Credit Risk Transfers and Risk-Retention:

Implications for Markets and Public Policy

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Abstract

Fannie Mae and Freddie Mac have undertaken Credit Risk Transfer (CRT) programs that sell off credit risk. The most common structures used are similar to synthetic CDOs. They are subject to moral hazard from the managers/sellers who choose their content. We analyze manager incentives, develop a notion of efficient structures and compare different incentive structures for different risk transfer structures. Sample deals are similar to our efficient structures, which have managers holding a "vertical slice" of the deal. However, they also differ in ways that suggest retaining some of the subsidy from their guarantees. The problems of evaluating these structures from a public policy perspective are the same problems as those in evaluating their traditional risks.

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1. Introduction

In 2012 Fannie Mae and Freddie Mac (FF), at the instigation of their regulator, began Credit Risk Transfer (CRT) programs, which sell some of their credit risk to private investors. A goal of this was to move some of FF's credit risk into the private sector (see FHFA (2015)). As of the end of 2017, FF had obtained coverage on around $70 billion on $2.1 trillion in loans or around 3% of the balances on those loans (see Goodman (2018)). We look at different forms of risk-sharing in terms of both market efficiency and shedding taxpayer risk. The recent CRTs do seem to work as efficient ways of structuring deals, but it is less clear how much risk they shed.

Selling off credit risk is not new: For instance, Freddie Mac sold off some risk around the turn of the millennium in the form of "Mortgage Default Recourse Notes" (MODERNs), which was essentially a reinsurance deal. The most common recent structures that have been used to transfer risk are essentially synthetic CDOs, which are not unlike the (infamous) "ABACUS" deal from 2007. We analyze stylized versions of different credit risk transfers using a notion of efficient incentives in structured securitization deals. We find that the structure of the most common recent CRTs mostly makes sense in terms of our model, but they have also been set up to retain some the FF subsidies from unpriced guarantees.

Because an agent of the seller (the manager) chooses the securities to which the payoffs are referenced (or sold) there is room for considerable moral hazard. All of the deals we look at have been *structured* in the sense of paying off in non-pro rata ways to different tranche-holders. The question addressed here is incentives for managers to control moral hazard. We develop models of risk-retention, i.e., requirement for managers to hold particular pieces of the deal that can undo agency problems involved in forming the pools, thereby keeping the advantages of structuring without the lemons problems. The model also has policy implications for retention requirement for structured deals in general. While our partial equilibrium approach is somewhat limiting it is the case that our main results are invariant for changes in presumably endogenous variables; they are typically corner solutions that hold generally.

Incentives and risk

Our focus is on incentives for deal managers when there is structuring and subordination of risk as in ABACUS, but with better incentives. Subordination can control risk in two ways. First, it acts as protection (like capital for a bank). Second, subordination can affect risk-taking via "skin-in-the-game" incentives. We focus on the second approach. We aim to design incentives such that management will perform in the interests of market efficiency even if how managers choose assets is not perfectly observable, so that they unravel the market failure generated by moral hazard.

Summary

In our first model incentives are embodied in the equity pieces (alternately a "horizontal" slice of the deal) that induces managers to maximize shareholder value. In that case if managers have the ability to hide risk, either from debt-holders (or depositors if the firm is a bank) or guarantors (for instance, sellers of credit default swaps or deposit insurers) they will maximize volatility. This moral hazard problem is well-known in the literature on conflicts of interest between shareholders and bondholders at least since Jensen and Meckling (1976), and 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.

Our second model adds stylized mezzanine tranches (which are similar to Conditional-Convertible, or CoCo, bonds) that are automatically converted into equity when capital levels fall below a prescribed level. Calomiris and Herring (2011), for instance, propose CoCo bonds as a tool that can incentivize firms to control risk and raise additional capital in times of trouble. Flannery (2009), Hilscher and Raviv (2012), and Sundaresan and Wang (2015) also provide discussions of incentives. Squam Lake (2010, 2013) develop a proposal for CoCo requirements and show that CoCos can play a role alongside a standard minimum book-value-of-equity-ratio requirement. These tranches increase protection for the senior pieces. Berg and Kaserer (2015) examine risk taking with CoCo bonds and find that they might actually increase risk-taking. We show how the bonds can help, albeit not in an efficient manner and they can either increase or decrease risk-taking.

We then consider a combination of shares, bonds and a "claw-back". If chosen properly (which is equivalent to equal slices of all the tranches), this maximizes unravels the distortions from moral hazard, making manager indifferent among capital structures. It is equivalent to "vertical" piece of the structure. The Dodd-Frank Wall Street Reform and Consumer Protection Act [1] requires in some cases that managers hold a position, such as an equity (first loss) position, or horizontal piece in private securitization deals. Our model suggests that managers be required to keep a vertical (*pro rata*) piece of the structure, rather than the horizontal position that has been widely suggested.

We find that the recent FF CRTs are similar to our notion of an efficient structure. But there is an exception: the CRTs keep the "catastrophic" loss piece. This is understandable to the extent to which there is an outside guarantor against whom the stakeholders can select by taking on risk. The model raises questions about the extent to which the required risk transfers actually lower taxpayer risk.

2. Basics and Models

Our point of departure is a structure like the ABACUS deal (depicted in figure 4 below), where outside managers are chosen to put securities into the reference pool for the synthetic CDO, and we present three models of incentives for them. We assume that risk neutral managers who know the quality of the assets in the deals individually, and they can, within some constraints) control deal content. To keep our analysis simple we use a version of models used to analyze risk in CDOs with imperfect information about diversification. We assume that loans are essentially the same, with the same probabilities of default and loss severity. All have the same known price if sold as whole loans. However, the default rates may be correlated, and the managers know how they are correlated, but buyers of pools do not. What they do know is the possible range of pool variance. So managers can, within some range, chose the variance of the pool.

It is not clear at all why FF would want to sell loans; they have scale economies and a subsidy (via their implicit guarantee) for taking risk, which the private market does not have, and they already

[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 taking up higher risk than necessary. See Thatcher (2011) and Sifma (2014) for summaries of rule-making.

have access to the bond market. Furthermore, selling might suggest lemons problems. With FF the sell decision has been a policy one designed to lower risk to the government. As a result part of the agency problem is avoided because they have been forced to sell, but that does not eliminate the problem of selecting the composition of the reference pool underlying the risk transfer. We assume a pool of fixed amount drawn from another (much larger) pool with asymmetric information about loan by loan characteristics.

We assume initially that the pool of securities to be sold is divided into two tranches, an equity (first loss/subordinated) and debt one (senior/"catastrophic"). We take size of the equity piece and the range of possible assets put into the pool to be given, and model what is put into the pool within the range permitted. We do not derive why the deals are structured (rather than straight pass-through securities). One reason could differences in information between investors; another is regulations related to rating agencies. We focus on the question of given the sale is structured and it has a given capital structure what are the implications of different incentive structures.

Efficiency

Absent asymmetric information all combinations of pools made up of the loans would all be possible to sell and would in a competitive market all be priced at cost, the same as if they were sold separately. However, the managers have more information than investors and their choices will depend on incentives, and these might spoil the pooling and pricing with a "Lemons" problem. We assume incentives are in the form of some combination of salary, which is at risk if the debt tranche is not paid off, and holding some peart of the structure. Our criterion for efficiency is a situation where the seller, via manager incentives, can credibly sell any feasible combination of assets and diversification, i.e., where the lemons problems are unraveled. In an otherwise first-best world this will be a socially efficient arrangement.[2]

3. A Model of Deals with Bonds as Assets

Here we model a structured deal incorporating mortgages or other bonds as assets. Our representative deal structure is a loan portfolio that is worth V at the beginning and V_T, which is

[2] For a fancier version of an asymmetric information model where the sellers are the managers see Beltran et al (2013)

stochastic, at maturity. The loans are chosen from an existing portfolio, and they are packaged and sold as a way of transferring risk. The manager of the portfolio knows the default probabilities of the loans one-by one, but the investors in the pool know only some range of risk possibilities, defined for instance by product type (e.g., subprime loans with ranges of credit scores). The deal has two tranches, an equity piece, which is subordinated to the senior debt piece, and the senior piece. The initial equity, or first loss piece is equal to E, and the face value of the senior piece is D. There are N loans of equal value, and N is taken to be the face value of the loans in the pool. The terminal value of the pool of loans that contains the deal's assets is the face value minus the number of defaulted loans, n, times average loss severity rates, l.

We assume that assets are made up of discount bonds with known and equal unconditional default rate, p, so that expected loss per loan is pl. The model runs for one period. If $V_T > D$ at the end, the debt is paid, and equity piece holders get the residual; otherwise the holders of the debt piece get whatever is left over. The loans' default probabilities are correlated, for instance, if they are concentrated in one region or product line. Managers can manipulate this covariance to maximize their expected value.

A candidate for the distribution of outcomes for the portfolio of loans is a binomial distribution, where the number of "tosses" corresponds to the number of independent loans in the portfolio. A binomial distribution can be approximated by several continuous distributions, such as the normal distribution. We assume that the number of defaults, n, is stochastic and that the outcomes of defaults in the pool are generated from a distribution function $F(n)$, density function $f(n)$ and volatility σ . All the loans have initial value of $(1 - pl)$, which is known to everyone. The only thing known by the managers but not depositors is σ,, which is assumed to be known to be within some range (maximum and minimum diversification. All agents are assumed to be risk-neutral.

The model

For simplicity we assume that interest rates are zero. We begin by assuming that managers of the structured deal control the deal and act in the interest of the equity owners because they are paid with an equity stake. Again, the best investors can do is to understand the range within which σ

lies. Formally, the deal has a portfolio of loans with par value equal to one and initial value equal to *V=(1-pl)N*. We set *N* equal to one. The manager chooses σ subject to the limits between minimum and maximum levels of possible risk given by σ_v^l and σ_v^l σ_v^h, respectively. We normalize all values by *V*. The equity investment in the deal becomes $e = E/V$. The par value of the pool is unity.

The value of the pool as a whole is

$$v_p = 1 - \int_0^1 f(n)nl\,dn = 1 - pl \qquad (1)$$

The value of the equity piece is

$$v_e = e - pl + \int_e^1 f(n)nl\,dn\,. \qquad (2)$$

That is, the equity holder gets back its investment minus losses, which are limited to its initial equity position. The third term in (2) represents the optionality in the equity piece. It is the expected value over a truncated distribution. Hence, the equity owner has limited liability. But because the assets are bonds, the portfolio does not have the same upside as a call option on a stock.

The value of the senior or debt piece is[3]

$$v_d = 1 - e - \int_e^1 f(n)nl\,dn\,. \qquad (3)$$

We can model $\int_e^1 f(n)nl\,dn$ as if it were a put option on *nl* with strike price *e*. We approximate *F*(*n*) with a normal distribution.[4]

[3] In the case of a bank with deposit insurance this is split between the depositors, who always get 1 – *e*, and the insurer, who gets the residual and whose expected losses are $\int_e^1 f(n)nl\,dn$.

[4] We are assuming that the probabilities of having zero losses and 100% losses are sufficiently small that we can take integration limited from negative infinity to positive infinity rather than from 0 to 1.

Then the value of the put on n is given by[5]

$$g = (pl - e)(1 - F(d(e,\sigma)) + \sigma F'\big(d(e,\sigma)\big) = (d\sigma)(1 - F(d(e,\sigma)) + \sigma f(d(e,\sigma))$$
(4)

where $d = \frac{e-pl}{\sigma}$, $F(\cdot)$ and $f(.)$ are cumulative normal and normal and σ is the volatility of n at the end of the period, and the length of the period is set to equal to one.

Then

$$v_e = e - pl + g. \tag{5}$$

Note that

$$\frac{\partial v_e}{\partial \sigma} = \partial g/\partial\sigma = f(d) > 0 \ . \tag{6}$$

So, as expected, the value of equity value is always increasing in risk, and may be either convex or concave.

4. Incentive Structures

Here we consider the incentive structures that were summarized above.

Model 1 Holding a Tranche

a. Managers paid in equity only

Because equity value is always increasing in risk (from (6)) the optimal choice for managers who are paid only in equity pieces is to maximize volatility. This implies that any type of structure overweighting loans that are riskiest in the sense of having highest covariance; and these loans

[5] See Dawson *et al* (2007) for a derivation of properties of options on underlying normally distributed assets.

will tend to be overvalued at the expense of other loans, ultimately leading to excess lending in places or products that move together.

b. Managers paid with the debt tranche only

In this case only the safest pool will be selected, and competitive investors will bid up the price. This is similar to a fee that is diminished as the pool deteriorates.

Next we consider adding an extra piece to the structure

Model 2 Managers paid in mezzanine or Coco Bonds and equity

A way of controlling risk is to introduce a reason to survive. Suppose managers are given both shares, as a fraction k of existing shares, and salary or mezzanine bonds, or Coco bonds, with face value B, which will be a fraction B/D (defined as b) of debt. We assume a simple conversion rule – the bonds will be converted to equity at the end of the period if the firm is insolvent ($V < D$).[6] In securitization deals this amounts to a mezzanine piece that is converted before the senior piece. This is equivalent to a salary that is only paid if there is positive equity at the end of the period.

The position of management at the beginning of the period is equivalent to a call on the deal's assets, or, by put-call parity, ownership of the assets along with a put. 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):

$$W^m = \begin{cases} B + k(V - D) & if \quad kD \leq kV \\ \\ 0 & if \quad kV < kD \end{cases} \tag{7}$$

We can model this as a call option on V with exercise price D, but which also pays off an amount B if it is exercised. As above, normalizing by dividing by V, we have managers' wealth as

[6] In practice, there are different conditions and terms for CoCo bond conversions, depending on the issuers.

w^m=*e-pl*+ *g*( ) +*b* $F(\frac{\rho}{\sigma})$ (8)

Where ρ=*e-pl* is the initial (expected) net worth of the pool

Then the first order condition for maximizing welfare of management is

$$\frac{\partial w^m}{\partial \sigma} = f\left(\frac{\rho}{\sigma}\right)(1 - b\frac{\rho}{\sigma^2}) = 0. \tag{9}$$

$\partial w^m/\partial\sigma$ is positive if *b* is zero (maximum risk again with nothing to live for) or ρ is negative (Negative equity means gambling right from the start), but the sign is not clear if it is positive. Equation (9) has two solutions. One is a corner solution at *f*(*d*) = 0, which is approached as σ approaches zero. The other is when the second term in the parenthesis is zero, which gives

$$\sigma^2 = 1 - b\rho \tag{10}$$

If *b* is big enough the safest risk portfolio will always (It's good to have something to live for) be chosen. It is shown in the Appendix that expression (10) generates a minimum rather than a maximum. In any event the result is a corner solution, which may be maximum risk or minimum risk. For ρ positive and 0 < *b* < 1, $W^m(\sigma)$ is U-shaped, as depicted in Figure 1 by the curve *BC*.

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

$$\Delta = w(\sigma^h) - w(\sigma^l) = (c(\sigma^h) - c(\sigma^l)) + b(F\left(d(\sigma^h)\right) - F\left(d(\sigma^l)\right) \tag{11}$$

The first term is positive (The call is more valuable when sigma is higher) and the second is negative because σ enters into the denominator of *d*( ).

Setting expression (11) equal to zero and solving for *b* as a function of *e* gives the locus of points where the firm is indifferent between high risk and low risk strategies. Points above that locus (with high values of *b* given *e*) are points where it is optimal for managers to choose the lowest risk. Hence, equation (11) implies a critical value of *b* satisfying

$$g(\sigma^h) - g(\sigma^l)(-b^c)\left[F\left(d^l\right) - F\left(d^h\right)\right] = 0. \qquad (12)$$

or,

$$b^c = \frac{g(\sigma^h) - g(\sigma^l)}{F(d^h) - F(d^l)} \equiv b(e). \qquad (13)$$

where b^c is the critical value of *b*. Above b^c minimum risk is taken. The numerator is increasing in e, and d is decreasing in *e*, so *b* is decreasing in *e*-the more equity in the pool the smaller the level of bonds needed to maintain knife-edge risk. This is depicted in Figure 2. Note that *b* has *k* in the denominator, so decreasing equity is like increasing bonds

Hence, by making the low risk strategy more likely, the existence of the bonds can deter management from taking too much risk. For instance, regulators can set $b > 2$ and assure minimum risk-taking. Nevertheless, there is a distortion, as in Model 1, in this case because only the safest and the riskiest are credible. Because these results come from the upper and lower bounds of the payoffs we expect that something like this carries over if there are several mezzanine pieces from which to choose

Different information

In the above it was assumed that the market knows whether the high risk or low risk pool was being supplied. Suppose investors do not know until after the pool is delivered; that is the pool is chosen as above but deal-makers don't' have to reveal which solution, high default or low default, is being chosen. To make the model stochastic, assume that *b* is stochastic, and the market knows the process for *b* but not the result. Then the market will pay only the average of the high price (low default cost) and low price (high default) with weights depending on the process for *b*. Then the low default strategy fails because its price will always be above the average. The high risk strategy will prevail.

5. Specifying payoffs graphically

Distortions (either through excess or deficient risk-taking) of asset allocation come from truncating the payoffs, creating optionality. Figure 3 depicts payoffs at maturity. Note that the slopes of OCE and –BDA are equal to *k,* the shares given to managers as a fraction of all shares.The horizontal axis shows the terminal value of the assets, given by the number of loans that survive through the end of the period. The length of the line *OV* represents the par value of loans in the pool, which is the payoff if none of them default. The length of *OD* represents the level of debt and *DV* represents the equity. *ODA* shows the possible end of period payoffs to managers if they are paid in nothing but equity. It is convex throughout. Clearly, given such payoffs, maximizing expected wealth, Jensens's Inequality, implies taking as much risk as possible. Debt pays off like OCG, which is concave. If paid only in debt managers will be conservative.

Letting *OB* be the amount of salary or CoCo bonds (*b* above), the line *ODCG* gives the payoff possibilities from the salary. It is convex to the left of *D*, suggesting it looks like equity and risk should be maximized, and concave to the right of *D,* suggesting it looks like debt and risk should be minimized. The payoff to the manager, including both shares and the bonds, is the line *ODCE*. It too is both convex and concave over different regions (because the bond provides concave payoffs).

Hence, incentives can go either way because there will be values of *b* (for which the two corner solutions have equal value, suggesting that the u-shaped wealth function in figure 1 is more general than the example used to derive it. A similar situation is the case where the manager is paid with a salary that is stopped if the firm is bankrupt. It too has limited liability and will have diminished incentives to take risk, but perhaps also too little risk. The varying convexity and concavity in the figure suggests that the curious u-shape of the wealth function in figure 1 might be general.

Model 3 Perfect offset

Here we add another claim that unwinds the distortion from both equity and bonds. Assume that the manager is paid a remuneration package that adds to the equity part a contingent claim, w^c, an offset derivative, which consists of $k(1-e)$ if the debt holders do not have losses, and $k(1-nl)$, which is proportional to the terminal value of the deal (net of default costs, including payout by the deposit insurer), if they do. The payoff from this is:

$$w^c = \begin{cases} k(1-e) & if \quad nl \le e \\ k(1-nl) & if \quad e < nl \end{cases} \tag{14}$$

or

$$w^c = \begin{cases} k(1-e) & if \quad nl \le e \\ k(1-e) - k(nl-e) & if \quad e < nl \end{cases}. \tag{15}$$

This part is, again, equivalent to a salary, $k(1-e)$, paid during the period, plus a claw-back in the event of bankruptcy.

The equity piece pays:

$$w^s = \begin{cases} k(e-nl) & if \quad nl \le e \\ 0 & if \quad e < nl \end{cases} \tag{16}$$

Then the payoff to the manager is:

$$w_m = \begin{cases} k(1-nl) & if \quad nl \le e \\ k(1-nl) & if \quad e < nl \end{cases} \tag{17}$$

The manager always receives $k(1-nl)$, which is proportional to the realized value of the asset pool, with upside capped at *V*, the same as for an all-equity lender. In Figure 3 the equity piece is given by *ODA*, which is a horizontal slice of the deal, and w^c is given by the line *OCG*. The segment *BG* is the equivalent of a salary as long as the deal pays off debt holders, and *BG* plus -*BD* is the claw-back if it fails. The equity piece is then added, and the total payoff to the manager is given by *OCE*, which is a straight line through the origin — neither convex nor concave. This is equivalent to a vertical slice of the deal. Note that this strategy does not require information about particular parameters of the distribution of risk.

Subsidies and three tranches

Not all the stakeholders are involved in buying and selling, so it is possible for some of them to rip off outside stakeholders. Here we consider the subsidy that FF get from their unpriced implicit guarantee and the imperfect ability of their regulators to measure their risk. We expand the number of tranches to have three agents: FF, investors and the guarantor. So we have an equity piece a mezzanine piece and a last or catastrophic loss piece.

As discussed above FF might be reluctant to sell off securities and save taxpayers money because they get a subsidy to take the risk. The sales are policy induced, but FF can adjust the pools to keep more risk than is obvious. Figure 8 shows performance by vintage over the last decade of FF (see FHFA 2015). Credit costs are usually low, and manageable without subsidy, but sometimes become very large. Then the catastrophic risk may be the risk that exploits the subsidy most. So FF will hold the last tranche to exploit its guarantee.

A structure with FF holding all of the last tranche and equal shares of the first two both satisfies the interests of the buyers and exploits the guarantee. The first two tranches together have payoffs that look like the payoffs in figure 3, where the vertical slice is efficient, so the vertical slice gives investors the same assurances about manipulations within the permitted risk class of mortgages sold. Who holds the last tranche does not affect the payoffs of the first two. The vertical slice of the first two pieces assures investors that FF are not manipulating payoff probabilities in terms of faster vs slower before catastrophic risk occurs.

As in Model 1 holding the last tranche induces safer loans being put into the pool, which means the loan portfolio that FF keeps will be riskier than before. This suggests that regulators' requiring vertical slices of all tranches might be the best policy solution (see below).

Comments

Models 1 and 2 are both not efficient in our sense in that managers are not unraveling Lemons problems. In Model 3 managers are indifferent to which securities are in the pool, and the moral hazard is unraveled, and any pool structure preference by investors can be accommodated. There are several ways of getting to an optimum. The simplest is to keep a vertical slice of the deal (not a horizontal slice). However it can also be attained with combinations of salary, bonds, equity and a claw-back. The ability of FF and investors to jointly rip off its regulator suggests FF holding all of the last tranche.

Next we look at the CRTs as well as other structures in the context of the incentive structures above.

5. Comparisons

Here we look at, ABACUS, MODERNs and FF CRTs and risk-shedding alternatives.

ABACUS

The ABACUS deal (see e.g., Wharton (2010) and Whalen (2011)) was a synthetic CDO in which investors (buyers) made bets on the performance of a reference pool of securities by selling insurance to the sellers. The investors paid what were essentially insurance premiums and were paid off as the reference pool took losses. The reference portfolio was filled with mezzanine pieces of private-label mortgage-backed securities. The pool had more complicated arrangements that are not important for our purposes. Its basic structure is depicted in figure 4.

In terms of incentives, the moral hazard problem was that the investors in the deal were told that the reference securities were chosen by someone who also would own pieces of the pool (take a long position); however they were chosen by someone who was buying insurance (shorting the pool). This is a radical version of the incentives from managers who are paid in only equity; they will form the riskiest pool possible, and equilibrium will be an Ackerlof type. The range of risk possibilities from mezzanine pieces of other deals was also rather large. How much of the failure of the deal was due to the incentives is not clear. Defaults were catastrophic.

MODERNs

In 1998 Freddie Mac did a one-time risk sharing deal called Mortgage Default Recourse Notes, or MODERNs. They were like insurance policies but with caps on loss per loan. Freddie Mac chose a reference pool of prime mortgages on which the "insurance' was to be based. They issued bonds to the investors, paid insurance premiums to them and deducted loss from the principal owed to the investors with a reference pool chosen. Not much has been written about the deal or researched. The salient point is that it was a one shot deal with Freddie choosing the reference pool. A problem (see Freddie Mac (2017)) was lack of confidence by investors in the information about the pools. This suggests a mini version of the ABACUS-with a "short" (Freddie Mac) picking the reference pool, but with loans being of higher quality.

Credit Risk Transfers

First we look at the most recent and largest in volume CRT. Figure 5 shows a stylized picture (see FHFA (2015) of it. Like a synthetic CDO (ABACUS) the deal references a pool of assets picked by FF from their own portfolios, who in effect buy insurance against the default losses in the pool. The deal has 4 tranches: one that absorbs the first loss, which is an equity piece, two that absorb middle or mezzanine losses and a senior or "catastrophic" loss piece. Investors, who are acting as insurers, buy shares in these tranches, and have balances that decrease along with losses to the pool of mortgages. These losses are paid off in sequence; they are taken first by the first loss piece, then the mezzanine piece etc.

Fannie Mae (see Fannie Mae (2018) argued that the vertical slice part was to align its interests with those of the various stakeholders, which is consistent with our model. However the deals also keep an extra cut of the catastrophic risk. So FF are keeping a vertical slice, but with an extended piece of the last tranche. This is an example of the structuring discussed at the end of the previous section. The structure is consistent with wanting to hold a vertical piece to assuage investor agency concerns, but not wanting to give up all of the subsidy for credit risk.

Other CRT vehicles

Next are two other recent structures (see FHFA (2015)). The first (figure 6) is a reinsurance deal. In this structure FF keep the first and last loss and sell only the credit risk in the middle. This would appear to provide incentives to provide risky pools and to exploit the guarantee by taking the catastrophic losses

Last, the Senior/ Subordinated deal (figure 7) is similar to the first CRT deal except that the structure holds the loans in the pool rather than referencing them. In this example they keep the last losses and part of the first losses.

Both structures (in figures 6 and 7) have mixed incentives for delivering risk, and both hold at least some of the first and last pieces but sell off the middle. This does not unravel the selection problems, but they do keep some of the subsidy for taking credit risk.

6. Comments and Conclusions

Credit risk transfers have become a part of the way Fannie and Freddie manage credit risk. They are similar in structure to previous securitizations of credit risk, but are different in terms of incentives and types of assets. Choosing assets to put into the CRT raises moral hazard problems because the deal manager knows more than the investors. Hence, incentives for the managers are important. A combination of equity, salary and "claw-back" can produce a structure that unravels adverse selection problems. This is equivalent to a "vertical slice" of the deal. The recent versions are similar to that structure except that FF keep the catastrophic risk, which can be interpreted as a reflection of subsidies for taking credit risk. Retaining the catastrophic risk allows exploitation of that subsidy. Hence the degree of protection to taxpayers is less.

Public policy note

Historically, the policy goals of FF have mostly been to increase homeownership and to stabilize the mortgage market. On the negative side have been their subsidy for risk-taking (with costs to taxpayers) and over allocation of resources to housing. The policy focus of CRTs has been on the risk side—shifting it to private investors. However, it is not entirely clear what shedding risk means. One version is getting risky assets off balance sheet or at least defeasing them. The economic meaning is more like limiting the cost of failure and government payoffs. These two are different notions. The first is easy to measure, and the programs appear to have been successful at it, and the programs appear to be successful market-wise. However, the latter notion is more important in terms of both resource allocation and taxpayer cost, but it is harder to measure, though easy to think about.

By keeping catastrophic risk FF are continuing to help keep the market open. Selling off some of the risk to investors who aren't subsidized probably increases capital costs for homeowners, and lowers subsidies to housing. From an FF risk control perspective the regulator should require that they hold a vertical slice of all tranches including the catastrophic risk. However, as it is also the goal of FF to keep markets open, taking on catastrophic risk is a way of limiting the liability of private investors in the same manner as its guarantees on its regular pools, which contributed to keeping markets open during the Great Crash.

This induces an inevitable conflict. FF will want the catastrophic risk tranche to be big, but the regulator will want it to be small. The size of the catastrophic tranche acts like capital cushion required for FF's portfolio so the problem is isomorphic with analysis of capital ratios for regular pools loans. The structure of the risk is the same in either case, so a final question is whether, given their extra complications and transaction costs, CRTs are worth bothering with.

Appendix

Recall that the first derivative of w^m is

$$\frac{\partial w^m}{\partial \sigma} = f\left(\frac{\rho}{\sigma}\right)(1 - b\frac{\rho}{\sigma^2}).$$

Which is zero at a maximum or minimum

Then the second derivative is

$$\frac{\partial^2 W_1}{\partial \sigma^2} = -\frac{\rho}{\sigma^2} f'\left(1 - b\frac{\sigma^2}{\sigma}\right) + f(d)b\left(\frac{2\rho}{\sigma\, 3}\right) \quad \text{(A-1)}$$

In the neighborhood of the first order condition, the first term in the parentheses in (A-1) is zero, and the second term is unambiguously positive if ρ is positive – when initial equity is positive. This says that equation (9) is the solution to solving the problem of *minimizing* the firm's wealth, or there is a corner solution**.** 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.

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Figure 1 Risk Level that Maximizes Wealth of the manager

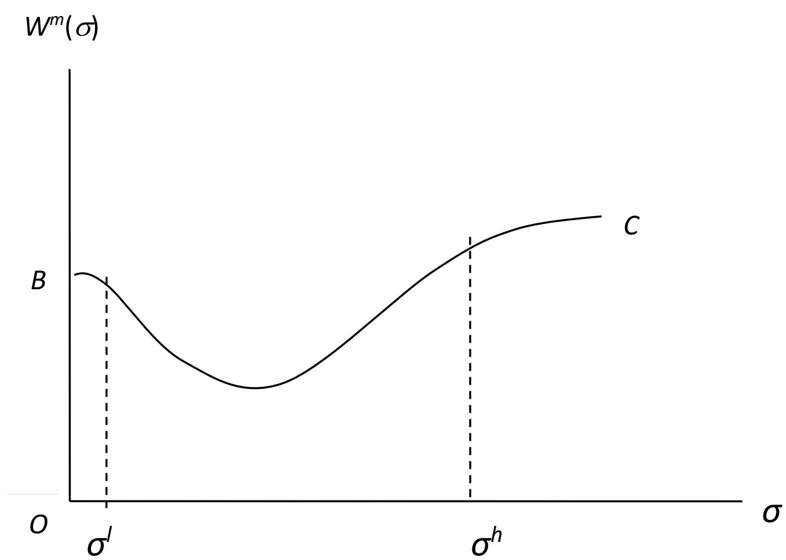


Figure 2　　Risk-Taking Strategy For Given Asset Values of the Firm

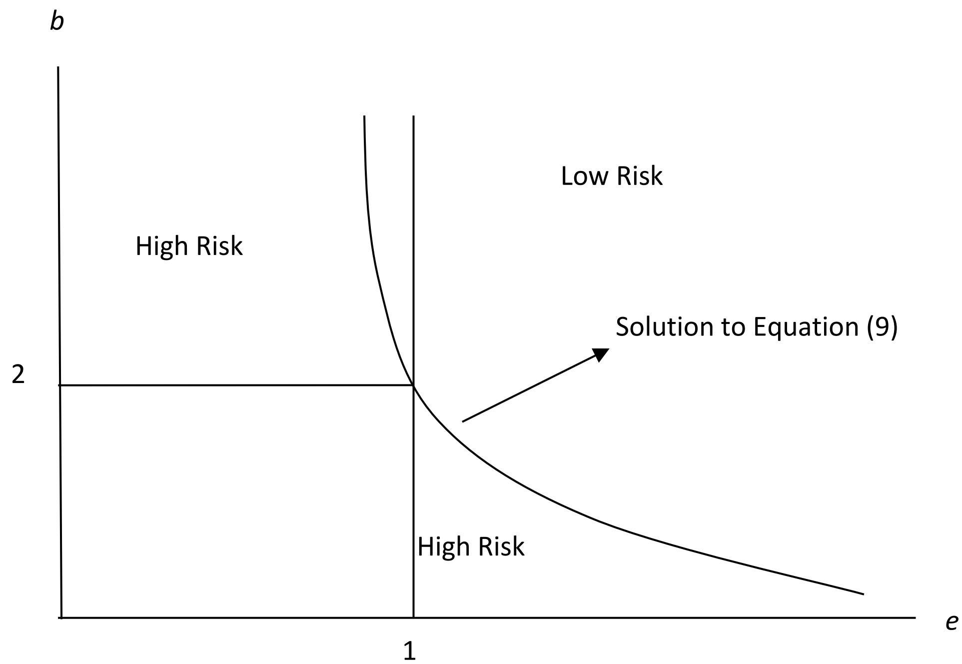


Figure 3 Payoffs to Managers in Bond Deal

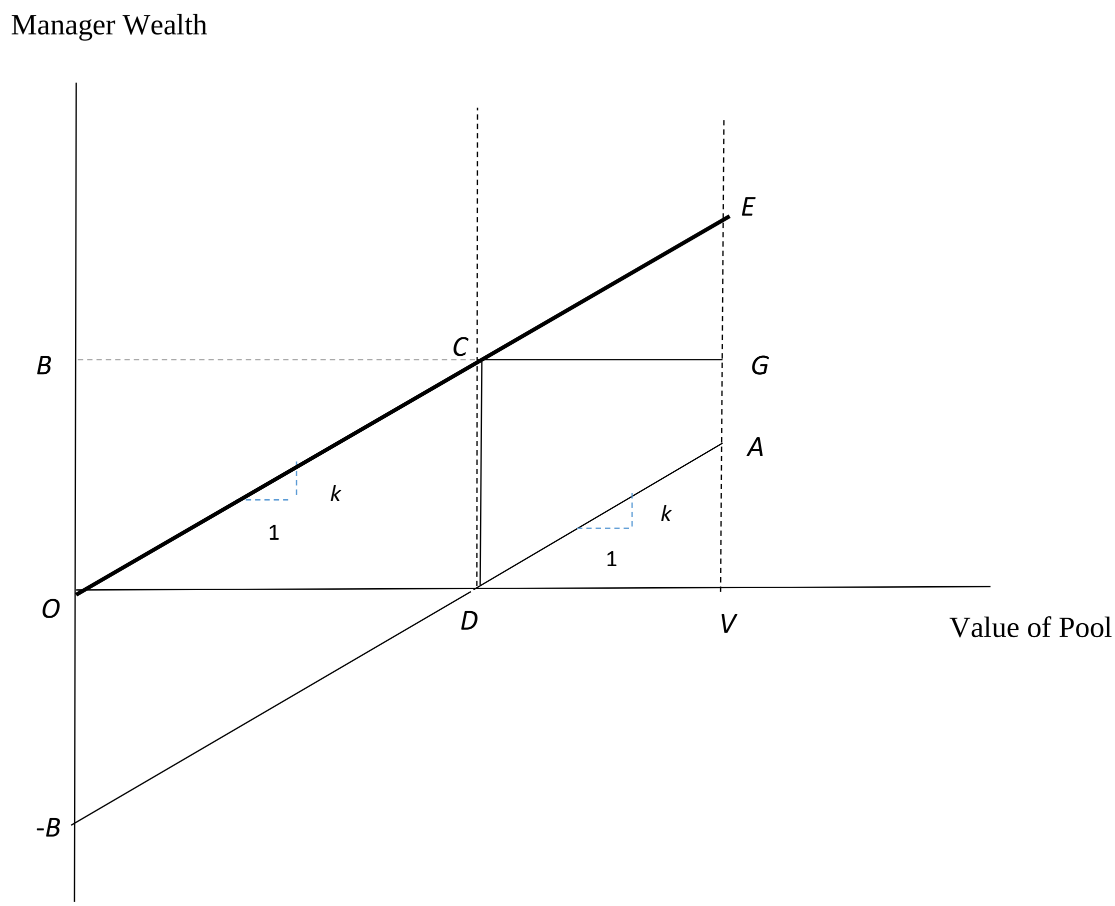
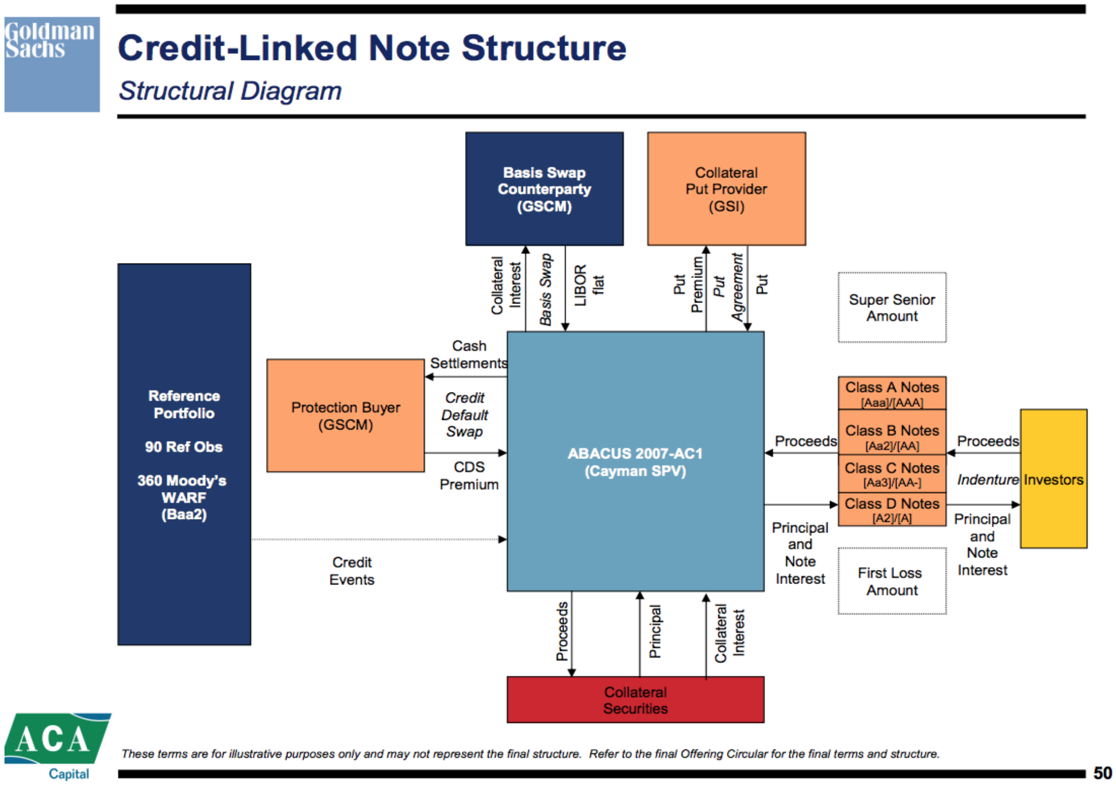
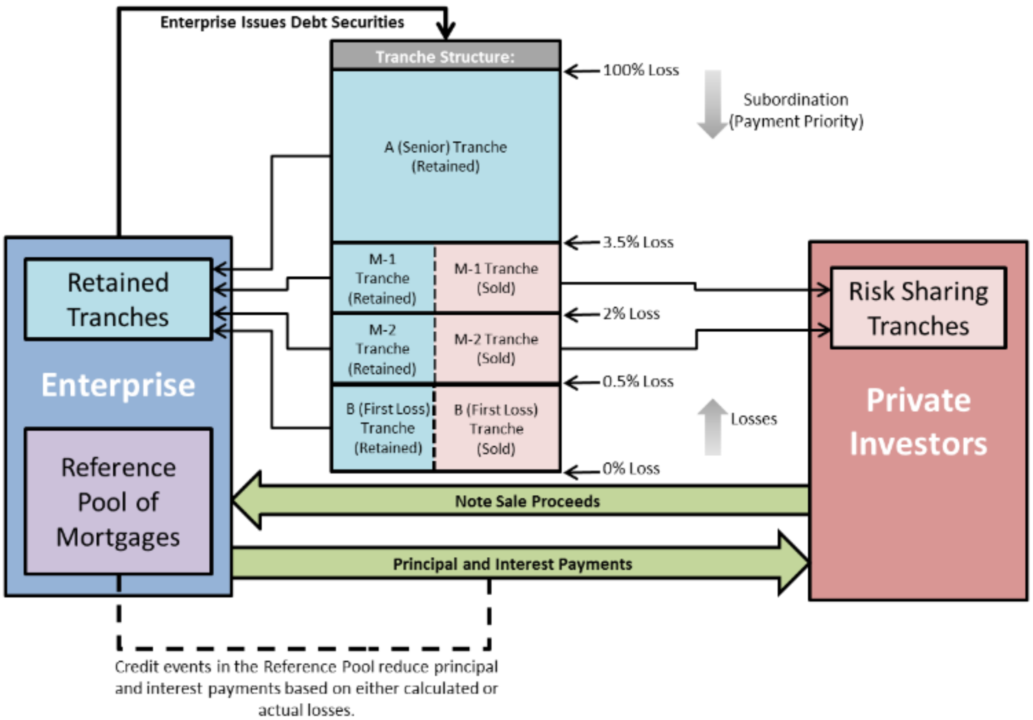


Figure 4. Abacus Structure



Note: This is a structured deal with 4 tranches, which sell insurance against losses in a reference pool of securities.

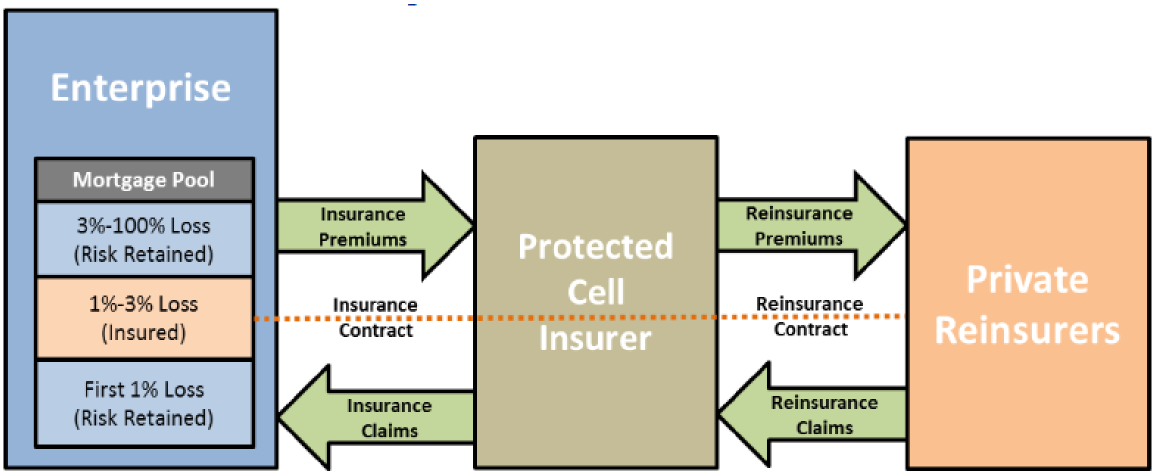
Figure 5. CRT: Stylized Credit Risk Transfer Structure (Investors sell insurance on a pool of securities). Pink is positions of investors and blue of FF



Source: FHFA

Note that the structure has FF hold vertical slices of the deal with an added slice of the catastrophic risk.

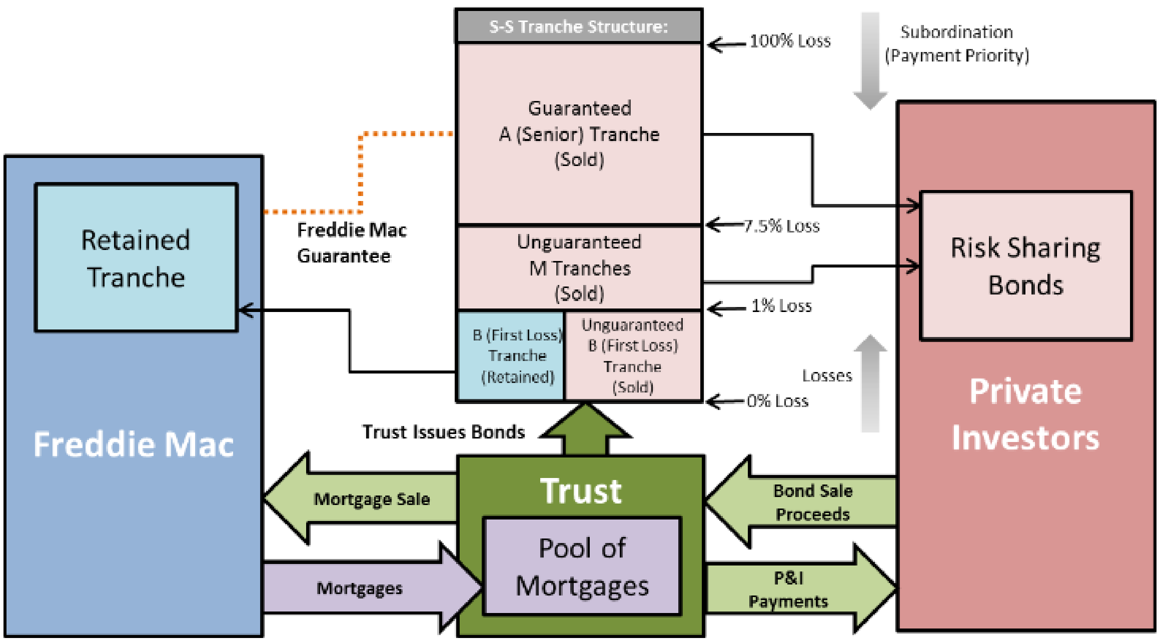
Figure 6. Reinsurance



Source: FHFA

Note that here FF hold the first and last loss positions – reinsurance is on the "mezzanine" part of the deal

Figure 7 Senior/Subordinated deal. The investors own the securities rather than insuring them (Pink pieces are sold to investors, but the last loss position is guaranteed by FF)



Note that this is quite similar to the reinsurance in figure 6 in terms of risk. The main difference is that FF sell off some of the first loss

Figure 8 Freddie Mac loss rates (FHFA (2015)

Freddie Mac Historical Loss Data: Percentage of Actual Losses and How Much is Left by Vintage (All figures shown as percentages of UPB at origination)					
	Actual Loss Rates				UPB Remaining
LTV Category:	All Loans	(0-60)	(60-80)	(80-95)	All Loans
1999	0.13	0.02	0.14	0.16	1.52
2000	0.18	0.02	0.16	0.25	0.75
2001	0.23	0.02	0.20	0.42	1.94
2002	0.34	0.04	0.31	0.67	4.12
2003	0.42	0.05	0.41	0.93	10.46
2004	0.92	0.13	0.96	1.45	12.80
2005	2.27	0.40	2.56	3.35	16.82
2006	3.34	0.62	3.86	4.06	15.30
2007	3.47	0.66	3.73	4.84	18.64
2008	1.56	0.21	1.79	2.23	16.17
2009	0.14	0.01	0.19	0.15	28.47
2010	0.03	0.00	0.04	0.03	42.27
2011	0.01	0.00	0.01	0.01	51.97
2012	0.00	0.00	0.00	0.01	84.74
2013	0.00	0.00	0.00	0.00	88.40