Disincentives for Risk-Taking in Mortgage and Other Financial Markets: Adjusting Management Remunerations

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Abstract

Guaranteed Financial Institutions can structure portfolios with imbedded options to take on excessive risk without paying for it. This provides an incentive to take on higher risk. This paper proposes variants on Contingent Convertible (CoCo) bonds to be mandatorily included in the management remuneration package as a disincentive to taking higher risk. We show how the conversion ratios of the CoCo bonds can affect managers' appetite towards risk-taking and how incentives can be set up to have management make choices consistent with those made under efficient pricing.

Keywords: Financial Institutions, Contingent Convertible Bonds, Management Incentives, Risk-Taking, Dodd-Frank Act

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1. Introduction

It is understandable that focus on the link between financial institutions (FIs) and the Great Recession has been primarily on risk-taking, bankruptcy and bailout costs. However, economic cost is better measured in terms of misallocated resources, both from mispricing risk and from macroeconomic costs of financial panics. Much of the discussion of regulating risk-taking by banks has focused on capital requirements as a way of preventing bankruptcy. Similarly, the Dodd-Frank Wall Street Reform and Consumer Protection Act [1] requires that an equity position be held by managers of private securitization deals that have loans with certain observable characteristics, such as low downpayment.

A critical problem in the Great Recession was, however, risks that were unobservable to investors and regulators. For instance, so called "Alt-A" mortgages, which were one of the major sources of default losses, generally had high downpayments and credit scores, but low documentation and unobservable (to investors) risks. Similarly some pools of loans had higher concentration levels (e.g., more geographic or product concentration) than believed. The focus of this paper is on the role of incentives for controlling unobserved risk for those who manage risk and on deriving the optimal risk structure for management compensation.

The problem is similar to well-known problems of conflicts of interest between shareholders and bondholders in corporate finance. This has been well studied in the case of banks and deposit insurance (e.g., Buser *et al* 1981). More recently, Blum (1999), Kim and Santomero (1988), Bris and Cantale (1998), and Mitchener and Richardson (2013) have discussed the roll of capital and risk-taking. As is pointed out in Kupiec (2013), the discussions of incentives for controlling bank risk have not focused much on risk-taking by management, as opposed to CEOs. We propose a structure that can be easily imposed on mangers of a financial institution. Kupiec (2013) looks at a similar problem with a different model.

[1] The Dodd-Frank Act proposed, among other things, improving the process of securitization by requiring securitizers to retain not less than 5% of the credit risk (for some types of pools) and establishing contingent capital requirements to ensure securitizers, loan originators and loan suppliers not take up higher risk than necessary.

The economic need for incentives comes from shareholders' desire to align management's interests with their own. We begin by assuming that this means paying them in equity shares. It is well known that managers of information-sensitive financial institutions, such as banks or managers of securitization deals, can make money for themselves and shareholders by structuring portfolios with imbedded options to take on excessive risk before depositors or regulators or investors can catch on to them. The role of capital in limiting costs of risk-taking has been a major part of the ongoing "Basel Process" as well as the Dodd-Frank Act.[2] The discussion has focused on how much capital is right and against what type of assets.

A part of that discussion has been contingent capital. Calomiris and Herring (2011), for instance, propose Contingent Convertible Bonds (or CoCo bonds) as a tool that can incentivize financial institutions to control risk and raise additional capital in times of trouble. Sundaresan and Wang (2013), Hilscher and Raviv (2012), Flannery (2009) and Lai and Van Order (2013b) also provide discussion and implications for incentives. Squam Lake (2010, 2013) develops a proposal for CoCo requirement and shows that CoCos can play a role alongside a standard minimum book-value-of-equity-ratio requirement. A much discussed resolution is putting CoCo bonds and similar contingent claims into remuneration packages as a way of unraveling risk-taking incentives. For securitization the discussion has been about requiring deal-makers to hold an equity interest in the deal, but not other tranches in the deal.

We derive an optimal risk structure for management compensation. We do this in a model where FIs should, absent asymmetric information or subsidies, be indifferent among assets, and investors should be indifferent among liability structures. In such a model any structure that favors one type of asset over another will affect its price and distort asset selection and pricing. We introduce asymmetric information as a distortion, and we analyze ways of unraveling its effects.

The central result is that neither CoCo bonds nor equity pieces in structured deals provide the best incentives. Rather managers have optimal incentives to control risk if

[2] The online version of the original document can be found from http://www.gpo.gov/fdsys/pkg/PLAW-111publ203/pdf/PLAW-111publ203.pdf.

they are required to hold a portfolio that reflects the overall liability composition of the structure, because holding only equity provides incentives to maximize volatility. Furthermore, the best strategy to control risk-taking beyond the neutral level, for instance in order to control macro costs of bank runs, is not to allow managers to hold equity positions at all, but rather to hold the safest liabilities of the bank or securitization deal.

2. Risk-Taking

We assume a simple form of FI, a one period bank or structured securitization deal that is made up of risky, non-dividend paying assets that are funded by a structure containing an equity piece plus a debt piece. The assets are worth V, equity is positive and equal to E, and the debt is comprised of zero coupon bonds that promise to pay off D at maturity time, T, if V exceeds D. If we assumed the same information by all agents, then absent guarantees or subsidies, there is no reason for FI management or investors to care about choices of either assets or liabilities. This is our "bench-mark" model, which we take to be socially optimal.

We assume that there is an elastic supply of loans available that FIs can purchase at a price equal to the expected present value of their cash flows. They know the details of the cash flows, loan by loan, but have to go to the market to raise money for the loans. However, investors in the FIs do not have loan level information, so there is an information asymmetry problem. In our model, anything that causes one type of asset structure to be preferred over another will raise its price and is therefore a distortion. The first best policy is to return managers to indifference among structures, which is consistent with the Modigliani-Miller irrelevance theorem.

As in Merton (1977), we assume the model runs for one period. If $V > D$ at the end, the debt is paid, and shareholders get the residual. Otherwise the insurer pays off the depositors in the case of a bank, or the debt holders lose the difference. We assume that V is stochastic but that interest rates are constant, so that we can stay within the tractable Black-Scholes (1977) framework. To this we adjust the option for FI managers to control the distribution of future values of V.

Let the value of the FI's assets, V, be a random variable following a geometric Brownian motion; that is,

$$dV_t = \mu_v V_t dt + \sigma_v V_t dz \tag{1}$$

where μ_v and σ_v are, respectively, the instantaneous mean and volatility of dV_t, and dz is a Wiener process. At termination, T, the value of the losses to debt holders or deposit insurers is given by the value of a put on the assets:

$$P_T = Max[D - V_T, 0]. \tag{2}$$

Assuming either complete markets or risk neutrality by traders, expressions (1) and (2) generate a value of the default option accepted by the debt owners which is the Black-Scholes formula for a European put with exercise price D:

$$P_t = DN(-d_2) - V_t N(-d_1) \tag{3}$$

where $$d_1 = \frac{\ln(V/D)_t + r(T-t) + \frac{1}{2}\sigma_V{}^2 T(T-t)}{\sigma_V \sqrt{T-t}},$$

$$d_2 = \frac{\ln(V/D)_t + r(T-t) - \frac{1}{2}\sigma_V{}^2 (T-t)}{\sigma_V \sqrt{T-t}}$$

r is the risk-free rate and t is the time at which the debt is issued. The value of the equity piece is the value of a call on the assets at the end of the period, which is equivalent to the put in equation (3) plus the initial equity, which is, $V_t - De^{-rt} + P_t$.

We further assume that management is paid with shares in the FI, and maximizes its own wealth. With the value structure of the bank as above, risk choice for management is to maximize wealth in a one-period structure by choosing the maximum value of P_t, which leads to maximizing volatility, because P_t is increasing in σ_v. We assume that risk is imperfectly observable, so that the best regulators (or investors) can do is to limit asset choices to maximum and minimum risk levels, σ_v^l and σ_v^h.[3] We next turn to ways of managing the risk-taking behavior by management.

3. "Skin in the Game"

A common way of controlling risk is through capital requirements. While it is clear that this will lower the value of the default put option, it will not change the incentive to take as much risk as possible, and so asset decisions will still be distorted. We analyse incorporation of virtual CoCo bonds (for banks) or mezzanine type tranches (for securitization deals) into the management remuneration packages as a way of controlling risk.

Risk can be mitigated if there is some benefit to surviving. A possible benefit is from "franchise value" (see Lai and Van Order (2013a)). Another is for the regulators to create it. CoCo bonds bear such incentives, depending on the details of their conversion. Suppose managers are given both shares, equal in amount to *k*% of existing shares, and CoCo bonds with face value *B*. We assume a simple conversion rule – CoCo bonds will be converted to equity at the end of the period if the FI is insolvent ($V < D$). Alternately in securitization deals this amounts to a mezzanine piece that is converted before the senior piece.

For simplicity, assume that interest rates are zero. Like shareholders, the position of management at the beginning of the period is a call on the bank's assets. The advantage of this call is that the management now gets *B* plus payoffs from shares if exercised. Then the payoffs to management at the end of the period are (dropping the time-subscript *T*):

$$W^m = \begin{cases} B + k(V - D) & if \quad kD \le kV \\ \\ 0 & if \quad kV < kD \end{cases} \tag{4}$$

[3] For instance, the missing information could come from not knowing the level of diversification of the portfolio, with maximum and minimum risk corresponding to minimum and maximum diversification.

We can model this as equivalent to a call option on *V* with exercise price *D*, but which also pays off an amount *B* if it is exercised.

Letting $\rho = \ln v$, *v=kV/kD*, $\sigma = \sigma_v \sqrt{T}$, *b=B/kD*, and setting *D*=1, the expected value of management's position is given by:

$$W^m(\sigma) = c^*(v,\sigma) + bN(d_2(v,\sigma)) \tag{5}$$

where $N(d_2(v,\sigma))$ is the risk neutral probability of surviving, $d_2(\cdot)$ is the same as d_2 in expression (3), and $c^*(v,\sigma)$ is the value of a call option on management's assets, per unit of deposits.

Management maximizes (5) with respect to σ. The first order condition is:

$$\partial W^m / \partial \sigma \; = vN'(d_1)\left(1 - b\frac{d_1}{\sigma}\right) = vN'(d_1)\left(\left(1 - \frac{b}{2}\right)\sigma^2 - b\rho\right)\frac{1}{\sigma^2} = 0 \tag{6}$$

This has two solutions. One is a corner solution at $N'(d_1) = 0$, which is approached as σ approaches 0. The other is when the second term in the parenthesis is zero, which gives

$$\sigma^2 = \frac{b\rho}{(1 - b/2)} \tag{7}$$

Because the required level of *v* is greater than one, it must be that $\rho > 0$.

It is shown in the Appendix that (7) generates a minimum rather than a maximum. $W^m(\sigma)$ is downward sloping everywhere if $b > 2$ (i.e. if the bonds are large relative to the shares given to management).[4] It can be shown (see Appendix) that for $0 < b < 2$, $W^m(\sigma)$ is U-shaped, as depicted in Figure 1 by the curve *BC*, and the solution is either minimum risk at one corner or maximum risk at the other. For $b > 2$ (bond

[4] The curve in Figure 1 cannot be upward sloping at the origin. However, the U-shaped part can turn up very quickly if *b* is small enough; the permitted risk-range is always upward sloping for small *b* provided minimum risk is positive.

amount more than twice equity amount) the bank always chooses the low risk strategy.

To see which corner solution, high risk or low risk, is an optimum we examine the levels of wealth where risk is either $\sigma^l = \sigma_v^l \sqrt{T}$ or $\sigma^h = \sigma_v^h \sqrt{T}$, , where $\sigma^l < \sigma^h$. Taking the difference between the two, we have

$$\Delta = W(\sigma^h) - W(\sigma^l) = c*(\sigma^h) - c*(\sigma^l) + bN(d_2(\sigma^h)) - bN(d_2(\sigma^l)) \tag{8}$$

Setting expression (8) equal to zero and solving for *b* as a function of *v* gives the locus of points where the bank is indifferent between high risk and low risk strategies. Points above that locus (that is, high values of *b* given *v*) are points where it is optimal to take the lowest risk during the first period. Hence, (8) implies a critical value of *b* satisfying

$$v\left[N\left(d_1^h\right) - N\left(d_1^l\right)\right] + \left(1 - b^c\right)\left[N\left(d_2^l\right) - N\left(d_2^h\right)\right] = 0.$$

or,

$$b^c = -\frac{vN\left(d_1^h\right) - vN\left(d_1^l\right) + N(d_2^l) - N(d_2^h)}{N\left(d_2^h\right) - N\left(d_2^l\right)} \equiv b(v). \tag{9}$$

where b^c is the critical value of *b*.

The relationship between b^c and *v* is depicted in Figure 2. For every *v*, there is a unique level of *b* that separates high risk and low risk strategies. For a given capital ratio, the level of risk-taking depends on the ratio of shares to CoCo bonds given to management. Note that *b* has *k* in the denominator, which means increasing the level of shares works the same as decreasing the level of bonds.

Hence, by making the low risk strategy more likely, the existence of CoCo bonds can deter management from taking too much risk. For instance, regulators can set $b > 2$ and assure minimum risk-taking. Nevertheless, because the FI is not indifferent among liability choices, decisions are still distorted; too many CoCo bonds can lead to too little risk-taking. Furthermore, the model leaves open the possibility of abrupt swings in risk choice. The only way to assure neutrality is to find a way to make $W^m(\sigma)$ in Figure 1 flat.

Figure 3 presents some intuition by presenting the payoffs for the various arrangements. The line *ODA* shows end of period payoff with guarantee but no CoCo bonds, which is therefore convex throughout. Clearly, given such payoffs and applying Jensen's Inequality, maximizing expected management wealth implies taking as much risk as possible. The line *ODCB'* gives the payoff from the CoCo bonds. The payoff to management, including the shares and such bonds, is the line ODCE. It is both convex and concave over different regions (because the bond has concave payoffs), which accounts for the ambiguity regarding taking maximum or minimum risk. Similarly, in the commonly suggested situation whereby conversion of CoCo bonds takes place before the FI defaults, at $V^c > D$, the payoff to management is the line *ODGH* (because the payoff of the CoCo bonds is *ODFB'*).

4. Perfect Offset — Optimal Risk-taking and Guarantees Co-exist

CoCo bonds (or mezzanine bonds in securitization deals) have limited liability that is similar to that of shareholders. Because of the convex payoff region still left to management, these bonds only imperfectly discourage risk-taking or lead to too little risk-taking. A question is whether we can set up a virtual bond that along with the equity piece can make the payoff linear and proportional to V. A way of doing it is to make the bond conversion into virtual securities that have payoffs based on asset value, so that managers lose as assets fall all the way down to zero.

To see this, suppose that we set up some incentive similar to the CoCo/mezzanine bond in the sense that the FI pays management a remuneration constituting an amount $B = kD$ when the FI succeeds, but kV if it does not. Then the payoff from this is:

$$W^c = \begin{cases} kD & if \quad D \le V \\ kV & if \quad 0 \le V < D \end{cases}.$$

And the equity piece pays:

$$W^s = \begin{cases} kV - kD & if \quad D \le V \\ \\ 0 & if \quad 0 \le V < D \end{cases}$$

Then the payoff to management is:

$$W^m = \begin{cases} kV & if \quad D \le V \\ \\ kV & if \quad 0 \le V < D \end{cases}$$

As a result, management gets kV no matter what, and we completely unwind the distortions from the guarantee or adverse selection.[5] In this case $W^m(\sigma)$ in Figure 1 is flat. This can be applied to any stock purchases by agents making decisions for the FI — they would be required to buy a derivative described by W^c above along with the stock purchases.

For securitization deals this means, contrary to Dodd-Frank, that deal makers should hold securities that reflect performance of all tranches in the deal; holding only the equity pieces increases distortions toward risk-taking. That is fine for securitizations deals, but probably not for banks if default has macro costs, for instance in the case where impending defaults lead to bank runs. A rule to control the chance of default is not to take a first loss position at all, but rather to take the safest, most convex position.

We have assumed so far that the only reason for paying management in the form of shares is to manage the risk of the portfolio. It could also be to induce management to try to enhance the value of the assets in the portfolio (cutting costs of managing them). For those purposes shares are imperfect because management does not accept all of the downside. By exposing management to the whole range of change in asset

[5] Existence of franchise value of the bank will also result in management taking less risk and therefore provides social benefit - management will take less risk now in order to ensure remuneration later by maintaining the franchise value.

value, the setup in this section improves on effort incentives as well as risk-taking incentives.

5. Conclusions

We show how simple adjustments to management remuneration can diminish risk-taking incentives from guarantees like deposit insurance or asymmetric information in structured securitization deals. A widely discussed vehicle is contingent convertible, or CoCo, bonds. However, while the usually understood CoCo bonds, along with traditional capital requirements, can take the default option further out of the money, they have limited incentive effects toward less risk-taking. If the desire is to keep decisions neutral relative to cases of symmetric information, then management should be required to hold some of all the deal's liabilities. If the desire is to minimize the chance of failure, then management should hold no equity but only the safest part of the deal.

Appendix

The second order condition is that

$$\frac{\partial^2 W_1}{\partial \sigma^2} vN'(d_1)\left(\frac{d_2 d_1}{\sigma}\right)\left(1-b\frac{d_1}{\sigma}\right)+vN'(d_1)b\left(\frac{d_2+d_1}{\sigma^2}\right)$$

$$= vN'(d_1)\left[\left(\frac{d_2 d_1}{\sigma}\right)\left(1-b\frac{d_1}{\sigma}\right)+b\left(\frac{d_2+d_1}{\sigma^2}\right)\right] < 0. \qquad \text{(A-1)}$$

In the neighborhood of the first order condition (7), the first term in the parentheses in (A-1) is zero, and the second term is

$$\frac{d_2+d_1}{\sigma^2} = \frac{2\rho}{\sigma^3} > 0. \qquad \text{(A-2)}$$

For positive equity, this says that equation (8) is the solution to solving the problem of *minimizing* the bank's wealth. Figure 1 shows the payoff to management as a function of risk. The slope of the curve is zero at zero risk and turns negative after that. Apparently, as risk increases from just above zero, the negative effect of increased risk on survival outweighs the positive effect on the current option value, but that is reversed at higher levels of risk. For b = 0, $W^m(\sigma)$ is always upward sloping. For b small it is downward sloping near $\sigma = 0$, but turns positive for low levels of σ.

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Figure 1 Risk Level that Maximizes Wealth of the Financial Institution

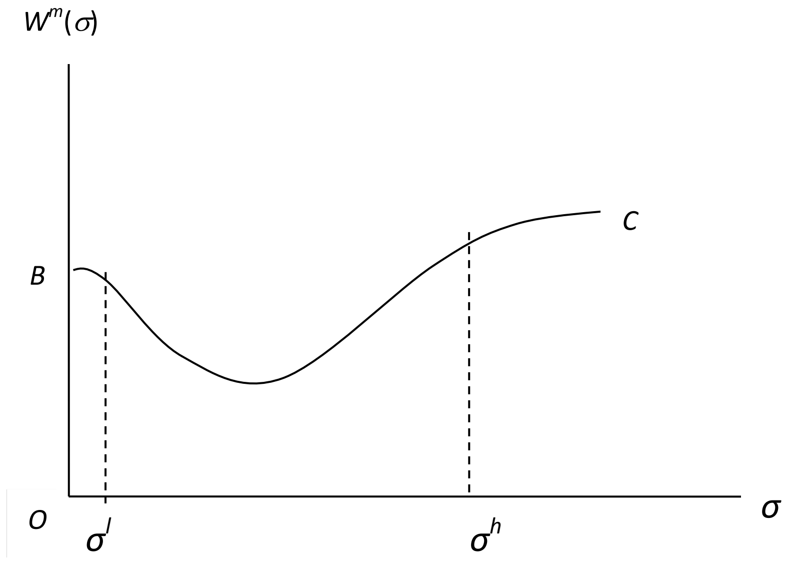

Figure 2 Risk-Taking Strategy For Given Asset Values of Financial Institution

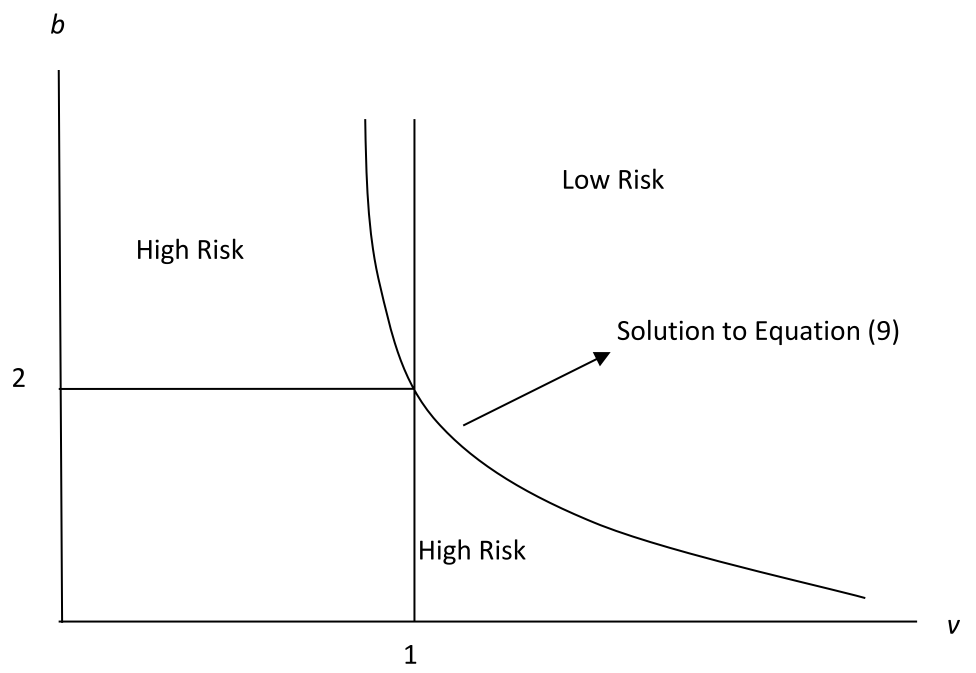

Figure 3 Manager Wealth under Different Compensation Schemes