CEO BEHAVIOR AND SUBPRIME MORTGAGE CRISIS

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ABSTRACT

The paper addresses the subprime mortgage crisis from the perspective of the CEO of a financial firm. We integrate agency theory with the asset-pricing model to explore factors affecting CEO risk aversion. Apart from wealth and effort, the two main factors in influencing the agent's risk preference, we also add a measure of CEO career concern to the model. Increasing peer pressure, high-incentive compensation structure, and declining market power diminish CEOs' alertness to risk, resulting in a departure of CEO actions from firm value. For reining in CEOs' excessive risk taking and aligning both interests of firms and CEOs, we suggest that the emphasis of the pay schedule should be adjusted according to market conditions, the relative performance evaluation be embedded into executive compensation, and the time span for performance evaluation be lengthened. The role of the board of directors and the function of risk management units should also be intensified.

JEL: D01, G21, M52

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INTRODUCTION

Global economy is besieged by the Great Recession following the meltdown of the subprime mortgage market in recent years. Panics about the rising rates of default and escalating foreclosures of subprime mortgages and in turn the overall mortgage market gave rise to a credit crunch, paralyzing the whole financial system and leading to a global economic calamity. An astronomical sum of taxpayer money in terms of billions was poured into financial markets with aim to save those big banks from failing. The extant sovereign debt crisis can be largely attributed to the subprime mortgage crisis as governments afflicted by subprime mortgage crisis accumulated large fiscal deficits and issued huge debts, aiming at alleviating the sufferings caused by the crisis. The damage left after the crisis is so vast and lingers so long.

It is widely believed that the last property prosperity resulted from lower interest rate with which the monetary authority spurred the gloomy economy after the technology bubble burst at the beginning of the new millennium. Such an advantage disappeared when the central bank started raising federal funds rate in 2004. Financial firms left out the fact that loose monetary policy had been reversed, and, on the contrary, they expanded their mortgage loans more aggressively in their portfolios. They even increased subprime share of total mortgage originations based on an illusion that the property market would keep prospering. A question to be answered is why financial firms chose to neglect those dramatic changes in the business environment and continued their gambling. It is unreasonable that firms would seek strategies which are pernicious to their own interests, so we turn our attention to the role of CEOs, who have decisive power over the ways how firms run their business, in the subprime mortgage crisis. The purpose of the paper is to present an alternative way of thinking about why the recent financial crisis befell the economy. Most of research looks at economic conditions, the loan- and borrower-specific factors. The worsening economic condition and declining quality of portfolios held by financial firms is the outcome of the crisis, not the cause. We hope that the paper can contribute to shape a clear picture of the recent financial crisis and provide some suggestions to improve the corporate governance of financial firms, thereby reducing the likelihood of future financial crises.

The next section will report related literature we refer to. In the modeling section, a set of factors that may influence CEOs' attitude toward risk are documented and are then included in a model.. We then suggest using incentive structures strategically to contain a CEO's excessive risk-taking in Section 4. The arguments and suggestions are then summarized in Section 5.

LITERATURE REVIEW

That management and ownership are separated is a common practice in a modern business. Completely monitoring all actions by CEOs is a mission impossible, compensation contracts based on chosen performance indexes are thus designed with a hope to align both interests of the principal and agent (Holmstrom, 1979, Milgrom, 1981). A specific compensation structure may have its impact on CEOs in a way that diverges from shareholders' expectation if such pay schedule is made just from the perspective of shareholders (Lamber, Larcker, and Verrecchia, 1991). Since CEOs command a fair control over their firms; they might use such an advantage to benefit themselves (Bebchuk and Fried, 2003). Thus, CEOs and shareholders are not always on the same line in respect of firms interests. When drawing a pay schedule, shareholders should consider what CEOs would react to a new compensation plan. One focus of our paper is to explore the impact of the incentive structures upon CEO attitude toward risk. Under certain circumstances, some compensation structures may provide CEOs an incentive to stray from what shareholders expect. Some empirical studies have shown that there is a strong causal relation between CEO incentive structures and the risk profile of a firm (Coles, Daniel, and Naveen, 2006, Guay, 1999). Firms with high-risk profile devise a compensation schedule with high convexity to make their CEOs more aggressive, and more risk-inducing incentives lead to a larger variance of performance for a firm. Among all components, option-like incentives are often used to increase the convexity of compensation and gain more and more popularity in the business community (Core, Guay, and Larcker, 2003).

But increasing the share of stock options in CEO compensation schedule does not guarantee that CEOs would follow the way expected by firms (Ross, 2004). In this paper we will provide a theoretical model to explore the relationship between CEO compensation and her/his risk preference, and restate the arguments made by Ross (2004) in a different way. Apart from aligning the interests of both firms and CEOs, a compensation schedule has its strategic role. In Kadan and Swinkels (2008), stocks could be used to prompt CEOs to work harder when firm viability is a big problem. On the contrary, when the nonviability risk is not a major issue, stock options always dominate stocks. The effect of CEO actions could span for a long period of time. The final results cannot be assessed in one year or two. For associating CEOs' remuneration more closely with their performance, firms can delay parts of CEO compensation until better information is available (Eaton and Rosen, 1983). In this paper, the incentive structures are used as an implement to diverge CEOs from heading into excessive risk takings. CEOs are also induced to care more about the long-term fundamental value of their firms.

Literature on finance has shown that social status concern has its role in influencing an agent's decision-making. People care about their relative living standard measured by the level of consumption, so a consumption externality exists as in Gali (1994). Bakshi and Chen (1996) assert that acquiring more-than-enough wealth can improve one's relative social status against peers in the same group may have direct impact on investors' decision-making. Managers will be ranked high if they create good outcomes for their firms when compared to their peers in the reference group. Higher evaluation means more satisfaction. CEOs, like other managers, also care about their standing relative to their competing rivals, so we include in the model an index measuring a CEO's relative social status. The resulting model can explain why CEOs tend to copy peers' successful strategies and herd into risky business activities without justification. If CEOs with career concern tend to do what other players do, we can find that a firm's own-performance may co-vary with variations in the market. This can explain, as revealed in Bertrand and Mullainathan (2001), why CEOs are paid for luck. The implication of such finding is that it is important to distinguish performance initiated by a CEO from that because of luck when arranging a CEO's compensation package. Reward should be paid for what a CEO does for the company with his own effort. Studies on the trade-off relationship between competition and stability in the banking industry are mixed. The traditional view asserts that increased competition may induce banks to take risks, and therefore, peril the financial stability (Allen and Gale, 2004, Keeley, 1990). But the contrary view says that increased competition is good for allocation efficiency without entailing financial instability (Boyd and De Nicolo, 2005). So there is a close association of competition with risk-taking of financial firms. Increased competition provides financial firms an incentive to tap opportunities which are underdeveloped but involve more risks, like subprime-related products in the last crisis.

Model

We follow literature on executive compensation that the utility function of a CEO takes the form of $H(s(R), a)$ where $s(R)$ is the compensation schedule granted to a CEO according to a measure of performance R, and a is the level of effort by a CEO. For giving CEOs a stimulus to work harder, they will be rewarded more as they contribute more to firm performance, that is, $s'(R) > 0$. Earnings are the most often used performance measure for bonus plan in finance and insurance industries (Murphy, 1999). Therefore, R of $s(R)$ is referred to as earnings for financial firms here. Candidate indexes for R could be net income, returns on assets or equity and the like. Earning assets, consisting mainly of loans and securities, command an overwhelming share of portfolios in financial firms and are the main source of revenues for the financial firm, so financial firms' earnings depend critically on the dollar value of their earning assets. For example, a larger portfolio of loans can earn more interest income, generating more profit for the financial firm. More profits, higher stock prices. So earnings R can be expressed as $R = g(X)$, where X represents the value of earning assets. Therefore, the pay schedule for a CEO can be expressed as $s(R) = s(g(X)) = \pi(X)$, and a CEO's utility function can be rewritten as $H(\pi(X), a)$.

Suppose that the portfolio of a financial firm consists of n earning assets, the value of the portfolio at time t can be written as

$$X_t = \underline{\theta}_t \underline{P}_t = \sum_{i=1}^{n} \theta_t^i P_t^i \tag{1}$$

where $\underline{\theta}_t$ is the quantity vector for the portfolio, $\underline{P}_t$ is the price vector, θ_t^i is the quantity of asset i in the portfolio, and P_t^i is the corresponding price for the asset i with the following stochastic process of *Itô*'s type:

$$\frac{dP_t^0}{P_t^0} = rdt\ , \tag{2}$$

$$\frac{dP_t^i}{P_t^i} = \mu_t^i dt + \sigma_t^i dB_t^i\ , \tag{3}$$

in which P_t^0 is the price for the riskless asset at time t with a constant r as its rate of return, μ_t^i and σ_t^i are the drift coefficient and diffusion coefficient for the price of the ith asset, respectively; B_t^i is a standard Wiener process with a unit variance for the ith asset.

For addressing CEOs' reputation concern, we include a measure of relative social status, k, in our model. We call k the relative performance index measuring the social status for the CEO and can be expressed as $k = V_r / V_i$, where V_r is the middle performance created by the reference group the CEO locates, and V_i is the performance by the CEO. By adding a relative performance index, a CEO's utility function is now extended to take the form of $H(\pi(X_t), k_t, a_t)$. Assume that $H(\pi(X_t), k_t, a_t)$ has at least third-order partial derivatives with respect to each argument involves. The resulting expected utility for the CEO at time t can be written as

$$U(\pi(X), k, a) = \int_0^{X+} H(\pi(X), k, a) f(X, a) dX \tag{4}$$

where X^+ is the maximum value for X, $f(X, a)$ is the density function for X given a. $H(\pi(X_t), k_t, a_t)$ and

$U(\pi(X_t), k_t, a_t)$ are assumed to move in the same direction under the influence of the arguments involved. We assume that a CEO's utility function is strictly increasing, but concave in pay, so $U_\pi > 0$ and $U_{\pi\pi} < 0$. An increment in pay generates less utility to a CEO who is wealthier. A rise in k means the CEO has poorer operating outcome relative to her/his reference group, and thus brings down her/his utility, that is, $U_k < 0$. If the structure of a CEO utility remains unchanged as k rises, the marginal utility with respect to pay will increase at a lower utility, that is, $U_{\pi k} > 0$. The likelihood of good performance increases as more effort from a CEO shifts the distribution induced by X to the right in the sense of first-order stochastic dominance, leading to $U_a > 0$. Contrary to the effect of k on the marginal utility with respect to pay, $U_{\pi a}$ is predicted to be negative. We also assume that the relative performance index, k, and the effort, a, have the following *Itô*'s processes:

$$\frac{dk}{k} = \sigma_t^k dB_t^k \ , \tag{5}$$

$$\frac{da_t}{a_t} = \sigma_t^a dB_t^a \ . \tag{6}$$

Equation (5) indicates that the firm does not have a dominant control over the whole industry. As k is the middle level of performance in the reference group, it is beyond a firm's control. So k is assumed to be determined exogenously. The level of effort is expended at the discretion of CEOs and is opaque to firm owners. Such a fact is reflected in Equation (6).

Suppose CEOs dynamically manage firms' portfolios. They make asset allocation for time $t + \Delta t$ at time t based on the information set F_t. Each portfolio is self-financing. For instance, $X_t = \underline{\theta}_t\underline{P}_t = \underline{\theta}_{t+\Delta t}\underline{P}_t$, the portfolio $\underline{\theta}_{t+\Delta t}$ is made at time t and continues to the time $t + \Delta t$. Now the problem for a CEO in the discrete time is to choose a set of control variables, that is, $\{(\underline{\tau}_t, \underline{a}_t)$: $t = 0, \Delta t, 2\Delta t, \ldots\}$, where $\underline{\tau}_t = (\tau_t^0, \tau_t^1, \ldots, \tau_t^n)$ is a portfolio vector with τ_t^i as the share of portfolio held in the form of the ith asset, and $\underline{a}_t$ represents a collection of effort expended at each time interval so as to

$$\max_{\tau_t, a_t} \sum_{t=0}^{\infty} e^{-\rho t} E_0 \left[U\left(\pi(X_t), k_t,\ a_t\right)\Delta t\right] \ , \tag{7}$$

subject to

$$\Delta X_t = X_{t+\Delta t} - X_t = X_t\left[(r + \textstyle\sum_{i=1}^n \tau_t^i(\mu_t^i - r))\Delta t + \sum_{i=1}^n \tau_t^i \sigma_t^i \Delta B_t^i\right] \text{ (See Appendix A)}, \tag{8}$$

where ρ is the time preference parameter. At the beginning, we assume that pay schedule is linear, that is, $\pi_X(X_t) = \pi_X(X_{t+\Delta t})$. This assumption will be relaxed later when investigating the effect of convex incentive structures on CEO risk preference. Bakshi and Chen (1996) develop an asset pricing model to analyze the effect of social status concern on investors' decision. Here we adapt their methodologies to build up our mode. The expected risk premium, a proxy for CEO risk preference, demanded by the CEO concerned on the risky asset in the continuous-time setting can be shown as follows,

$$u_t^i = \mu_t^i - r = -\frac{X_t U_{\pi\pi,t}\pi_{X,t}}{U_{\pi,t}}\sigma_{i,X} - \frac{k_t U_{\pi k,t}}{U_{\pi,t}}\sigma_{i,k} - \frac{a_t U_{\pi a,t}}{U_{\pi,t}}\sigma_{i,a} \text{ (See Appendix B)}, \tag{9}$$

where $u_t^i = \mu_t^i - r$ is the expected risk premium demanded by a CEO on asset i at time t, reflecting CEO risk attitude towards holding the risky asset. Asset i here can be an individual asset, a class of assets, or an investment project. A rise in u_t^i means that, from the perspective of the CEO, the risk in investing in asset i increases and the CEO will reduce the amount of money allocated to the asset. On the contrary, the CEO augments the share of the asset i in the firm's portfolio as u_t^i reduces. Terms $\sigma_{i,X}$, $\sigma_{i,k}$, and $\sigma_{i,a}$ are the covariances of the rate of return on asset i with the growth on the firm value, the variation in the relative performance index, and the change in effort, respectively; that is,

$\sigma_{i,X}dt \equiv \text{cov}(dX_t/X_t, dP_t^i/P_t^i)$, $\sigma_{i,k}dt \equiv \text{cov}(dk_t/k_t, dP_t^i/P_t^i)$, and $\sigma_{i,a}dt \equiv \text{cov}(da_t/a_t, dP_t^i/P_t^i)$.

Concentration Risk

If a CEO considered is a risk averter with respect to pay as assumed above ($U_{\pi\pi,t} < 0$), CEO pay is increasing in the value of performance estimator ($\pi_{X,t} > 0$), and growth in portfolio value is positively associated with the return on the risky asset ($\sigma_{i,X} > 0$), then $-(X_t U_{\pi\pi,t}\pi_{X,t}/U_{\pi,t})\sigma_{i,X}$ in Equation (9) is positive. If a CEO is more risk averse to pay (larger $-U_{\pi\pi,t}/U_{\pi,t}$), she/he will be more careful to manage the asset portfolio. This is especially true as the level of pay for the CEO is high because of better performance, for preserving her/his reputation, she/he will be conservative in decision-making. When managing a larger portfolio (larger X_t), a CEO will be more alert to risks involved in her/his investment decision. Higher sensitivity of CEO pay to firm performance (i.e., $\pi_{X,t}$ is larger) is accompanied by larger risk premium demanded. Such risk awareness also increases in $\sigma_{i,X}$, a measure for the relationship between returns on asset i and the growth on the portfolio, X_t. If asset i accounts for a substantial proportion of the portfolio, the total return on asset portfolio will be closely related to asset i, resulting in a bigger $\sigma_{i,X}$. Larger $\sigma_{i,X}$ leads to a risk averse CEO. This reflects a fact that it is a risky policy to put all eggs in one basket. Firms that focus on only few assets easily fall prey to market shocks. For example, mortgage loans comprised the largest part of assets in lenders in last financial crisis. As house prices plummeted resulting from the collapse of the housing bubble, lenders incurred a great amount of bad loans as the rates of delinquency rate and foreclosure ascended. So the best policy for firms or CEOs acting on their behalf is to diversify their portfolios and broaden the branching network.

Proposition 1: With other things being unchanged, if a CEO cares more about each dollar of the pay, her/his pay is closely related to firm performance which in turn relies on heavily on the risky asset concerned, and the asset portfolio managed is larger, she/he will refrain from putting too much stake on such risky asset.

Performance-Induced Social Status Concern

As noted above, a CEO with concentration risk concern demands more risk premium on the risky asset which is associated with firm performance more closely. Concern for risks involved in holding the asset increases as its share in firm portfolio becomes larger. But we find that mortgage-related products accounted for a largest proportion of the portfolios held in financial firms in the last housing boom; at the same time, the proxy for risk premium, the spreads between the mortgages rates and the federal fund rates, declined. It reveals that financial firms bet more fortune on the already-inflated assets instead of diversifying their portfolios. The practice is contrary to the prediction above. There must be some other factors reversing CEOs' risk alertness. We attribute such excessive risk-taking among financial firms to the peer pressure. Equation (9) shows that the effect of k on CEO risk aversion depends on the term $U_{\pi k,t}$. As shown above, $U_{\pi k,t}$ is predicted to be positive, leading to a negative $-(kU_{\pi k,t}/U_{\pi,t})\,\sigma_{i,k}$. The CEO tolerates more risks involved in an asset that is positively associated with peers' performance, that is, she/he will increase the stake on a risky asset which helps competing rivals create superior outcome. That is, the CEO will be herded into what her/his peers are doing.

Proposition 2: With other things being unchanged, a *CEO's sense of risk is dulled if she/he faces a stronger peer pressure, and she/he tends to mimic those strategies which make her/his peers better .*

Cross-sectionally, the expected risk premium on an asset with more association with k is smaller than that of another asset with less association. This means that a CEO would like to stake more money on an asset which delivers a larger contribution to the peer group's performance. To see this, we differentiate u_t^i in Equation (9) with respect to $\sigma_{i,k}$ and we get the following result:

$$\frac{\partial u_t^i}{\partial \sigma_{i,k}} = -\frac{kU_{\pi k,t}}{U_{\pi,t}} < 0 . \tag{10}$$

As $-kU_{\pi k,t}/U_{\pi,t} < 0$, a CEO demands less risk premium on an asset that is more closely associated with the relative performance index. So if there exist tow asset, asset i and asset j, $i \neq j$, and $\sigma_{i,k} < \sigma_{j,k}$; then the expected risk premium on asset j will be smaller than that on asset i. A CEO is more willing to hold asset j instead of asset i.

In the last housing boom, financial firms profited a lot from subprime mortgages. When peers staked a great sum of money in subprime mortgages and had superior performance, the term $\sigma_{i,k}$ in Equation (9) became larger, where the ith asset denotes subprime mortgages here. Larger k and $\sigma_{i,k}$ trimmed down the expected risk premium demanded by the CEO; that is, the CEO was induced to allocate part of resources to subprime mortgages. When more players herded to scramble for the sizzling assets, subprime mortgages became even hotter, resulting in a mortgage bubble. The quality of portfolios held by financial firms deteriorated as market players lowered their underwriting standard to enlarge their share of subprime mortgage market. Higher delinquency rate and consequent foreclosure caused a great loss to financial firms. As the bubble burst, all financial firms involved suffered a lot, leading to a financial tsunami. In this case, the career concern dims CEO's sense of risk. They are induced to follow what their peers are doing without justification. Such actions are rational from the perspective of CEOs, but they are pernicious to long-term interests of firms they work for. The subprime mortgage crisis is a conflict of interest problem between the principal and the agent. As CEOs with career concern tend to copy actions of their peers, their own-firm performance is seen to co-vary with market fluctuations. As CEO pay is performance-based, there exists a correlation between CEO pay and market performance. This can explain why CEOs are paid for luck, as revealed in Bertrand and Mullainathan (2001).

Incentive Structures and CEO Behavior

Now we relax the assumption that the pay schedule is linear, then $\pi_X(X_t) \neq \pi_X(X_{t+\Delta t})$. The focus of the analysis is to see whether the incentive structures play an important role in affecting CEO risk preference. The relaxation of assumption changes the equation for the expected risk premium demanded by the CEO on a risky asset into the following form,

$$u_t^i = -X_t\left(\frac{U_{\pi\pi,t}\pi_{X,t}}{U_{\pi,t}} + \frac{\pi_{XX,t}}{\pi_{X,t}}\right)\sigma_{i,X} - \frac{k_t U_{\pi k,t}}{U_{\pi,t}}\sigma_{i,k} - \frac{a_t U_{\pi a,t}}{U_{\pi,t}}\sigma_{i,a} . \tag{11}$$

Equation (11) differs from Equation (9) by including the term $-\pi_{XX,t}/\pi_{X,t}$, the ratio of second derivative of pay schedule over its first derivative with respect to X. Now a compensation schedule exerts its influence on CEO through three terms, that is, $-U_{\pi\pi,t}/U_{\pi,t}$, which reflects CEO risk preference with respect to pay, the pay-performance relationship, $\pi_{X,t}$, and the convexity of the incentive structure, $-\pi_{XX,t}/\pi_{X,t}$.

For prompting CEOs to work harder, they are paid according to firm outcomes they achieve. Provided that pay is a primary source of revenue for CEOs, their exposure to firm-specific risks is larger than more diversified shareholders. Since $U_{\pi,t} > 0$ and $U_{\pi\pi,t} < 0$, a higher $\pi_{X,t}$ reduces a CEO's appetite for risk involved in a risky asset and make CEOs conservative in their investments. Although an incentive structure based on performance align the interests of both CEOs and shareholders, firms may lose some growth opportunities because conservative CEOs may put those seemly risky investment projects with positive net value on the self. As noted above, plethora of CEO risk aversion would potentially restrain a firm from growing. Option-like incentive schemes, by providing convex payoffs, can alleviate a CEO's aversion to risky policies. In Equation (11), the term $\pi_{XX,t}$ is positive for a compensation schedule with convex payoff, and this leads to $-X_t(\pi_{XX,t}/\pi_X)\sigma_{i,X} < 0$. Such a high-incentive compensation schedule reduces CEOs' alertness to risk involved in the risky asset.

Proposition 3: A compensation schedule with more emphasis on convex components will lure a CEO to take on more risk, given other things being the same..

There is an upswing in the use of stock options in CEO pay recently (Core, Guay, and Larcker 2003). By 1994, options had become a major component of CEO annual pay, with 70 percent of CEOs receiving new option grants, and mean option grants is almost parallel to the level of cash pay. Also Murphy (1999) reports that stock options have become the single largest component of executive compensation during the early 1990s. A consequence accompanying such an increased use of stock options is the augmented convexity in compensation schedule, increasing CEOs' appetite for risks; so larger convexity in CEO compensation results in riskier policies, including more aggressive investments, more business focus, and higher leverage, as documented in Coles et al. (2006).

CEOs with career concern are induced to do what other players do in the market. They are inclined to gamble on the inflated asset, like subprime mortgages in last financial crisis. High-incentive compensation schedule tempted CEOs to stake more on the gambling asset for winning themselves a gorgeous pay. That is why lenders acquired recklessly subprime mortgage-related products when warnings from internal or external sources showed that the quality of the risky asset had been deteriorating in last crisis. Career concern and convex pay stimulus together aggravate a CEO's excessive risk-taking. The CEO's interest diverges from that of the financial firm she/he works for.

Market Structure and CEO Risk Aversion

If a firm is a real player in the market, for instance, each lender has its say in pricing products or services in the market. Being agents for firms; CEOs have their sway over firm competitive strategies, so there exists a relation between CEO actions and the return on the risky asset, that is, $\sigma_{i,a} > 0$. The term $\sigma_{i,a}$ in Equation (11) measures the market power for a financial firm. Larger $\sigma_{i,a}$ implies that a CEO has more discretion to manipulate prices to secure their advantages. The effect of $\sigma_{i,a}$ upon CEO risk preference depends on the sign of its coefficient,$-(a_tU_{\pi a,t}/U_{\pi,t})$. We have shown before that $U_{\pi a,t}$ is negative; therefore, $-(a_tU_{\pi a,t}/U_{\pi,t})$ is positive in sign. From Equation (11), the expected risk premium on the risky asset increases when $-(a_tU_{\pi a,t}/U_{\pi,t})\sigma_{i,a}$ is included. With more market power, that is, $\sigma_{i,a}$ is larger, CEOs tend to ask a higher premium on services or products firms provide to their customers. On the contrary, a decrease in market power is followed by riskier strategies. This is the first paper which relates CEO risk aversion to market power theoretically.

Proposition 4: Market power has its effect on a CEO's appetite for risk. A fall in market power tends to drop a CEO's aversion to risk.

The implementation of financial deregulation in past decades weakens the market power for lenders, $\sigma_{i,a}$ is thus brought down in Equation (11). With declining franchise value, CEOs of financial firms are prone to risk-taking. For improving their dropping profitability, CEOs of financial firms are forced to tap under-developed areas which involve more risk. That is why some lenders in last housing boom chose to downgrade their underwriting standards and extended loans to those who were rejected because of poor credit quality, betting on a continual price appreciation in the real estate market. At the beginning, those ambitious lenders benefited a lot from subprime mortgages, enhancing their status in the industry. Then other CEOs felt peer pressure and were driven to follow suit. In addition, strong incentives were provided by shareholders in order to induce more CEO effort on the thriving business. As more and more lenders were lured into such a profit-pursuing activity, a bubble loomed large in the subprime mortgage market. The anticipated long-lasting housing boom was proved to be an illusion at last; the house price tumbled as investors drew back their money from the market. Subprime mortgages were the first victim because of poor quality. Investors holding securities associated with subprime mortgages suffered a lot as their investments were discounted substantially when the subprime panic prevailed. The contagion of subprime panic to other markets triggered a credit crunch which paralyzed the world financial system, leading to an economic catastrophe. Disappearing market power laid the ground for the development of subprime mortgages. Career concern and convex pay stimulus sped up the burgeoning of the market.

Regulators around the world have been castigated for not taking actions early enough to stave off the meltdown of financial market, so more strict regulation and supervision is anticipated in the near future. But too restrictive regulation may stifle innovation and liquidity in the financial market and consequent welfare loss is also substantial. Most importantly, it cannot assure a complete avoidance of future financial crises. When CEOs are dominated by career concern and speculation-spurred pay schedule, excessive risk-takings by CEOs, as a threat to the financial stability, could resurge in the future, notwithstanding stringent regulations. We have learned painful lessons from past crises, and reforms have been churned out from time to time with a hope that the economy can be immune from any shocks thereafter. But history still repeats itself. There must be something that we miss when exploring the root cause of the financial crisis. As note above, CEOs of financial firms played a nontrivial role in the crisis. Corporate governance in financial services industry needs to be updated.

<u>Incentive Structures as a Strtegic Tool</u>

The subprime mortgage crisis reveals that there are some problems existing in the financial system. Governments around the world have launched a series of financial reforms with aim to stabilize the toppling financial system and fend off future financial crises. Most of reforms impose more restrictions on risky practices of financial firms. Little has been done to deal with the conflict of interest between the principal and agent, which plays an important role in causing the crisis. We will try to give some suggestions on the corporate governance practices which may improve the agency problem in financial firms. CEOs behave under the influence of incentive structures, peer pressure, and market power, as shown in Equation (11). Apart from the shrinking market power for financial firms because of deregulation, too risky policies emerge because high-incentive compensation and CEO career concern dominates. For those factors affecting CEO behavior, only incentive structures can be managed by firms. For exploring the effect of reshaping executive compensation on the CEO risk preference, we rewrite Equation (11) as follows:

$$u_t^i = f\big(A(\pi),\, D(\pi),\, C(\pi)\big) - \frac{k_t U_{\pi k,t}}{U_{\pi,t}}\sigma_{i,k} - \frac{a_t U_{\pi a,t}}{U_{\pi,t}}\sigma_{i,a}, \qquad (12)$$

where $A(\pi) = -(U_{\pi\pi,t}/U_{\pi,t}) > 0$, which denotes the coefficient of absolute risk aversion with respect to pay, $D(\pi) = \pi_{X,t} > 0$, which gauges the sensitivity of pay to performance, and $C(\pi) = -(\pi_{XX,t}/\pi_{X,t})$, which measures the convexity of CEO compensation schedule. The sign of $C(\pi)$ depends on the convexity of a pay schedule. If the pay schedule is convex, $\pi_{XX,t} > 0$, leading to $C(\pi) < 0$. By contrast, $C(\pi) > 0$ if the pay schedule has concave structure. Now the CEO risk preference for a risky asset is a function of $A(\pi)$, $D(\pi)$, and $C(\pi)$, given other things being the same. For examining how a change in incentive structures (π) impacts a CEO's risk preference for a risky asset, we differentiate Equation (12) with respect to π, holding the last two terms constant. The result we obtain is as follows,

$$\frac{du_t^i}{d\pi} = f_A\frac{dA}{d\pi} + f_D\frac{dD}{d\pi} + f_C\frac{dC}{d\pi}. \qquad (13)$$

Equation (13) shows that the effect of a change in incentive structures on CEO risk preference depends on variations in CEO absolute risk aversion with respect to pay, the sensitivity of pay to performance, and the convexity of the compensation package. According to Equation (11), an increase in $A(\pi)$ raises the aversion of a CEO to risk, therefore, $f_A > 0$. A CEO becomes conservative in the decision-making if $\pi_{X,t}$ is higher, so $f_D > 0$. As for the sign of f_C, an increase in $C(\pi)$ means a reduction in convexity of incentive structures, and this will reduce a CEO's willingness to take risks, that is, $f_C > 0$. The term $f_A(dA/d\pi)$ is

similar to the "translation effect", measuring a change in CEO risk preference with respect to pay arising from an adjustment in CEO compensation, $f_D(dD/d\pi)$ to "magnification effect" which gauges the impact of variations in sensitivity of pay to performance, $f_C(dC/d\pi)$ to "convexity effect" representing the impact from any changes in convexity of CEO compensation schedule, as in Ross (2004).
The condition for reshaping executive compensation to dampen a CEO's appetite for risk is

$$f_A \frac{dA}{d\pi} + f_D \frac{dD}{d\pi} + f_C \frac{dC}{d\pi} > 0 . \quad (14)$$

On the contrary, for making the CEO more aggressive in actions, the condition changes into

$$f_A \frac{dA}{d\pi} + f_D \frac{dD}{d\pi} + f_C \frac{dC}{d\pi} < 0 . \quad (15)$$

Based on our model, CEO behavior is procyclical. When the market is in prosperity, the relative performance index (k) and the association of the risky asset with peers' performance remain large. Combined with aggressiveness-oriented compensation plans, CEOs are tempted to gamble on the risky asset, exposing their firms to the systemic risk when the market trend reverses. That is why the subprime mortgage crisis broke out. On the contrary, if the market is in slack, they become more conservative in their decision-making. So offering a high-incentive compensation schedule to their CEOs does not always lead CEOs' actions to the interests of the firms. Executive compensation package should be managed dynamically according to the conditions of markets. When the economy is in upturn, CEOs are easily induced by high-incentive executive compensation and peer pressure to be less rise averse.

The firm can reduce the convexity ($dC/d\pi > 0$) and increase the delta ($dD/d\pi > 0$) of the pay schedule granted to CEOs. The components of a pay schedule with convex payoff should be reduced and the sensitivity of pay to firm performance be enhanced. On the contrary, when market demand is slack or the economy is in recession, more stimuli are required to attract and encourage the CEO to be proactive in her/his actions. Then firms may enlarge the convexity and lower the performance-pay relation of the pay schedule. The synchronization of the interests of both firms and CEOs can be assured more by a dynamically-managed CEO compensation schedule. Since the possibility of conflict of interest between the CEO and the firm exists, the board of director should play a role of guard to align both interests of the CEO and the firm. The function of the risk management units should be also intensified.

The interference from the CEO or other executives in the risk management practices should be reduced to the extent that the units can work independently. CEOs with status concern tend to mimic strategies that make their peers more successful. However, such reckless herding raises the likelihood of paying CEOs for luck and increases firms' exposure to external disturbance as coordinated actions by market players may lead to a bubble. Firms may perform well as the bubble grows, but a catastrophe befalls as the bubble bursts. For signaling to CEOs that there is no free lunch and urging them to create their own successful model, the relative performance evaluation (RPE) can be added to the compensation packages for CEOs. The introduction of RPE blocks the loophole where CEOs have chances to shirk their responsibilities and lessen CEOs' incentive to follow their peers' steps without justification. The term $-(kU_{\pi k,t}/U_{\pi,t})\ \sigma_{i,k}$ in Equation (11) is thus reduced or eliminated. The likelihood of taking excessive risks by CEOs with career concern can be relieved substantially. The impact of CEO actions on firm outcome may last for several periods of time. Thus, if the time span of CEO performance evaluation is lengthened and parts of compensation are delayed until the noise in the information on CEO performance disappears, CEOs would be ushered to pay more attention to the effects of their actions for later years. Suppose a firm decides to relate CEO compensation to a two-year performance index and has obtained considerable profits in the first year, for assuring that the good performance will continue to the next period and then a handsome pay will be rewarded, the CEO would be cautious about her/his actions in the second year. Each dollar of pay will contribute more utility to a CEO, and the absolute risk aversion with respect to pay in Equation (11), $-(U_{\pi\pi,t}/U_{\pi,t})$, rises. The CEO loses some appetite for risks.

However, if the firm undergoes a tremendous loss in the first year, the CEO has to work harder to boost firm performance in the following year; that is, more aggressive actions must be taken. This implies that $-(U_{\pi\pi,t}/U_{\pi,t})$ will go down. Otherwise the CEO will get miserable income and/or be dismissed.

CONCLUSION

The paper addresses the subprime mortgage crisis from the perspective of CEOs of financial firms. We combine agency theory with studies on asset pricing to present a model with aim to explore the propensity of CEOs to risks. In developing the model, we follow the traditional literature on agency theory that pay (here the proxy for wealth) and effort are two main factors in maximizing the utility of a CEO. Another factor used as a proxy measuring the social status concern of a CEO is added to the model as literature on finance has shown that such status concern has an important role in affecting an agent's decision making. Some studies on the subprime mortgage crisis focuses on the deterioration in economic condition or the quality of portfolios held by financial firms, but the worsening economic recession or rising delinquency rates are the outcome, not the cause of the crisis. Other research puts emphasis on the close relationship between high-incentive executive compensation and CEOs' excessive risk-taking. But such argument fails to explain why a great number of CEOs of financial firms put substantial resources in the subprime-related products at the same time.

Actions taken by CEOs in the process of maximizing their own interests are not always consistent with the benefits of shareholders as well as fundamental value of the firm, so some institutional mechanisms intended to stave off CEOs' irrational aggressiveness should be established. Independent board of directors could play a role of guard to stop excessive risk-taking by a CEO. The isolation of risk management system from the control of a CEO allows more room for those staff of risk management units to work as a qualified goalkeeper. For aligning both interests of firms and CEOs, CEO compensation package could be used strategically to alter CEOs' inclination to risk under different economic conditions. For motivating a CEO to pay more attention to the long-term interests of the firm, part of pay for the CEO could be delayed until more information gathered can be used to judge the outcome of the CEO's actions. CEOs with career concern tend to copy actions of peers to enhance their social status; it is possible that CEOs are paid for luck. For reducing the likelihood of offering CEOs free lunch, relative performance evaluation could be used as an important component of the executive compensation package. Deregulation of financial services has promoted market efficiency and increased product diversity, but subsequent competition also squeezes the franchise value of financial firms. With shrinking profits, financial firms are easily induced to tap business opportunities which involve more risks. Monitoring of business activities of financial firms should also intensifies after deregulation.

The subprime mortgage crisis is essentially an agency problem, resulting from the conflict of interests between the principal and agent. More comprehension of agent behavior will be helpful to shape a clear picture of how an economic problem evolves, and subsequent policies arrived at will work better. So research on agent behavior deserves more attention and resources from financial academics. An immediate example is the role of a government in the current sovereign debt crisis. The extension of our model to empirical studies may encounter some problems; especially data on some variables (e.g., the effort) may be unobtainable. How to make the model more empirically available is the focus of our future research.

APPENDICES

Appendix A: Calculation of *Itô*'s Process for X_t

(1) Assume that a firm's portfolio is self-financing. Then

$$\sum_{i=0}^{n}\theta_t^i P_t^i = \underline{\theta}_t \cdot \underline{P}_t = \underline{\theta}_{t+\Delta t} \cdot \underline{P}_t = \sum_{i=0}^{n}\theta_{t+\Delta t}^i P_t^i ,$$

where $i = 0,1,\ldots,n$, $\underline{\theta}_t$ and $\underline{P}_t$ are the quantity and price vectors of assets in a firm, respectively.

(2) We know that

$$X_{t+\Delta t} = \sum_{i=0}^{n}\theta_{t+\Delta t}^i P_{t+\Delta t}^i = \underline{\theta}_{t+\Delta t}\cdot \underline{P}_{t+\Delta t} = \underline{\theta}_t \cdot \underline{P}_t + \underline{\theta}_{t+\Delta t}\cdot \underline{P}_{t+\Delta t} - \underline{\theta}_{t+\Delta t}\cdot \underline{P}_t$$

$$= X_t + \underline{\theta}_{t+\Delta t}\cdot(\underline{P}_{t+\Delta t} - \underline{P}_t) = X_t + \underline{\theta}_{t+\Delta t}\cdot \Delta \underline{P}_t. \quad \text{(A1)}$$

(3) The increment to the asset value at time $t + \Delta t$ can be expressed as,

$$\Delta X_t = X_{t+\Delta t} - X_t = \sum_{i=0}^{n}\theta_{t+\Delta t}^i\left(P_{t+\Delta t}^i - P_t^i\right)$$

$$= \theta_{t+\Delta t}^0 P_t^0 r\Delta t + \sum_{i=1}^{n}\theta_{t+\Delta t}^i P_t^i(\mu_t^i\Delta t + \sigma_t^i \Delta B_t^i)$$

$$= r\Delta t\sum_{i=0}^{n}\theta_{t+\Delta t}^i P_t^i + \sum_{i=1}^{n}\left[\theta_{t+\Delta t}^i P_t^i\left((\mu_t^i\Delta t + \sigma_t^i\Delta B_t^i) - r\Delta t\right)\right]$$

$$= rX_t\Delta t + X_t\sum_{i=1}^{n}\frac{\theta_{t+\Delta t}^i P_t^i}{X_t}(\mu_t^i - r)\Delta t + X_t\sum_{i=1}^{n}\frac{\theta_{t+\Delta t}^i P_t^i}{X_t}\sigma_t^i\Delta B_t^i$$

$$= X_t\left[\left(r + \sum_{i=1}^{n}\tau_t^i(\mu_t^i - r)\right)\Delta t + \sum_{i=1}^{n}\tau_t^i\sigma_t^i\Delta B_t^i\right], \quad \text{(A2)}$$

where $\tau_t^i = \theta_{t+\Delta t}^i P_t^i / X_t$ is the share of total asset assigned to the asset i. Note that $\sum_{i=0}^{n}\tau_t^i = 1$.

Appendix B: The Derivation Of Equation 9

(1) Suppose that the CEO reallocate firm portfolio by changing the quantity of asset i, $\theta^i_{t+\Delta t}$, at time t. Note that $\theta^i_{t+\Delta t}$ will continue to time $t + \Delta t$ until the new portfolio decision is made. Note that $X_t = \underline{\theta}_t\underline{P}_t = \underline{\theta}_{t+\Delta t}\underline{P}_t$. The portfolio $\underline{\theta}_{t+\Delta t}$ spans over time t and time $t + \Delta t$. For solving the maximization problem facing a CEO, we use the methodology in Bakshi and Chen (1996) and arrive at,

$$e^{-\rho\Delta t}E_t\left[U_\pi(X_{t+\Delta t}, k_{t+\Delta t}, a_{t+\Delta t})\pi_X(X_{t+\Delta t})P_{t+\Delta t}^i \middle| F_t\right] - U_\pi(X_t, k_t, a_t)\pi_X(X_t)P_t^i = 0 , \quad \text{(A3)}$$

where F_t denotes the information set at time t.

(2) Rearranging the terms in Equation (A3) and assuming that the pay schedule is linear, i.e. $\pi_X(X_t) = \pi_X(X_{t+\Delta t})$, we get

$$1 = e^{-\rho\Delta t}E_t\left[\frac{U_\pi(X_{t+\Delta t}, k_{t+\Delta t}, a_{t+\Delta t})}{U_\pi(X_t, k_t, a_t)}(1 + \frac{\Delta P_t^i}{P_t^i}) \middle| F_t\right]. \quad \text{(A4)}$$

(3) With the same line of calculation, a similar equation can be obtained for the riskless asset,

$$1 = e^{-\rho\Delta t} E_t\left[\frac{U_\pi(X_{t+\Delta t}, k_{t+\Delta t}, a_{t+\Delta t})}{U_\pi(X_t, k_t, a_t)}(1 + r\Delta t) \mid F_t\right]. \quad (A5)$$

(4) Subtracting Equation (A5) from Equation (A4) , we obtain

$$0 = E_t\left[\frac{U_\pi(X_{t+\Delta t}, k_{t+\Delta t}, a_{t+\Delta t})}{U_\pi(X_t, k_t, a_t)}\left(\frac{\Delta P_t^i}{P_t^i} - r\Delta t\right)\middle| F_t\right]. \quad (A6)$$

(5) Taking the Taylor's expansion of $U_\pi(X_{t+\Delta t}, k_{t+\Delta t}, a_{t+\Delta t})$ around $(X_t,\ k_t,\ a_t)$, we get

$$0 = E_t\left[\left(1 + \frac{X_t U_{\pi\pi,t}\pi_{X,t}}{U_{\pi,t}}\frac{\Delta X_t}{X_t} + \frac{k_t U_{\pi k,t}}{U_{\pi,t}}\frac{\Delta k_t}{k_t} + \frac{a_t U_{\pi a,t}}{U_{\pi,t}}\frac{\Delta a_t}{a_t} + o(\Delta t)\right)\left(\frac{\Delta P_t^i}{P_t^i} - r\Delta t\right)\middle| F_t\right], \quad (A7)$$

where $o(\Delta t)/\Delta t \to 0$ as $\Delta t \to 0$, $U_{\pi,t} = U_\pi(X_t, k_t, a_t)$, and $U_{\pi\pi,t} = U_{\pi\pi}(X_t, k_t, a_t)$, etc.

(6) Applying *Itô*'s Lemma to Equation (A7), passing the expectation operator through the terms in the bracket,

$$\left(\mu_t^i - r\right)\Delta t = -\frac{X_t U_{\pi\pi,t}\pi_{X,t}}{U_{\pi,t}}\sigma_{i,X}\Delta t - \frac{k_t U_{\pi k,t}}{U_{\pi,t}}\sigma_{i,k}\Delta t - \frac{a_t U_{\pi a,t}}{U_{\pi,t}}\sigma_{i,a}\Delta t + o(\Delta t), \quad (A8)$$

where $\sigma_{i,X}\Delta t \equiv \mathrm{cov}\left(\frac{\Delta X_t}{X_t},\ \frac{\Delta P_t^i}{P_t^i}\right)$, $\sigma_{i,k}\Delta t \equiv \mathrm{cov}\left(\frac{\Delta k_t}{k_t},\ \frac{\Delta P_t^i}{P_t^i}\right)$, and $\sigma_{i,a}\Delta t \equiv \mathrm{cov}\left(\frac{\Delta a_t}{a_t},\ \frac{\Delta P_t^i}{P_t^i}\right)$.

(7) We get Equation 9 by dividing both sides of Equation (A8) by Δt and letting $\Delta t \to 0$,

$$u_t^i = \mu_t^i - r = -\frac{X_t U_{\pi\pi,t}\pi_{X,t}}{U_{\pi,t}}\sigma_{i,X} - \frac{k_t U_{\pi k,t}}{U_{\pi,t}}\sigma_{i,k} - \frac{a_t U_{\pi a,t}}{U_{\pi,t}}\sigma_{i,a}.$$

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