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WHY DID INVESTMENT BANKS TAKE MORE RISK THAN OPTIMAL? A THEORETICAL ANALYSIS OF REASONS FOR SUBPRIME CRISIS

In this paper we build a game model to show that high-power compensation incentive, following strategies under information asymmetry and severe competition, and government's bail-out policies and deregulation are the main reasons to tempt investment banks to take too much risk. Our work supports the empirical findings of R. Fahlenbrach & R.M. Stulz (2011) while refutes the conclusion of Alan Blinder(2009) that poor incentives were "one of the most fundamental causes" for the crisis.

Keywords: *investment bank; compensation incentive; informational asymmetry; competition; government bail-out; regulation.*

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ЧОМУ ІНВЕСТИЦІЙНІ БАНКИ НАСТІЛЬКИ РИЗИКУЮТЬ? ТЕОРЕТИЧНИЙ АНАЛІЗ ПРИЧИН КРИЗИ СУБСТАНДАРТНОГО КРЕДИТУВАННЯ

У статті побудовано ігрову модель, що демонструє, яким чином матеріальне заохочення, інформаційна асиметрія, жорстка конкуренція та урядова фінансова підтримка банків стали ключовими причинами надмірних ризиків з боку інвестиційних банків. Наші результати суперечать доволі розповсюдженій думці, що незначні заохочення топ-менеджерів стали однією з головних причин кризи.

Ключові слова: *інвестиційний банк; матеріальне заохочення; інформаційна асиметрія; урядова підтримка; регулювання.*

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ПОЧЕМУ ИНВЕСТИЦИОННЫЕ БАНКИ ТАК РИСКУЮТ? ТЕОРЕТИЧЕСКИЙ АНАЛИЗ ПРИЧИН КРИЗИСА СУБСТАНДАРТНОГО КРЕДИТОВАНИЯ

В статье построена игровая модель, демонстрирующая, каким образом материальное поощрение, информационная асимметрия, жесткая конкуренция и финансовая поддержка банков правительством стали ключевыми причинами чрезмерных рисков со стороны инвестиционных банков. Наши результаты противоречат довольно распространённому мнению, что незначительное поощрение топ-менеджеров стало одной из главнейших причин кризиса.

Ключевые слова: *инвестиционный банк; материальное поощрение; информационная асимметрия; правительственная поддержка; регулирование.*

1. Introduction. The 5 biggest U.S. investment banks all suffered from the financial storm triggered by the subprime crisis, and the business model for independent investment bank was hit badly. Currently, most researchers in finance agreed that

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investment banks took too much risk by investing in high risk subprime loans as well as their derivatives and operating with high financial leverage. But what are the fundamental reasons to explain the high risk-taking behavior of investment banks? Some researchers, like Alan Blinder, argued that poor incentives were "one of the most fundamental causes" of the credit crisis (Wall Street Journal, 2009). While R. Fahlenbrach & R.M. Stulz (2011) found that "the banks with CEOs whose incentives were better aligned with the interests of shareholders performed worse and no evidence that they performed better". Yet these works were mainly empirical and their conclusions were not consistent.

This paper tries to build a game model of internal compensation incentives within investment banks, a game model of trading on derivatives between investment banks, as well as of financial aid to investment banks from the government, to explain why investment banks bear much more risk than they should. And our main conclusion support the findings of R. Fahlenbrach & R.M. Stulz (2011) that stock incentives of CEOs made them choose high risk business.

Our work differs from previous research in two ways. First, this article uses formal game models to explore the reasons why the banks prefer high risks. Second, this paper combines high compensation, industry competition and the government implied insurance to study the reasons why the banks prefer high risk business, and we come to the conclusion that the integration of these 3 factors intensify the banks' preference to choose high risk.

2. Game model of investment banks

2.1. Incentive compensation and high risk preference in a single investment bank. As one of the methods to solve agency problem in modern companies, compensation incentive is used widely. Empirical studies show that employees can be incented by compensation based on performance, and hence enhanced profits (Jensen and Murphy, 1990, Murphy, 1999, Hall and Liebman, 1998).

We set a game model between shareholders (or the board on behalf of shareholders and compensation committee) and CEOs. First, shareholders decide whether to implement incentive compensation or not. Then, given the shareholders' behavior, CEOs decide to choose high risk or low risk business. In order to simplify the analysis, we hypothesize that shareholders and CEOs know each other completely. Now, consider that there are 2 products at a market: high risk products and low risk products. We further suppose that high risk products may be defaulted and can't take back principals (the yields are standardized as 0). If they are not defaulted, they yield Y_H. The defaulted rate of high risk products is P, $0 < P < 1$. The defaulted rate of low risk products is too low to consider, so they yield fixed Y_L, $0 < Y_L < Y_H$. One real example of high risk products is subprime loans and their derivatives, while low risk products can be viewed as products like treasury bonds.

According to the classical agency theory (Holmstrom, 1979, Holmstrom and Milgrom, 1987), the incentive compensation provided by shareholders can be described as $W = S + bY$; S is the basic salary; b is the proportion of incentive, $0 < b < 1$; Y is earnings. After pay salary W to CEOs, the remained $(1-b)Y-S$ belongs to shareholders. When CEO chooses high risk business, he must work harder this to control risk, compared with low risk business. Hence, we suppose that the cost of efforts paid by a CEO when taking high risk is C_H. When a CEO Chooses low risk, the cost is C_L, $C_H > C_L > 0$.

When shareholders implement incentive compensation, if CEO chooses high risk business, the shareholders' expected income is $[(1-b)Y_H - S](1-P) + (-S)P$, the CEO's expected income is $(S+bY_H)(1-P) + SP - C_H$; if a CEO chooses low risk business, the shareholders' expected income is $(1-b)Y_L - S$, the CEO's expected income is $S + bY_L - C_L$. When shareholders don't implement incentive compensation, no matter how many proceeds a CEO brings, shareholders only pay basic salary S to a CEO. At this time, shareholders' income is $Y-S$. If a CEO chooses high risk, the shareholders' expected income is $(Y_H - S)(1 - P) + (-S)P$, CEO's expected income is $S(1-P) + SP - C_H$; if a CEO chooses low risk, the shareholders' expected income is $Y_L - S$, the CEO's expected income is $S - C_L$. We summarize the above in Figure 1.

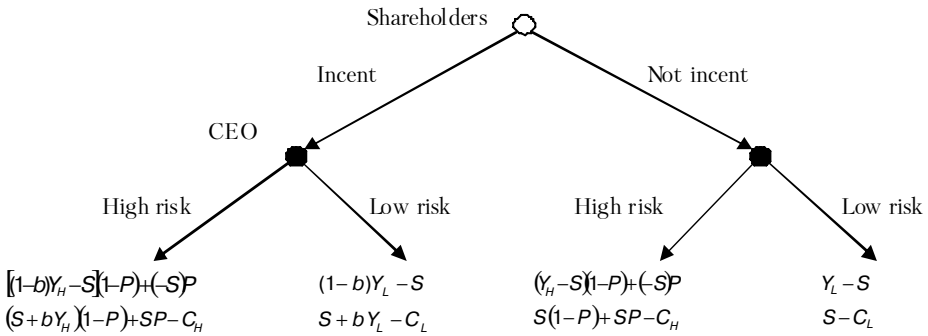

Figure 1. **The game between shareholders and CEO**

Solving the SPNE of the above game, we have the following conclusions: when $b < \Delta C/\Delta Y$ or $b > \Delta Y/[Y_H(1-P)]$, shareholders choose not to provide incentive compensation, and CEO chooses low risk business; when $\Delta C/\Delta Y < b < \Delta Y/[Y_H(1-P)]$, shareholders choose to provide incentive compensation, and CEO chooses high risk $(\Delta C = C_H - C_L,\ Y = Y_H(1-P) - Y_L)$. The explanation is that when $b < \Delta C/\Delta Y$, by taking high risk the expected income of CEO is lower than the extra efforts compared to low risk. CEO will choose low risk business. Meanwhile, shareholders can't get excess income from low risk business, so they choose not to provide incentive compensation. When $\Delta C/\Delta Y < b < \Delta Y/[Y_H(1-P)]$, shareholders encourage CEO to explore new business by giving incentive compensation. If the incentive rate is high, CEO's expected income is higher than the extra efforts. CEO will take high risk. When $b > \Delta Y/[Y_H(1-P)]$, because of the high risk CEO takes, shareholders' benefit will be hurt. Then, shareholders will not provide incentive compensation, and CEO turns to low risk.

In the U.S., before the subprime crisis, the subprime mortgage rate was 2-3% higher than common mortgage rate. Accordingly, the yearly yield of subprime bonds was 30% higher than that of the same term for higher grade bonds. The YTM of 10-year Treasury bond is about 4.3%. The loss rate of A grade RMBS estimated by "Standard & Poor's" is 22.2%, while that of BBB grade is 45.9%. Thus, given the positive expectation of shareholders and CEO, the condition $\Delta C/\Delta Y < b < \Delta Y/[YH(1-P)]$, can be satisfied easily. At this time, shareholders will provide incentive compensation to CEO, and CEO will choose high risk business.

Conclusion 1: When $\Delta C/\Delta Y < b < \Delta Y/[Y_H(1-P)]$, shareholders will provide incentive compensation to CEO, since the expected yield is higher than the incentive cost. High incentive rate encourage CEO to explore high risk business.

2.2. Competition and copycats in the investment industry. Consider two representative investment banks – A and B. They can choose to buy a subprime derivative with high risk and high expected return, or choose not to but it. If both choose to buy, they share gains and losses evenly; if one chooses "buy" and the other not, the "buy" side attains all the gains (or all the losses). Let Q be the net gain, P_1 and P_2 are the default rates, $0 < P_1 < P_2 < 1$, so the expected return of the derivative is Q (1-P1 (orP2)).

According to the practice of investment banks, we assume that the sunk cost to take part in subprime derivative trading is C, including the cost of advertising. If one chooses "not to buy", the sunk cost C can be saved. Generally, we assume that under lower default rate P_1, $Q(1-P_1) > 2C$; under higher default rate P_2, $Q(1-P_2) > C$. The reasoning for above assumption is that when default rate is lower, it is profitable for two investment banks (even more) to participate. When default rate is high, even if only one investment bank chooses "buy", thus obtaining all the gains and losses, the deal is still unprofitable. This means that the default rate has vital influence in the choice of investment banks. In the game model, let A choose first, then B makes its decision after observing the decision of A. The payments corresponding to different combination of actions are shown in Figure2.

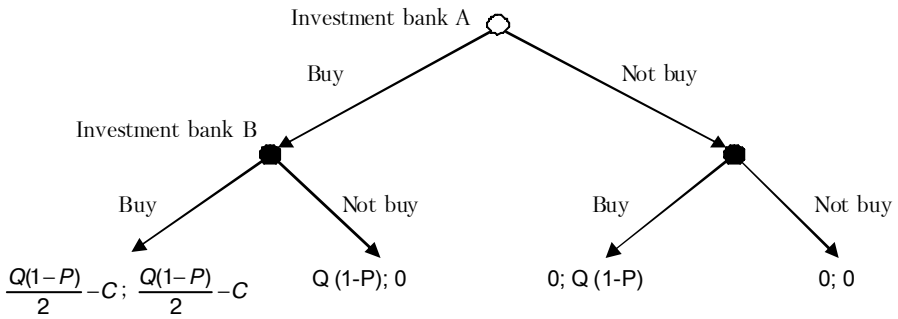

Figure 2. **Game model between investment banks on derivative trading**

Using backward induction, we can get that when the default rate is P_1, the SPNE is (buy; buy), the expected return is:

$$\left[Q(1-P_1)/2-C,\quad Q(1-P_1)/2-C\right]$$

When the default rate is P_2, the SPNE is (not buy; not buy), the expected return is (0; 0). From the analysis above, we can see that the best practice of B is to copy A's decision irrespectively of the default rate level. A will make its decision according to expectation of default rates, the result of this gaming process is (buy; buy) or (not buy; not buy) respectively.

In the framework presented above, the first-mover A expects lower default rate, thus chooses "buy". Then B observes A's move and copies it. Given the assumption

that "when default rate is lower, it is profitable for two investment banks (even more) to participate; when default rate is high, even if only one investment bank chooses "buy", thus obtaining all gains and losses, the deal is still unprofitable", A's "buy" decision would further enhance B's expectation that default rate would remain at a lower level. Finally, the result tends to be (buy; buy). Actually, U.S. subprime default rate was declining in 2002-2006, from 9.6% to 1.71%. And BIS ("Bank for International Settlements") data showed that investment banks were one of the major participants at CDS market.

Conclusion 2: Because of information asymmetry, investment banks rely on the action of others when making decisions in subprime derivatively trading, irrespective of default rates. During periods of market consensus of low expected default rate, investment banks will choose to buy subprime derivatives, and the copying characteristics will lead to the situation of high risk projects preference of the whole industry, foreshadowing the ending of investment banks as individual entities.

The analysis in this section naturally leads to another question: why the first-mover A chose to buy the subprime derivatives with high risks (thus leading to the risk accumulation in the whole financial sector)? Except from false expectation from historical data, two other factors may be also related. The first one is the incentive compensation mechanism discussed in Section 2, which spurred management's preference for risk. The second factor is government's implied bail-out insurance, discussed in detail in Section 2.3.

2.3. Government's Behavior and Investment Banks' Preferences. Krugman (1998) points out that government's guarantee to bank debts (deposit) would lead to overinvesting of commercial banks, then causing the increase of asset price, making the financial system more fragile. The following part of this section will establish the game model to analyze the behavior of government and investment banks' preference. Consider a sequential-move game between government and a representative investment bank. We assume that government has all the information about the investment bank's operations, and the investment bank gets all information about the government bail-out policy.

When the investment bank chooses low risk projects, the government chooses to rescue, the payments are R_L and $U - G_L$ respectively, where U is the government's gain from social stabilization, G_L is the cost of rescuing troubled investment banks, and let $U - G_L > 0$. With the government's rescue plan, the investment bank does not need to worry about the possibility of bankruptcy, it gets the subsidy R_L. When investment bank chooses to undertake low risk projects and the government does not rescue, the payment to government is $-U_L$ because of the social turbulence caused by bankruptcy and unemployment, while the loss to the investment bank is $-L_L$.

When the investment bank chooses high risk and the government chooses to rescue, the payments are R_H and $U-G_H$ respectively, where G_H is the cost of rescuing the troubled investment banks, and let $G_H > G_L$ to measure the higher cost of rescue related to the high risk projects; R_H is the expected return for investment banks, and $R_H > R_L$. When the investment bank chooses high risk projects and the government chooses not to rescue it, the payments are $-L_Y$ and $-U_H$ respectively, where $-L_H$ is the loss of the investment bank, and $-U_H$ is the cost of negative impacts on the society borne by the government, and let $-U_H < -U_L$, $-L_H < -L_L$ to reflect the larger loss incurred by high risk projects. The whole process is described in Figure 3.

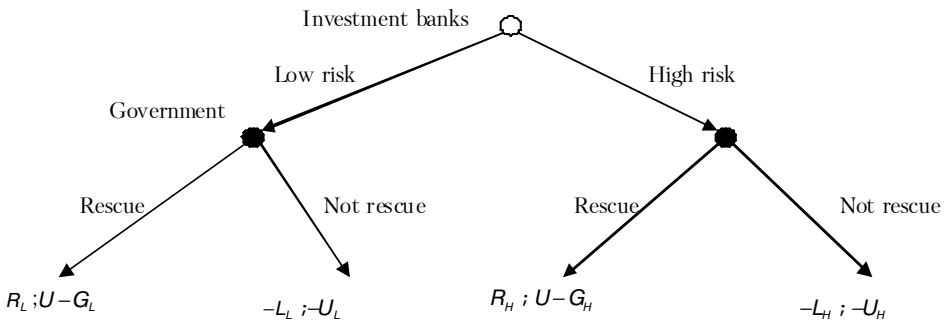

Figure 3. **Game between government and investment banks**

As we can see, despite the choice of investment banks, the government will choose to rescue for the payment is larger ($U\text{-}G_L > -U_L$, *or* $U\text{-}G_H > -U_H$). Expecting the rescuing plan of government, the investment bank will choose high risk projects for the higher return ($R_H > R_L$). Thus, when the expectation of government bail-out is strong enough, the problem of moral hazard will emerge, and the investment banks will undertake high risk projects. Actually, if investment banks observe the behaving pattern of the government in crisis before making decisions, and observe that the government would lend a helping hand almost in every crisis, the expectation about government rescuing would gradually form, and this expectation would lead to moral hazard. If we relax the assumption about effective regulation and government's knowledge about the investment bank's operation, the results are still similar.

Conclusion 3: Government's rescuing behavior in previous crisis enhances the expectation of government bail-out plans, thus forming an implied guarantee for high risk (insurance for these projects). As a result, investment banks unscrupulously choose high risk projects.

2.4. A Discussion: Combination of All Three Factors. From the analysis above, we can see that the 3 factors (exorbitant incentive ratio, copying under information asymmetry and competition, implied government bail-out) are not isolated from each ofter. Figure 4 shows the relation between frem.

First of all, under implied government bail-out and lack of regulation, shareholders of investment banks have an over-optimistic expectation about future returns, then design an exorbitant incentive ratio for management, thus entice CEO to choose high risk projects.

Basing on the model described in Figure 1, we introduce government bail-out. If government undertakes the losses in the case of default, expected default rate P will decrease, and the incentive compensation providing criterion $\Delta C/\Delta Y < b < \Delta Y/[Y_H\,(1\text{-}P)]$ will loosen. Consider the case of direct government subsidy. Let A be the subsidy amount, the shareholders get $[(1\text{-}b)\,Y_H - S]\,(1\text{-}P) + (A\text{-}S)P$. If the incentive compensation is provided, the criterion for CEO to choose high risk projects is $\Delta C/\Delta Y < b < (\Delta Y+AP)/[Y_H\,(1\text{-}P)]$. It is easy to prove that the upper limit is larger than the one without government subsidy. This means that with government bail-out, the possibility of incentive compensation is larger, and without requirements of reserve equity, CEOs prefer higher leverage and higher risk, thus increasing performance to maximize compensation.

Secondly, lack of government supervision exacerbates information asymmetry so that the influence of default rates in decision making decreases, leading to the higher risk preference of investment banks.

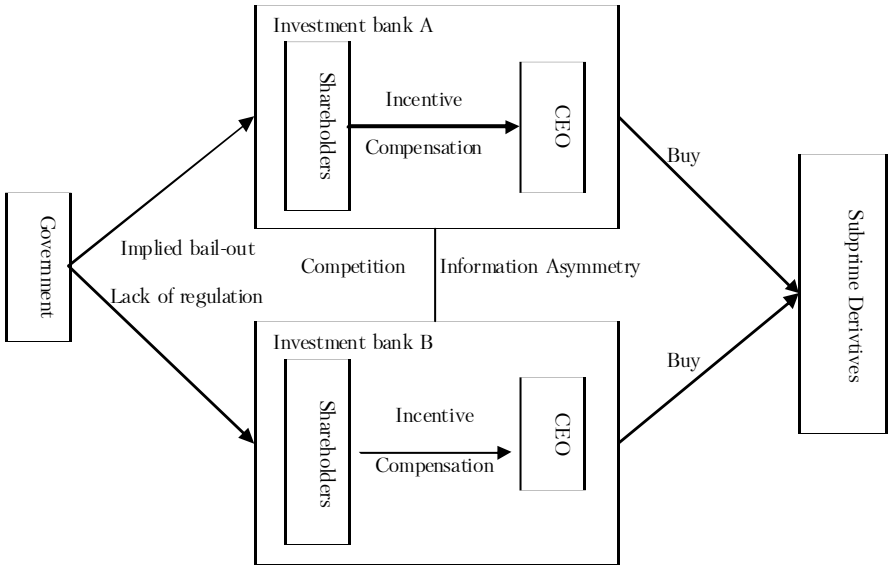

Figure 4. **Investment banks' preference towards high risk projects**

Investment banks are not that strictly regulated as commercial banks. Besides, the risk characteristics of subprime derivatives are uncertain. According to the framework presented in section 2.2, investment bank B would follow the decision of the first-mover A irrespectively of the default rate level. Observing B's action, A would make a decision based on its expectation of future default rates. Under implied government bail-out, the cost incurred when higher default rate happened was lower, encouraging investment banks to undertake higher risk projects. And the extent of risk chasing activity of investment banks depends on the amount of losses government would compensate.

3. Conclusions and Implications. In this paper we explore the underlying reasons why investment banks prefer higher-risk projects by building a game model describing the compensation incentive design, derivatives trading between investment banks and the interaction between investment banks and government. We show that high-power compensation incentive, following strategies under information asymmetry and severe competition, and government's bail-out policies would be the main reasons to tempt the investment banks to choose higher risk. Moreover, integration of these factors would worsen the situation investment banks have been confronted and inevitably make them collapse.

From this paper, we can get 4 empirical implications about high risk projects of investment banks, which can be the null hypothesis for future research.

Firstly, investment banks' high risk projects preference should be positively related to the power of incentive compensation. Incentive compensation can help solving

principle-agent problem, but high incentive power would also incur short-term performance aimed risk chasing activities of management.

Secondly, the investment banks' high risk projects preference should be positively related to the competition pressure. Because of information asymmetry and competition, the decision making process of a particular investment bank relied on the decision of other participants and the work of rating agencies. Based on the expectation that all participants will "share the pains, share the gains", the best strategy is to follow the decision of others. The final result is that no matter the level of default rates, as long as one investment bank buys the subprime derivatives, all others would follow, thus increasing the risk level of the whole industry.

Thirdly, investment banks' high risk projects preference is positively related to government bail-out (historical cases) and lack of regulation.

Lastly, government implied bail-out and lack of regulation will interact with incentive compensation and competition, enhancing the influence of these factors. On one hand, government undertaking part of investing losses will incur shareholder providing more powerful incentive plan, thus encouraging management seeking riskier projects. On the other hand, based on the common knowledge that "all participants will share the pains, share the gains", government undertaking part of investing losses will encourage first-movers to undertake higher risk, followed by other participants, and finally lead to the "once in a century credit tsunami".

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