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Inherent Conflicts in Risk Allocation, Complexity of Financial Engineering, and Fragility of CRT Markets

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Abstract

There are conflicts between risk sharing and incentive provision in financial contracting under information asymmetry. Efficient risk allocation is appropriate risk sharing subject to incentive constraints. Credit risk transfer changes incentive structure of financial contracts and has dilution effect on incentive of risk seller. Contract design and reputation discipline may reduce moral hazard but cannot eliminate it. Furthermore, the complexity of structured products created through financial engineering along the risk transfer chain makes the markets very opaque, which magnifies the information problems to the extreme. The inherent fragility of CRT markets provides an important role for regulation to improve risk allocation.

Keywords: risk allocation; contract design; inherent conflicts; CRT markets; financial engineering

1. Introduction

Traditionally, credit risk has been transferred through guarantees and insurance for a long time. In recent years many innovative tools of credit risk transfer (CRT), especially loan securitization and credit default swap, have been widely used. Their core values lie in providing more risk-sharing opportunities, which may not only enable financial institutions to diversify risk more conveniently, but also improve credit availability for entrepreneurs and households. However, owing to the break-out of subprime crisis, CRT markets have been put under the spotlight. There is growing literature which focuses on the negative impacts of CRT on resource allocation and financial stability. Some researchers point out that risk transfer may induce loan originators to reduce monitoring of borrowers (see Morrison 2001, Duffee and Zhou 2001, Behr and Lee 2004, Partnoy and Skeel 2007). Keys et al. (2008), Downing (2008), and Amromin and Paulson (2009) empirically show that securitization leads to a decrease in loan quality.

Based on previous researches, a deep analysis of the key problem of risk allocation is required to explain the above questions. My paper offers a perspective on the links between contract design theory and CRT mechanism. The focus of this paper is on the conflict between risk sharing and incentive provision in financial contracting and the magnification effect of complexity of financial engineering on

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incentive misalignment. If innovations of CRT lead to excessive risk sharing between risk buyers and sellers, the incentive structure of financial contract will be distorted, which may cause a series of negative influences on financial stability. Although these effects may be partly mitigated by contract design and reputation discipline (Gorton and Haubrich 1987, Chiesa 2008, Fender and Mitchell 2010), the inherent fragility in CRT markets cannot be eliminated. In addition, complexity of structured products created through financial engineering makes the markets more opaque, which magnifies the information problem throughout risk transfer chain. Accordingly, the imperfection of markets provides an important role for regulation to improve risk sharing.

The rest of this paper is organized as follows. Section 2 explores dual motivations of risk allocation and their conflicts. Section 3 proposes rule of optimizing risk allocation and constraints of risk sharing. Section 4 analyses conflicts in CRT transaction and incentive dilution. Section 5 explores limitations of endogenous incentive optimization in CRT markets. Section 6 describes how complex financially engineered structures lead to information loss and magnify incentive distortion. Section 7 concludes.

2. Conflict between dual motivations for risk allocation in contract design

There are two branches in contract design theory : risk-sharing paradigm emphasizes that contract arrangement should be based on risk preference of both parties, aiming to attain Pareto- Optimality of risk sharing, whereas risk-neutral transaction-cost approach focuses on how to reduce agency cost by providing sufficient incentive to agents. In real world, contract choice is driven by both the motivations for risk allocation and faces a trade-off between risk sharing and incentive provision.

2.1. Motivation of risk sharing

We first consider an extreme scenario: the outcome of contract is affected by uncertain future state of nature and actions of one party and there is no information asymmetry. That implies moral hazard doesn't exist. In such context, risk allocation between parties is simply driven by risk sharing motivation. The goal of an optimal allocation of risk is to maximize expected utility of both parties by sharing risk and thereby adjusting their risk position. When there is heterogeneity between the parties' risk attitudes and risk perception, risk sharing will be desirable. If impacts of a risk event on the parties are not positively correlated, they are also willing to share risk.

2.2. Motivation of incentive provision

Now consider another extreme situation: both parties are risk neutral and have the same risk perception, while there exists information asymmetry between them. One party may damage the other's benefit, but his choice of actions is unobservable or monitoring cost is expensive. Accordingly, incentive provision is the only driving force of risk allocation. To achieve incentive compatibility, the principal may let the agent assume some risk. Exposed to potential bankruptcy cost , the agent will become quasi-risk averse and choose to act on behalf of both parties.

2.3. Conflict and tradeoff between two motivations

In real world, uncertainty and information asymmetry usually exist side by side. So risk allocation is driven by the dual conflicting motivations. Pareto-optimal risk sharing might be unable to induce proper incentives for taking correct actions. Excessive risk sharing will lead to insufficient incentive provision, which means the agent's cost of taking risk doesn't exceed expected earnings of his opportunism behaviors. On the other hand, overemphasizing incentive provision may result in excessive risk taking. If the agent is forced to bear too much risk beyond tolerance, his expected utility of entering into the contract will be rather low, which may cause the contract cannot be signed. Overall , how to solve conflict between the dual motivations is the key problem of risk allocation. Contract choice depends on trade-off between benefits of risk sharing and losses of insufficient incentive.

3. Basic rule of optimizing risk allocation

3.1. Framework of financial contract design

With standard principal-agent paradigm, taking a funding transaction between a capital demander and a supplier as an example, the fundamental framework of financial contract design may be established. Let $a \in A$ denote effort devoted into an investment project by the investee, A being his possible action set. Let $C(a)$ denote cost of taking an action a, with $C'(a) > 0$, $C''(a) > 0$, $C'(0) = 1$. θ denotes future state of nature, which is a random variable. Investee will choose a before θ realizes. Project payoff x is determined by both θ and a, i.e. $x=x(a, \theta)$. Given the state of nature, higher effort level will produce more output, but marginal product of effort is diminishing, with $\partial x / \partial a > 0$, $\partial^2 x / \partial a^2 < 0$. Given the fund raiser's effort level, $\partial x / \partial \theta > 0$. Probability density function of x is $f(x; a)$, which implicitly contains the influences of θ on probability distribution of x.

The investor's problem is to design a contract to share uncertain project payoff between the two parties. He has two choices. First, investee is rewarded for the efforts exerted by him. This input-based contract has monitoring costs of m_c. Second, investor offers an output-based contract, the sharing rule of which is $s(x)$, namely the portion distributed to investee. Investor needs to collect information on project output, with collection cost m_x. Provided $m_c > m_x$, that means the costs for principal to monitor the agent is relatively high. The investor's utility function is $v(\cdot) = v(x - S(x))$, with $v' > 0$, $v'' \le 0$. And the investee's utility function is $u(\cdot) = u(S(x) - C(a))$, with $u' > 0$, $u'' \le 0$. Both parties are risk neutral or risk averse. Objective function of the investor is given by:

$$\underset{s(x),\, a}{Max} \int v(x - s(x)) f(x; a) dx \qquad (1)$$

subject to

$$\int u(s(x) f(x; a) dx - c(a) \ge \bar{u} \qquad (2)$$

$$\int u(s(x) f(x; a) dx - c(a) \ge \int u(s(x) f(x; a') dx - c(a') \qquad (3)$$

Constraint (4) is participation constraint, where $\bar{u}$ is the minimum level of expected utility that investee can attain from the contract. This constraint ensures that investee would like to accept the contract. Constraint (3) is incentive compatibility constraint, where a' denotes the actions of agent which are undesirable for principal, aiming to discourage investee form shirking or cheating. This constraint may be transformed to the first order condition:

$$\int u(s(x) f_a(x; a) dx = c'(a) \qquad (5)$$

Let λ and μ represent the Lagrange multipliers of (2) and (4), respectively. An optimal sharing rule has the following feature:

$$\frac{v'(x - s(x))}{u'(s(x))} = \lambda + \mu \frac{f_a(x; a)}{f(x; a)} \qquad (6)$$

Which is the classic Mirrlees—Holmstrom Condition.

3.2. Rule of optimizing risk allocation and constraints of risk sharing

Participation constraint and incentive compatibility constraint lead to two risk allocation criteria.

First, risk should be allocated to the party having the least risk-bearing cost. If there is difference between risk-bearing costs of two parties, it is required to minimize the parties' aggregate cost of risk bearing through risk allocation. According to participation constraint, contract designer must assure the agent to get expected welfare no less than his reservation utility. The cost incurred by the agent includes not only direct cost of effort, but also potential cost of bearing risk. The agent's certain equivalent ε may be used as a proxy for his risk aversion. It is obvious that his reservation utility $\bar{u}$ has to be at least $u(\varepsilon)$. If the agent has a lower risk tolerance, thereby his risk-bearing cost is higher, more risk should be allocated to the principal whose risk taking propensity is relatively high.

Second, risk should be allocated to the party best able to manage it. If the roles of two parties in producing project output are different, risk should be allocated to the party who directly acts on the outcome. Actions of investee directly affect probability diffusion of output, whereas investor doesn't participate the production process. Furthermore, it is hard for investor to differentiate actual effects of the two factors（a， θ）on x. Based on incentive compatibility constraint, the agent's risk-bearing may serve as an incentive device to urge him to manage risk better. The risk allocated to investee should be enough to motivate him to try to reduce the probability of risk materialization.

Criterion 1 focuses on risk sharing effect to lower overall risk-bearing cost, while Criterion 2 lays emphasis on incentive effect to mitigate moral hazard. Contract performance is determined by the two effects together. Preventing moral hazard is the constraint of risk sharing. Accordingly, efficient risk allocation in financial contracts is appropriate risk sharing subject to incentive constraint.

3.3. Background factors of contracting and optimal choices of risk allocation

Based on the rule of risk allocation inferred from the above statement, characteristics of optimal financial contracts are the function of dual demands for risk sharing and incentive provision, which are respectively determined by several background factors as follows.

3.3.1. Risk attitudes and level of project risk

The contracting party's demand for risk sharing is an increasing function of his risk-bearing cost, which depends on his risk attitude and the project risk . If there is no information asymmetry, it implies that the incentive compatibility constraint need not be considered in contract arrangement, i.e. μ in equation (5) equals to zero. Then optimal risk allocation should have the following feature:

$$\frac{v'(x-s(x))}{u'(s(x))}=\lambda \qquad (6)$$

Proposition 1: In the context of no information asymmetry, given the level of project risk, first-best Pareto risk sharing is determined by risk preferences of the contracting parties. The risk taken by a party is proportional to his risk tolerance. The higher the project risk, the stronger risk averse party's demand for risk sharing.

3.3.2. Expected benefits of incentive, efficiency of effort, and monitoring cost

Demand for incentive effect in contracting depends on the following factors.

（1） Expected gains from incentive provision and efficiency of agent's effort

Let a_0 denote the effort level chosen by investee under first-best risk sharing. Probability density function of project output is $f(x; a_0)$ and expected output is $\bar{x}_0$. Due to information asymmetry and investee's opportunist tendency, obviously a_0 isn't first-best effort level. Given distribution of θ, let f^* denote the possible best distribution of project income when $a \to \infty$. In such a situation, the expected output is $\bar{x}^*$. d represents the difference between $\bar{x}_0$ 和 $\bar{x}^*$. The larger d implies the greater potential gains from incentive, so demand for incentive provision in contract design is stronger.

Given the gain from incentive, demand for incentive also depends on the efficiency of agent's effort, which equals to his marginal productivity. Let η present the efficiency index of effort, then probability density of project output x is $f(x;\eta a)$. Assume when $\eta a \to \infty$, this probability density function evenly converges to probability density f^*. The relationship between efficiency of agent's effort and solution to the principal - agent problem may be described by the following proposition.

Proposition 2: In a situation of asymmetric information, when $\eta > 0$, the feasible solution of contract arrangement will not be first-best risk sharing. As $\eta \to \infty$, the difference between feasible solution and first-best risk sharing will tend to 0.

If $\eta = 0$, meaning that f isn't affected by a, risk allocation is a problem of pure risk sharing, and first-best solution may be achieved. When f is affected by a, i.e. $\eta > 0$, contract designer has to provide incentive to the agent owing to information asymmetry and first-best risk sharing will not be feasible. Nevertheless, if η is high, implying high productivity of agent's effort, the agent only has to devote a little effort in order to make output x approach to its best level f^*. Consequently, the demand for incentive effect is not strong.

（2） principal's monitoring cost

In the situation of $\eta > 0$, there are two ways for principal to motivate agent to take actions on his behalf, including monitoring and providing incentive. If it costs a lot to monitor, principal will impose incentive on agent to save monitoring cost. If monitoring cost is relatively low, principal may substitute for incentive provision partly by direct monitoring, so that risk allocation may pay more attention to the parties' demand for risk avoidance and thereby approximate to first-best risk sharing.

Proposition 3: When $m_c > 0$, feasible solution for contract design won't be first-best risk sharing. If m_c is relatively low, the gap between feasible solution and first-best risk sharing may be reduced.

According to above-mentioned analytical results, contract designer has to take account of a series of parameters （r， σ； d， η， m_c） in risk allocation. The optimality of risk sharing that can be attained by contract arrangement is the function of these background factors. To provide incentive to agent, the optimality of risk sharing has to be sacrificed to a certain extent. Nonetheless, if efficiency of agent's effort is high and / or monitoring cost is low, risk allocation may get close to firs-best risk sharing.

4. Conflicts in CRT transaction and Incentive Dilution

Based on theoretical analysis on the core problem of risk allocation, this section will turn to explore inherent conflicts in CRT transaction. According to financial intermediary theory, banking plays a unique role in savings-investment process. In tradition, loan is untradable contract and held by banks until maturity. That means banks are at risk during whole life of loan so that they have enough incentives to screening loan applicants and supervise borrowers. Accordingly, there is a paradox hiding behind secondary trade of credit risk. Buyer of risk needs seller release information about the risk, supervise borrowers and help to enforce loan contract. But bankers have no incentive to provide these services after they sell out the risk exposure. Risk transfer changes incentive structure of financial contract and has "dilution effect" on incentive of risk transferor, which makes bankers have opportunism propensity, because they are insulated from risk. Their moral hazard may express in three ways.

- **Selling Lemon Loan.** Bankers have private information of loans and may choose to sell loans with poor quality.
- **Reducing efforts expended on supervision.** Once banks discharge risk burden, their incentive to supervise borrowers will be weaken.
- **Lowering screening standards for loan applicants.** Because lenders anticipate risk of loan will be transferred to the third party, they won't try to investigate creditworthiness of applicants.

At the early stage of loan sale market development, some researchers point out that risk transfer may have negative impacts on incentive. Gorton and Pennacchi（1995）argue that the key reason causing loan illiquidity is preventing creditor's moral hazard. Duffee and Zhou（2001）discuss lemon problem and moral hazard in CRT. With evidence from subprime loans, Keys, et al.（2008）find that securitization leads to lenders shirking on borrower screening. Downing（2008）shows that market for mortgage backed securities is a market for lemons.

5. Limitation of incentive optimization mechanism in CRT markets

5.1. Hypotheses on endogenous incentives optimization in CRT markets

Before the outbreak of subprime crisis, quite a number of researchers and some government officials hold optimistic attitudes towards innovations of CRT. They deem that an efficient market has self-optimization mechanism which can relieve negative incentive effect incurred by CRT.

5.1.1. Providing incentives through proper contract design

Some scholars think that diluting effect of CRT on incentive may be relieved through contract arrangement. Gorton and Pennacchi（1995）suggest that bankers sell part of loan and retain rest share to assure loan buyers to believe they will still provide credit services. DeMarzo (2005) shows that banks may transfer signal of loan quality to outsiders by holding equity tranches in loan securitization. Duffee and Zhou（2001）find that there often exist term mismatches in credit derivative contracts, whose terms are shorter than that of underlying contact. The reason for this is that banks possess more information of short-term cash flow than that of long-term cash flow of loan, so they may transfer early default risk to outsiders and retain risk of default in the later period of loan. Arping（2004）argues that short-term credit protection may help to improve supervision efficiency of bank. If bankers find borrowers shirk and loan quality becomes poorer, they can ask the firms liquidate before due date of loan. bank's losses will be compensated by protection seller of CDS on the loan. So the "exit option" of bank is strengthened.

5.1.2. Incentive effect of market reputation on risk seller

Reputation Effect may impose implicit incentive on agents. If there exist repeated games, risk buyer will perceive the type of risk seller, and the perception will produce an effect on trade in the future. To establish their reputation, risk sellers need to consider not only current profits, but also the influences of previous contract performance on next trade. Thus they will form self-discipline mechanism to maximize their benefits in the long run. Gorton and Pennacchi（1995）believe that if loan seller break their promise, they will lose loan sale opportunity in future. Santomero and Trester（1998） think that it is difficult to sell loans at overestimated prices in repeated trades, because of reputation binding. Otherwise, loan buyers will charge “distrust premium”.

5.2. Limitation of contract design and reputation effect

5.2.1. Limitation of contract design

Contract design to mitigate dilution effect of risk transfer on incentive may be summarized as follows: First, risk exposure is tranched into multiple levels. Risk seller retains the first loss of equity tranches and buyers hold senior tranches. Second, risk exposure is decomposed into different periods. Banks transfer risk of early stage and retain risk of late stage. And third, payment of credit derivative links to default or bankruptcy index, which cannot be manipulated by both sides of trade. Although these arrangement may reduce moral hazard to some extent, but their application is limited in practice, or incentive provided by them is insufficient.

Risk tranching is widely applied in loan securitization. Nevertheless, even transferring part of loan risk still weakens incentive on risk seller. If a bank doesn’t provide full guarantee for loan repayment, his effort devoted into screening and supervising borrowers will be less than first-best level. Term mismatch is limited by bank’s hedging demand and capital restriction. Those banks with insufficient capital need insurance for long-term default risk of borrowers and require credit protection covering the whole life of loans. Indexing credit derivatives are typical parametric contracts, whose payment to hedgers isn’t based on their real losses. That means there is “quality basis risk”.

5.2.2. Limitation of Reputation Effect

Reputation effect may reduce information asymmetry problem but cannot eliminate it. Although market players may consider loan default as signal of bank shirking, it contains noise. Uncertainty of exogenous nature states is also the likely cause of loan default, leading the markets to attribute nonperforming loans to bad luck. Since loan default cannot serve as a fully representative signal of bank supervision level, reputation effect is incomplete.

A model is established to analyze whether reputation discipline may induce banks to monitor borrowers. Within the context of an infinite-horizon, the bank may repeat transactions with investors in CRT markets. Assume that it discounts profits with a factor γ . In each period, the bank lends to a borrower and then transfers the credit risk to other investors. The borrower raises capital to fund a project. If the project succeeds, it will produce payoff S and the bank will be paid S' , with $S' \le S$, otherwise it will receive F , i.e. liquidation value of project. A possible situation is that borrower can only engage in a low-risk project with success probability P_{I} , which will be observed by bank after originating loan with probability π . Another situation is that the borrower can choose either the relatively safe project or a riskier one that succeeds with probability P_l , where $P_l < P_{I}$ .Borrower may get private gain from the latter project, which implies the bank is subject to moral hazard with probability .

Bank can reduce probability of loan default by monitoring borrower. The cost of monitoring is m_c . When there is moral hazard and bank chooses to monitor in order to prevent borrower from undertaking high-risk project, project’s probability of success will rise from P_l to . If borrower may only choose the low-risk project, monitoring will not affect its probability of success. That means information about probability of success may signal bank’s monitoring decision. In order to encourage bank to monitor, investors must be able to assess whether the bank has monitored and reward it for monitoring and punish it for shirking. They may use the bank’s past loan defaults as a noisy signal of no monitoring. As long as bank can maintain its reputation, it will get a rent R in each period, otherwise $R = 0$.

Assume that a single default will cause bank to lose reputation and be excluded from CRT markets. E_n and E_d respectively denote expected present value of the bank's future profits when there is no default
or a loan default. So we have

$$E_d = 0 \tag{7}$$

$$E_n = R + (P_h)\gamma E_n + (1 - P_h)\gamma E_d = R + (P_h)\gamma E_n \tag{8}$$

$$E_s \quad (1 - \pi) m \quad E_n = \frac{R}{1-(P_h)\gamma} \tag{9}$$

If bank doesn't monitor, it may still get R in current period, because it locks profit by credit risk hedging and saves monitoring cost . But the probability of loan default rises and the probability of getting the rent in future decreases. Let denote expected present value of the bank's future profits when it shirks, we have

$$E_S = R + (1-\pi)m_c + (P_l + \pi(P_h - P_l))\gamma E_n \tag{10}$$

If $E_n \geq E_s$, bank won't choose to shirk, which may be written as:

$$P_l \quad \frac{(P_h - P_l)\gamma R}{1-(P_h)\gamma} \geq m_c \quad m_c \tag{11}$$

Accordingly, the bank is more likely to monitor under the following situations: First, discount factor γ is higher. That means the bank values long-term profits more. Second, P_l is higher, implying signal of bank's monitoring contains less noise. And is larger, thereby monitoring reduces probability of default by more. Third, monitoring cost is lower. If quality of borrower is very low, the signal passed by loan default is too noisy, it is hard for bank to reduce the default probability substantially by monitoring, a banker places great value on short-term profit, and / or monitoring cost is expensive, it is likely that reputation equilibrium will not be reached. So it can be explained why reputation effect isn't significant in subprime mortgage market.

6. Complexity of financial engineering and opaqueness of CRT markets

As discussed above, conflicts in CRT transaction cannot be eliminated through contract arrangement and reputation discipline. Furthermore, complex structured products created by financial engineers lead to opacity of CRT markets and magnify the information problem. When unfavourable shock hits, the fragile and opaque markets get into a total panic and break down.

6.1. Increasing complexity of financially engineered products and information loss

In recent years lending institutions have been engaging in creating affordability products for low-income groups. The innovative subprime mortgage products, such as Hybrid ARM, intend to allow riskier borrowers access to mortgage. A significant portion of subprime mortgages are sold to SPV after origination, serving as collaterals for MBS. To attract a broader range of investors, securitisation arrangers tranche claims on the cash flow from underlying loan pool and generate securities with varying risk-return profiles. Particularly, the key of pooling and tranching process is to create securities whose rating is higher than average rating of the underlying assets, because conservative investing institutions and remote investors with little ability to monitor the quality of underlying mortgages are only interested in investment-grade bonds.

The next link in the risk transfer chain is resecuritization of MBS. A special purpose vehicle purchases portfolio of MBS and other fixed income assets and finances the purchase via issuing different tranches of

CDOs. The senior tranches may get AAA rating and are popular for pension funds and insurance funds. Then the mezzanine tranches with smaller demand are pooled again and put into another CDO portfolio, as collateral for CDO-Squared. Analogously, CDO^n may be created, backed by CDO^n-1. Through repeated pooling and tranching, securities with higher rates may be sifted out from underlying portfolios and sold to more investors. Financial engineers achieve value mining to the fullest extent.

Besides cash CDOs, Synthetic CDOs may also be used to trade subprime risk, which invest in credit default swaps referencing subprime bonds or via an index linked to a basket of such bonds. Being combination of credit derivatives and structuring technology, Synthetic CDOs are typically divided into tranches to cater to investors' preferences to particular exposures that are unavailable in cash markets.

Bringing their creativity to full play, financial engineers provide more investment opportunities for investors and help to complete financial markets, but they also introduce the problem of complexity. Pooling and tranching makes evaluation of risk and return of a structured product very complicated. In addition, as chain of risk transfer extends, the distance between borrowers and ultimate risk holders increases. Along the chain, information flow about quality of underlying assets reduces and the degree of information asymmetry rises. Figure 1 describes the risk transfer chain and information loss.

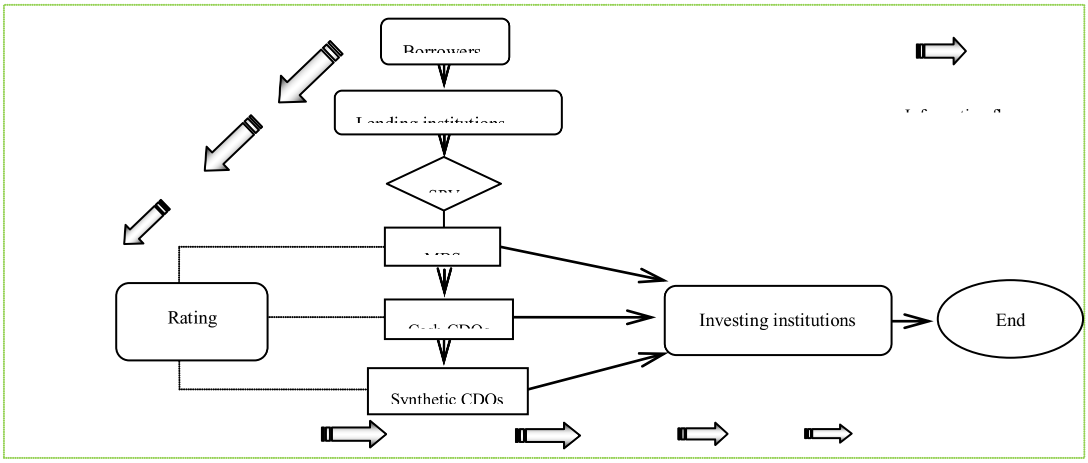

Figure 1 Complex risk transfer chain and information loss

6.2. Systematic incentive distortion along risk transfer chain

Due to information loss, the incentive problems in multi-tier agency relationships are amplified and accumulate. There is potential moral hazard in every link of CRT chain. First, the originate-to–distribute model leads to deteriorating loan underwriting standards and weakened due diligence. Second, credit rating agencies induced by rating shopping of issuers underestimate the risk of subprime-related structured products. Finally, the compensation scheme rewarding short-term profits encourages managers of investment institutions to take excessive risk.

6.3. Market panic under unfavourable shock

The complicated trading structures make CRT markets become a maze. Investors cannot penetrate the chain backward to the underlying assets. When housing prices declined dramatically, it was hard for market participants to determine the size and location of exposure to the shock. Everyone was left in a state of anxiety, fearing counterparties were better informed. Market euphoria turned to a crisis of confidence, which triggered the panic and caused CRT chain rapidly unraveled.

7. Conclusion

Contract design in engineering is driven by dual conflicting motivations of risk sharing and inventive provision. Excessive risk sharing will lead to insufficient incentive provision. Efficient risk allocation in financial contracts is appropriate risk sharing subject to incentive constraint. Credit risk transfer has dilution effect on incentives of risk transferors, which induces bankers to shirk in screening and monitoring borrowers. Although proper contract design and reputation concerns may provide incentives to risk sellers, the endogenous incentive optimization in CRT markets has limitations. The key task for regulators is to improve bottom-up disclosure of information on underlying portfolios， participating institutions, and the markets as a whole， which will help to reduce incentive misalignments along CRT chain and allow risk allocation to get close to Pareto optimal risk sharing.

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