiency of action C combined with the managerial preference for that action implies that it is always optimal to continue after a good short-term performance. Continuation then both increases investor return and boosts managerial incentives.

Anticipating on our treatment, the rationale for introducing action G is to create scope for asset substitution by shareholders in control of an undercapitalized bank. Asset substitution will be a concern under a negative macroeconomic shock, and the presence of action G will make forbearance undesirable.

The verifiability of profits gives value to equity as the "residual claim" (by contrast, only "hard" claims have value in models with unverifiable profits). The non-verifiability of the action choice introduces a second moral hazard problem to the model besides the managerial effort choice, and therefore creates a need for endowing the investor in control with an incentive scheme, so as to appropriately discipline the manager. Finally, adding a continuous unverifiable signal s (which is defined so as to be higher, the higher the gain of choosing action C over action L) will allow us to uniquely define the capital ratio which implements the second-best managerial incentive scheme.

2.2 Managerial incentives

Ex-post profit maximization is inconsistent with the manager choosing $\bar{a}$, which is costly for her; for, ex-post profit maximization leads to a continuation rule ("always C") that is independent of past profit and so to a managerial utility that does not respond to the choice of effort.

We already noted that regardless of the value of s, continuation is optimal after the high profit $\bar{\pi}$: It maximizes the ex-post profit *and* it strengthens the incentive to choose the high effort $\bar{a}$. By contrast, inducing some liquidation after $\underline{\pi}$ is necessary to induce the high effort $\bar{a}$. The least-cost approach to inducing managerial effort is to liquidate when the short-term profit is $\underline{\pi}$ and the expected long-term profit is low.[1] Hence ignoring

[1] Strictly speaking, and because of our extreme assumption on managerial preferences, the man-

implementation issues (the topic of subsection 2.3), there should be liquidation after $\underline{\pi}$, iff $s \leq s^*$ with s^* defined by:

$$[1 - (1 - \overline{p}) \Pr(s \leq s^*)]B - \psi = [1 - (1 - \underline{p}) \Pr(s \leq s^*)]B$$

or:

$$(\overline{p} - \underline{p}) \Pr(s \leq s^*)B = \psi.$$

The objective to induce the high effort in the least-cost fashion thus uniquely defines the threshold s^*.

Result 1: The optimal way to induce the manager to exert the high effort is to choose action L *after bad short-term performance whenever the unverifiable signal is lower than* s^*.

The higher the cost of effort ψ, or the lower the private benefit B, the higher the threshold s^*, and thus the higher the probability $\Pr(s \leq s^*)$ of liquidation after a low short-term profit.

2.3 Allocation of control

We now show that standard securities, debt and equity, can be chosen so as to implement the contingent policy described in subsection 2.2. We let D denote the face value of debt. Debt is here a claim on the bank's long-term profit; it is senior to the shareholders' claim. As we will show below, we can implement the second best with a moderate debt level, i.e. $D < \alpha$.

We first determine under which conditions shareholders choose action C when in control. First, note that they never pick action L for any (nonnegative) level of debt, since this safest action is not ex-post efficient and furthermore debtholders are senior claimants relative to shareholders. Neither do shareholders choose action G for an arbitrary signal s, provided the level of debt is not too high, that is, provided that D satisfies:

$$(s + \tau)(1 - D) \leq s(1 - D) + s(\alpha - D),$$

ager/entrepreneur only aims at minimizing liquidation subject to obtaining financing from outside investors. This least-cost (i.e. constrained-efficient) solution is only weakly optimal for the manager/entrepreneur in general. However, with more general preferences (monetary responsiveness for example), or with variable project size and size-dependent private benefits ($B(I)$), it would be *strictly* optimal.

or:

$$\tau(1 - D) \leq s(\alpha - D).$$

Call $D^+(s)$ the maximum level of debt such that this condition is satisfied:

$$D^+(s) = \frac{s\alpha - \tau}{s - \tau}. \tag{2}$$

Note that the level $D^+(s)$ is positive (from (1)), rises with s and is strictly less than α (and therefore less than 1); it approaches α as τ goes to 0.

Now that we have determined shareholders' action choice conditional on profit, let us consider the following capital-adequacy-requirement implementation mechanism: Shareholders are in control provided they keep debt less than or equal to some D^* to be defined below; posit for now that D^* is lower than $D^+(s^*)$ and bigger than the net proceeds from liquidation $\ell + \underline{\pi}$:

$$\ell + \underline{\pi} < D^* < D^+(s^*). \tag{3}$$

Otherwise, control shifts to debtholders who, we assume for now, choose action L. Assume further that the bank has a level of (long-term) debt equal to D^* at the initial stage (we shall discuss this later).

If $\pi = \overline{\pi} > 0$, at stage 3, shareholders have control and can distribute up to $\overline{\pi}$ as dividend without increasing leverage, and they find it in their interest to distribute this maximal amount. Indeed, shareholders do prefer to receive dividends whenever this does have any impact on control allocation: Not maximally distributing dividends just raises the value of the debt, without any impact on total surplus.

If instead $\pi = \underline{\pi} < 0$, shareholders lose control unless they re-invest the absolute value of $\underline{\pi}$ into the bank. They are willing to recapitalize provided that:

$$\underline{\pi} + s(1 + \alpha - 2D^*) \geq 0. \tag{4}$$

Indeed, shareholders obtain nothing when control shifts to debtholders, provided they go for liquidation. Alternatively, shareholders can recapitalize the bank (at the cost of the absolute value of $\underline{\pi}$) and implement action C, which gives them an expected revenue of $s(1 - D^*) + s(\alpha - D^*)$.[2]

Clearly, recapitalization is more attractive, the higher the signal s. One can define D^*

[2] This reasoning assumes that $\alpha \geq D^*$, because shareholders are meant to receive $\max\{0, \alpha - D^*\}$. But we have already assumed that $D^* \leq D^+(s^*)$ (an assumption we discuss later on), which implies $D^* < \alpha$.

such that:

$$\underline{\pi} + s^*(1 + \alpha - 2D^*) = 0,$$

or:

$$D^* = \frac{s^*(1+\alpha) + \underline{\pi}}{2s^*}, \tag{5}$$

and this implies that shareholders keep control if and only if $s \geq s^*$.[3]

To ensure that our capital-adequacy-requirement mechanism implements the desired actions, we finally have to check that debtholders find it preferable to liquidate instead of paying $-\underline{\pi}$ to workers and suppliers and go for continuation whenever $s \leq s^*$.[4] This requires:

$$\ell \geq 2s^*D^* = s^*(1+\alpha) + \underline{\pi}, \tag{6}$$

an assumption which will be satisfied provided $\underline{\pi}$ is low enough.

Remark 1. Our various conditions require some assumptions on the possible values of $\underline{\pi}$. First, there is condition (6). Second, the above condition defining D^* implies, together with (3), that $\underline{\pi}$ should not be too low, or more precisely that:

$$\ell + \underline{\pi} < \frac{s^*(1+\alpha) + \underline{\pi}}{2s^*}. \tag{7}$$

The third relevant technical condition relevant is that the prescribed debt level D^* does not induce shareholders to pick action G when they are in control. This means $D^+(s) > D^*$ for all $s \geq s^*$. Since $dD^+/ds > 0$, this requires $D^+(s^*) > D^*$, or:

$$\frac{s^*\alpha - \tau}{s^* - \tau} > \frac{s^*(1+\alpha) + \underline{\pi}}{2s^*}. \tag{8}$$

Once again, this will be satisfied provided $\underline{\pi}$ is low enough.

Taken together, conditions (6) to (8) require that $\underline{\pi}$ must satisfy:

$$\ell + \underline{\pi} < \frac{s^*(1+\alpha) + \underline{\pi}}{2s^*} < \min\left\{\frac{\ell}{2s^*}, \frac{s^*\alpha - \tau}{s^* - \tau}\right\}. \tag{9}$$

Since $\overline{s} < 0.5$, these conditions are not incompatible. We thus have the following result:

[3]Note that, for $s = s^*$, shareholders are indifferent between leaving control to debtholders and paying $-\underline{\pi}$ in order to choose action C. Since we have assumed that $D^* < D^+(s^*)$, this means that, when $s = s^*$, they strictly prefer leaving control to debtholders to choosing action G. Since the payoff associated with G is increasing in s, this also means shareholders will not be tempted to pay $-\underline{\pi}$ in order to choose action G for any $s < s^*$.

[4]We do not need to consider action G, as debtholders always prefer C to G (from $(s+\tau)D^* < 2sD^*$ for all s and conditions (2) and (3)).

Result 2: Assuming conditions (1) and (9), one can implement the performance-contingent corporate action choice described in Result 1 through a cap on leverage defined by D^**. This cap can alternatively be reinterpreted as a minimum capital requirement* $(\mathrm{I} - \mathsf{D}^*)/\mathrm{I}$.[5] *Preventing shareholders from choosing the gambling action* G *requires that* $\mathsf{D}^* < \mathsf{D}^+(\mathsf{s}^*)$.

Recapitalization is less attractive, the higher D^* is, which is a form of "debt overhang". Moreover, when $\underline{\pi}$ is lower, so must D^* be: otherwise, one will have excessive liquidation, because shareholders will too often be unwilling to recapitalize the bank.

Remark 2. While contingent control and non-contingent securities can implement the second-best optimum, so can non-contingent control and contingent securities. The model only predicts (i) the performance sensitivity of the compensation of the investors in control, and (ii) the need for a second group of outside investors to "balance the books". But, for the sake of realism, it makes sense to implement the second-best with standard securities.

2.4 Discussion

Renegotiation. Would renegotiation among investors make the capital structure irrelevant and thus bring us back to a Modigliani-Miller world? While properly allocated control by an investor who does not maximize ex-post profit boosts managerial effort, once effort has been chosen, it is in the community of investors' interest to renegotiate away the ex-post inefficiency. As discussed in Dewatripont and Tirole (1994a), for the Modigliani-Miller irrelevance-of-financial-structure theorem not to apply, one needs either imperfect renegotiation or the inability for the manager to avoid concessions and to fully free-ride on the renegotiation process. For example, when faced with the prospect of liquidation, the manager might be forced in the renegotiation process to give up some of her financial compensation (in the more general version of this model, in which the manager responds to monetary incentives) or to disclose some way of increasing profitability under continuation at the detriment of her private benefits.

Rationale for regulation. As for the rationale for regulating banks, our book (Dewatripont and Tirole, 1994b) argued that banks (and for similar reasons insurance companies, pension funds ...) differ from regular firms in that their debtholders, i.e. depositors, are

[5] Allowing $\overline{\pi}$ to be distributed, and requiring $\underline{\pi}$ to be 'neutralized', maintains the capital ratio unchanged, at least when we take a historical-cost-accounting approach. Such an approach makes sense because the true value of the bank only varies as a function of the *unverifiable* signal s, for which there is thus no market-based measurement.

not able to exert control rights appropriately and need to be "represented". Disciplining managers appropriately then calls for a depositors' representative. The exercise of regulatory control is for example key to preventing banks in trouble from "gambling for resurrection" by raising interest rates on deposits and attracting funds from depositors who "count" on implicit or explicit support from the authorities (deposit insurance fund) or from taxpayers.

Deposit insurance in this respect has a further benefit beyond its primary goal, the prevention of bank runs (Diamond-Dybvig 1983). If coupled in bad times with control rights allocated to either the deposit insurance fund or to the regulator entrusted with the defence of depositors, deposit insurance provides the representative of passive depositors with an incentive scheme. Under this view, the depositor representative's mission is to minimize losses borne by the insurance fund, or equivalently maximize the value of deposits.

Lower leverage? Let us now return to the assumption that the manager/entrepreneur chooses to start at stage 1 with debt level D^*, and not with a lower level, that is, leverage is the maximum level compatible with the capital adequacy requirement. Actual regulation indeed only sets a cap on leverage, and not a prescribed level. But in fact, setting D below D^* would compromise financing as this would reduce the probability of liquidation after low short-term profit and therefore violate the manager's incentive constraint (in this sense, debt no longer acts as a managerial disciplining device). So, here, the manager/entrepreneur is induced to choose a debt level no lower than D^*, even though we have not introduced any tax advantage of debt or "bailout premium".

Risk weights and the Basel regulation regime. The above setting is an oversimplified version of the Basel regulatory regime. In particular, it lacks risk weights (whether exogenously chosen – as in Basel I – or ratings- or internal-model-based – as in Basel II and III). However, a simple reinterpretation of the model demonstrates the benefits of risk weights. Introduce a stage-1 choice of investment that increases its riskiness, in that $\underline{\pi}$ decreases and $\overline{\pi}$ increases (this is a mean-preserving spread if $\overline{p}\ \overline{\pi} + (1 - \overline{p})\underline{\pi}$ remains constant). From (5), D^* must decrease. That is, an increase in risk must result in a lower allowed leverage ratio, which is exactly what risk weights on assets, as used since Basel I, achieve.

In sum, our setting indicates that the "Basel philosophy", namely a (risk-based) cap on leverage, is not incompatible with optimality. This assertion should however be accompanied by two caveats. First, it is of course only qualitative, since our setting does not allow us to discuss the calibration of the Basel capital adequacy ratio. Second, our treatment so far has ignored macroeconomic shocks, which we now turn to.

3 Macroeconomic shocks

We now add a macroeconomic shock. Recall that Basel I and II do not make any distinction between micro- and macro-shocks: In the context of our model, this means that the maximum leverage that shareholders have to satisfy is D^*, whether low short-term profits are the result of poor individual performance or a negative macroeconomic shock. What if we introduce a *verifiable* macroeconomic shock however? Assume for example that a macro shock transforms short-term profit π into $\pi + \varepsilon$, where $\varepsilon \in \{\underline{\varepsilon}, \overline{\varepsilon}\}$ can be positive (boom) or negative (recession). By contrast, the random variable s remains idiosyncratic (and nonverifiable). Then we can immediately say a number of useful things.

3.1 Basel I/II regulations do *not* treat optimally macroeconomic shocks

Incentive theory tells us that "pure noise" should not enter an optimal incentive scheme (Holmström, 1979) or, to cast it in terms of the above setting, that the probability of liquidation should be $\Pr(s \leq s^*)$ after poor individual performance $\underline{\pi}$, regardless of the value of ε.

This means that ignoring the distinction between an idiosyncratic and a macroeconomic shock as Basel I or II do, namely asking shareholders to bring in the absolute value of $\underline{\pi} + \varepsilon$ back into the bank if they want to keep control, is suboptimal: *it will lead to excessive liquidation in a recession, that is, action* L *chosen for some* s*'s higher than* s^**, and insufficient liquidation in a boom, that is, action* C *chosen for some* s*'s below* s^*.[6]

Basel I/II regulations may also have another cost in terms of managerial incentives. If the probability of a boom is large enough, continuation is more likely for profit $\underline{\pi}$ than in the absence of macroeconomic shock and so the manager no longer has an incentive to exert effort at stage 2: She then bets on the occurrence of a macroeconomic boom that will in part compensate for her lack of effort.

The idea that one should add a "macroprudential" perspective to the "purely microprudential" Basel I/II approach is by now well accepted (for a voice calling for such a

[6]The cutoff signal $s^*(\varepsilon)$ in state ε is then given by

$$\underline{\pi} + \varepsilon + s^*(\varepsilon)(1 + \alpha - 2D^*) = 0$$

(provided that macroeconomic shocks are not too large).

macroprudential approach before the 2007-8 financial crisis, see Borio, 2003). Note however that the idea is often cast more in terms of the dangers of "procyclicality", that is, in terms of its impact on third parties – amplifying impact of deleveraging through fire sales, domino effects, ... – than in terms of the incentives it implies for bank managers and investors.

3.2 Forbearance is not optimal either

While an explicit macroprudential approach is a new concept in regulatory rules, macroeconomic shocks have not always been "ignored" in regulatory practice. In fact, "forbearance" is a frequent response to banking crises caused by negative macroeconomic shocks. For example, as has been widely documented (see Dewatripont and Tirole (1994b) for a summary), in the US 1980's Savings and Loans crisis, a reduction of the capital ratio as well as regulatory accounting changes reduced the recapitalization requirements of S&L's (i.e. allowed a rise in leverage) when these institutions were hurt by a sharp rise in interest rates and then by a recession. In terms of our setting, this amounts to allowing shareholders to put only the absolute value of $\underline{\pi}$ back into the bank to keep control, rather than the higher absolute value of $\underline{\pi} + \underline{\varepsilon}$, namely to "ignore" the negative $\underline{\varepsilon}$.[7]

Such forbearance is also suboptimal: While it partially protects the bank manager against excessive liquidation (it does not do it fully, since the rise in leverage reduces their incentive to recapitalize), it does alter shareholder incentives by allowing leverage to increase in a recession. If debt goes beyond $D^+(s)$, shareholders choose action G, namely gambling for resurrection. In fact, this practice was widespread in the S&L crisis.[8]

The point to stress here is that neither Basel I/II nor forbearance "remove noise" from both the *shareholders'* and *managers'* incentive schemes. The next subsections investigate various schemes that neutralize the impact of macroeconomic shocks on shareholders and thereby maintain appropriate discipline on managers.

[7] This was also done to some extent in 2008, and one of the many purposes of Basel III is to eliminate that by "focusing only on high-quality capital". Interestingly, there seems to be a pattern where existing regulation is "twisted" after big recessions, which leads to a need for a new regulation.

[8] Gambling occurs whenever

$$\frac{1+\alpha-2D^+(s)}{1+\alpha-2D^*} > \frac{\underline{\pi}+\underline{\varepsilon}}{\underline{\pi}}.$$

3.3 Transient macroeconomic shock: dynamic provisioning and countercyclical capital buffers

Suppose first that the economy goes through a deterministic cycle of booms and recessions; in order to rule out potentially complex multi-period incentive schemes, we assume that managers live for only one period (where each period is made up of stages 1 through 5); the action L should here be viewed not as a liquidation, but as a conservative policy that yields a safe payoff to the investors and no private benefit for the manager. Moreover, after having chosen action L, the debtholder representative will find a new set of shareholders willing to invest at the start of the following period. Finally, by defining $\underline{\pi}$ and $\overline{\pi}$ adequately, we can always assume that $\underline{\varepsilon} + \overline{\varepsilon} = 0$.

In this extreme situation, the bank can *self-insure* and does not need to contract for a macro hedge. In the spirit of the Spanish "dynamic provisioning" policy of the last decade or Basel III's countercyclical capital buffer, assume that when $\overline{\varepsilon}$ is realized, it has to be "hoarded" so as to be "released" when $\underline{\varepsilon}$ is realized one period later: Assuming that the interest rate on the safe store of value in the economy is 0, we can then get back to a D^* defined by:

$$\underline{\pi} + s^*(1 + \alpha - 2D^*) = 0.$$

This scheme forces the bank to be better capitalized in booms and allows it to use retained earnings accumulated during a boom to eliminate its need for recapitalization in a recession. Dynamic provisioning and the countercyclical capital buffer however share the usual drawbacks of self-insurance; for example, it cannot address the possibility of i.i.d. shocks (there might be multiple negative shocks in a row), let alone the case of permanent shocks. The requirement for a negative shock to be "transient" in the sense adopted here is therefore strong; we here mean a certitude of a future offset.

3.4 Macro hedges: capital insurance and CoCos

The simplest way of keeping managerial and investor incentives unchanged in the presence of macroeconomic shocks is to keep capital ratios constant and arrange *automatic* cash inflows and outflows. That is, the bank may contract with a provider of insurance who commits to bring cash in a recession and receive money from the bank in a boom.

This solution is straightforward, and admits several variants considered below. But it raises difficult, general-equilibrium issues that we will only touch on in Section 4. Indeed risk-shifting only displaces the problem: Given that the shock is by definition a macro shock, who will bear it? How will the insurance provider cope with its own dual incentive problem? Clearly some economic agents must bear the macroeconomic risk.

"Macro hedging" is related to the possibility of capital insurance, as suggested by Kashyap et al. (2008): When a bad shock occurs, the bank automatically receives capital as an insurance payment, against a premium paid to a private or public insurance fund.[9] The appeal of capital insurance is that it complies with Holmström's precept of "fully neutralizing" shocks that are not controlled by management.

Capital insurance can in a sense be interpreted as a "prefunded bailout". Such a "bailout" is not a source of moral hazard provided that the insurance payment offset solely the macroeconomic shock. To take an example, let us keep the assumption that $\underline{\varepsilon} + \overline{\varepsilon} = 0$ and assume that $\underline{\varepsilon}$ and $\overline{\varepsilon}$ are equiprobable. Consider now a contract where the insurer makes a payment $\overline{\varepsilon}$ to the bank when $\varepsilon = \underline{\varepsilon}$, and receives $\overline{\varepsilon}$ from the bank when $\varepsilon = \overline{\varepsilon}$. The bank will still be liquidated whenever $\pi = \underline{\pi}$ and $s \leq s^*$, regardless of whether the macroeconomic shock is favorable or unfavorable.

In our setting, the optimal policy can alternatively be implemented through a capital insurance line or the use of contingent convertible bonds (CoCos).[10] The trick for the capital insurance implementation is to define maximum leverage D^* as before and to have the bank sign a capital insurance contract which 'neutralizes' the macro shock represented by $\overline{\varepsilon}$ and $\underline{\varepsilon}$. Alternatively, one can introduce CoCos, such that a fraction is converted into shares in a recession. This conversion wipes out an amount Δ of debt $\widehat{D}$ ($> D^*$) such that:

$$\underline{\pi} + \overline{\varepsilon} + s^* \left(1 + \alpha - 2\widehat{D}\right) = 0$$

and:

$$\underline{\pi} + \underline{\varepsilon} + s^* \left(1 + \alpha - 2(\widehat{D} - \Delta)\right) = 0.$$

Thus, capital insurance and CoCos look pretty similar in partial equilibrium.

3.5 Macroeconomic shock to prospects

We have so far assumed that the macroeconomic shock affects the short-term profit. Alternatively, this shock could affect prospects. Suppose that the distribution of s is conditioned by the macro shock ε (the cumulative distribution function, $G(s\,|\,\varepsilon)$, is a function of ε). Efficiency requires that the same cutoff s^* be applied when short-term

[9] In Dewatripont and Tirole (1994b), we had a similar idea when we advocated procyclical deposit insurance premia (with the insurer being then the public sector).

[10] CoCos are convertible bonds for which the conversion into shares is contingent on a specified, verifiable event. We here take the contingency to be a macroeconomic event, although more generally CoCos may be contingent on all kinds of verifiable events. See for example Bolton and Samama (2012) for a discussion of various alternatives.

profit is $\underline{\pi}$, regardless of the realization of ε. Letting Pr $(s \leq s^*) \equiv E_\varepsilon$ [Pr $(s \leq s^* | \varepsilon)$], the manager's incentive constraint is still

$$\Pr\,(s \leq s^*)(\overline{p} - \underline{p})B = \Psi.$$

The optimum can therefore be implemented through a maximum leverage D^* given by the familiar expression:

$$\underline{\pi} + s^*\,(1 + \alpha - 2D^*) = 0.$$

3.6 Summing up

The results of this section can be summarized as follows:

Result 3: Capital adequacy requirements can be rationalized as a way to achieve optimal managerial discipline, at least in the absence of macroeconomic shocks. Neutralizing such shocks in order to maintain optimal managerial discipline is at odds with Basel I or II: a macroprudential approach is needed for optimal managerial discipline, and not solely to avoid macroeconomic procyclicality.

Result 4: The key to optimality is to keep the incentives of both managers and shareholders unaffected by the macroeconomic shock. This requires an automatic injection of fresh capital in a recession: like Basel I/II, forbearance is suboptimal.

Result 5: When positive and negative shocks alternate deterministically, requiring banks to build up capital in booms and allowing them to release it in recessions, as with dynamic provisioning or with countercyclical capital buffers, is an appropriate solution.

Result 6: When macroeconomic shocks are random, requiring banks to subscribe to a capital insurance scheme, or to issue CoCos, is an appropriate solution. While such a scheme looks de facto like a prefunded bailout, it does not lead to moral hazard provided that it is fully tied to exogenous macroeconomic shocks.

4 Towards a general equilibrium setting

While general equilibrium questions are very interesting, they lie beyond the scope of this paper. Let us therefore content ourselves with a couple of remarks on this topic.

CoCos and capital insurance both "do the job" from the point of view of an efficient bank governance. They differ, though, in the amount of cash that is supplied to the bank from outside. With CoCos, a fraction of long-term debt is de facto written off, which restores shareholders' incentives without external intervention. By contrast, capital insurance brings direct cash to the bank.

Given that the shock is macroeconomic, a natural question for capital insurance is: Who will supply the corresponding cash in case of a negative shock? The first possibility is that the economy has enough stores of value that can be employed to this purpose. However if there is a shortage of existing stores of value (to some extent, there must be, otherwise hedging would be costless in our framework), these stores of value command a premium, and insurance against macroeconomic shocks is limited. And in fact, the same question arises concerning the use of CoCos. While CoCos do not require an injection of external cash in a recession, the loss they incur from conversion during a recession is necessarily priced out and therefore must reflect the shortage of cash in that macroeconomic state.

A second way to address macro shocks is to have the state bring liquidity in bad states of nature. Liquidity provision by public authorities in the case of macro shocks is then useful for two reasons (Holmström-Tirole 1998, 2011): (i) their taxing powers give them a unique access to the future income of consumers; and (ii) they can act ex post after learning the state of nature, while private ex-ante investments in liquid assets are wasted in the case of positive macro shocks. This argument, applied to the implementation of optimal managerial incentive schemes through capital regulation, points at some superiority of state-provided over privately-provided capital insurance (assuming away political economy problems).

5 Conclusion

Our model departs from Modigliani-Miller in that the allocation of control rights to outside investors serves to discipline managers, and income rights of outside claims influence investors' exercise of their decision rights. It predicts that debt and (outside) equity can be used to deliver efficient contingent control. Together with the representation hypothesis, the model rationalizes typical capital-based banking regulation: after bad performance, control shifts from equityholders to a debtholder representative unless equityholders recapitalize the bank.

Benchmarking actual regulation against the theoretical paradigm, we noted that Basel I/II regulation fails to "control" for macro shocks: the regulations are too tough in recessions and too lenient in booms. Forbearance ("ignoring" the recession by allowing lower capital ratios) is also inadequate as it leads to gambling for resurrection. What is needed is "real money" to control for the macro shock. In the case of positive and negative shocks that deterministically offset each other over time, dynamic provisioning or the Basel III countercyclical capital buffer are appropriate ways to deal with these shocks. In the case of random macro fluctuations, capital insurance or CoCos, both indexed on the macro shocks, are appropriate.

We conclude with two alleys for future research. First, and as discussed in section 4, a key issue with macroeconomic shocks is, in general equilibrium, that of the supply of macro hedges. Second, a number of recent models have posited substantial benefits to stores of value that are safe or nearly safe (e.g. Stein 2012, Gennaioli et al forthcoming); it would be interesting to analyse implications of such an hypothesis for the cost of outside equity or that of contingent instruments such as CoCos.

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