Deterring Inefficient Gambling in Risk-Taking Agents

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Honors Thesis submitted in partial fufillment of the requirements for Graduation with Distinction in Economics in Trinity College of Duke University

Duke University
Durham, NC
2015

Acknowledgements

I want to thank Professor Taylor for all of the guidance and advice he gave me throughout the research process. His encouragement inspired me to undertake the project and without his support, the writing of this paper would not have been possible.

I would also like to thank my friends and family for their constant love and motivation. I'd especially like to thank Charlotte Lee for her endless support and discerning eye for editing.

Abstract

This paper proposes a model describing the incentive issues faced by principals and agents when the agent has limited liability and is capable of undertaking unidentifiable, inefficient risky behavior. We propose a contract structure by which the principal deters risk by deferring payment to the agent until she reaches an absorbing steady-state in which promised equity alone deters inefficient behavior. The paper discusses the effect of exogenous parameters on the tradeoffs facing the principal as well as the implications they have on the efficient choice of contract. We also outline extensions to the model in which the principal has access to a costly monitoring technology to identify inefficient risk taking. The theoretical results have implications for real-world employment contracts and practices in financial firms such as investment banks and private equity funds.

JEL Classification Numbers: G320; L14; D860; D820.

Keywords: Risk Management; Optimal Contracts; Contract Theory; Moral Hazard.

1 Introduction

Effective risk assessment and management is essential to not only the health of any enterprise, but also the health of the world economy. Firms face a number of financial, operational and geopolitical risks that serve as opportunities and threats to their success. The Global Financial Crisis was caused primarily by the failure of major financial institutions to effectively address these risks present in various markets (White House). This lack of control came as the result of perverse incentives among key personnel of the most important corporations in the global markets (Crotty 2009).

High ranking employees of major financial institutions had strong incentives to act riskily in the years leading up to the Global Financial Crisis. The global economy had been growing at an incredible rate and opportunities to capitalize on this growth were ubiquitous. As the prices of securities continued to rise, increased leverage multiplied profits and amplified the successes of investors. A rapidly expanding US housing market, coupled with the collateralized securitization of home loans, encouraged lenders to loan out massive sums of money to as many would-be home owners as possible, no matter their qualifications. A booming market and favorable borrowing conditions led to a record number of merger and acquisition deals (M&A). Across all of these markets, increased risk resulted in increasing profits as long as the economy continued to expand.

Behind these risky bets was an issue of moral hazard. Executives and other high ranking agents of financial institutions had compensation packages heavily tied to the success of their firms. In the peak of the pre-crisis era, traders at the largest investment banks were receiving bonuses as high as $50 million for their successes. Even as the company teetered upon collapse, Merrill Lynch paid out $240 million to its chief executives (Crotty 2009). While performance based compensation packages are generally lauded for their ability to align the incentives of agents and firms, they also create a convex payoff structure (Leroy 2010). In short, agents were rewarded for successes but did not face consequences for failures.

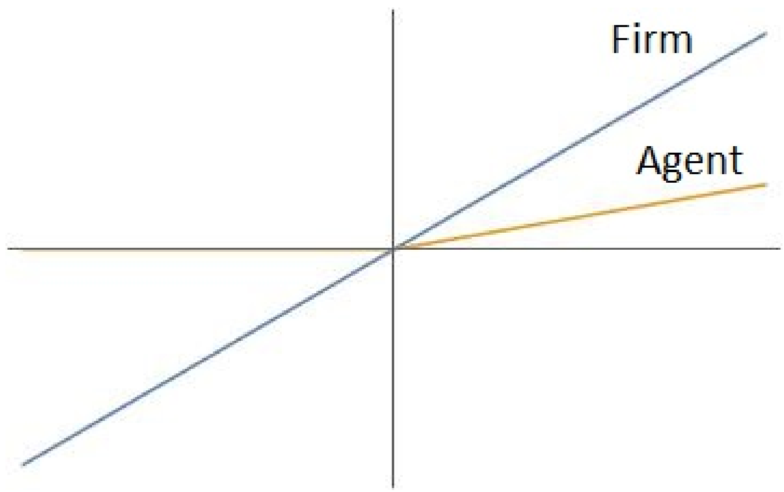

Figure 1: Plot of value functions for a firm and agent against the revenues of the firm

Take for example, an executive with a performance based compensation package at a company that provides consumer home loans. In the years leading up to the financial crisis, this executive would have faced a series of strategic decisions regarding subprime home loans. At the time, there existed a large, underserved market of consumers with subpar credit who wanted to purchase homes. If the executive chose to lend to these consumers, he or she faced two possible outcomes. In one scenario, the housing market would continue to expand, employment conditions would continue to improve and all of these subprime borrowers would pay back their loans at incredibly profitable interest rates. In this situation, the executive would receive an exceptionally favorable bonus linked to the massive revenues that these loans would generate. In fact, this was the case for a few years before 2007, leading to large personal gains for executives. In the other scenario, the housing bubble would collapse, borrowers would default on their loans and the home loan firm would face immense losses. While the firm would experience insurmountable deficits, the individual executive would face no consequence more severe than loss of employment. Thus, the executive has a metaphorical call option on the success of the subprime loans he or she issues. This convex payoff structure skews the way in which the executive evaluates risk and creates a disconnect between the incentives of the firm and the agent.

This paper suggests a contract structure that addresses this problem of moral hazard. In this paper, we will define inefficient risky behavior as strategies that result in increased variation of returns but cause a lower expected return than a more conservative available strategy. Previous papers have suggested that deferral of compensation to risk-taking agents is an optimal payment structure for deterring inefficient risky behavior. The basic premise behind this structure is that the principal is giving the agent something to lose in the case of disaster. By delaying the agents payments, she is always owed compensation and thus must behave properly in order to ensure the eventual payment of this debt.

In this paper, we expand upon that idea by proposing a model under which the agent builds up promised equity until she reaches a steady state in which her payment no longer needs to be delayed. The contract eventually reaches an equilibrium in which the expected value of the agents future wages are enough to incentivize her not to take inefficient risks.

2 Literature Review

There is a fairly extensive body of literature surrounding compensation of managers and aligning manager incentives with those of the firm and shareholders. It is generally accepted that principals can use different compensation schemes to incentivize agents to act in the best interest of the firm. The framework by which we approach the problem of inefficient risk taking is based off of the book *The Theory of Corporate Finance* by Nobel Prize winning economist Jean Tirole. In his book, Tirole compiles the research of many corporate finance economists into a cohesive model. He outlines a fixed investment model in which agents must be compensated in order to prevent shirking (Tirole 2006). His use of a probabilistic fixed return and a fixed cost of effort in the agents incentive constraint, as well as his use of a limited liability constraint, inspire the general parameterization of our model. Furthermore, Tirole outlines an extension of his model in which the agent controls the correlation of multiple products that she is managing. He demonstrates that under a traditional contract, the agent would want to increase the correlation between simultaneous projects, creating a mean-preserving spread (an inefficient risky behavior) (Tirole 2006). In this paper we generalize risky behavior and discuss methods of preventing any sort of inefficient risky behavior.

Jensen and Meckling were the first researchers to propose risky behavior as a problem of moral hazard. They propose the problem of risk as a moral hazard problem and show that equity compensation creates a convex payoff structure (Jensen & Meckling 1976). Many papers have suggested deferred compensation as a strategy to deter inefficient risk. After the Global Financial Crisis, a number of economists met and produced the book *The Squam Lake Report: Fixing the Financial System.* This book suggested that systematically important financial institutions should be required to defer compensation to major executives, a sentiment echoed by former Federal Reserve Chairman Ben Bernanke (French et. al. 2010)(Bernanke 2010).

Our model most closely resembles the risk deterrence scheme proposed by Peter M. DeMarzo, Dmitry Livdan, and Alexei Tchistyi (2013). Like in our model, they propose a continuous time model in which the agent can choose between low effort and high effort as well as low risk and high risk. This risky action exposes the principle to a disaster state that causes a large loss. They demonstrate that the possibility of this risky action forces the principal to cede additional rent to the agent. They also emphasize that the primary method of disincentivizing gambling is by ensuring the agent has skin in the game. Their paper suggests that firms use deferred compensation to give agents something to lose in the case of a disaster.

Another major influence on our model is the paper *Stairway to Heaven or Highway to Hell: Liquidity, Sweat Equity, and the Uncertain Path to Ownership* (Krishna, Lopomo & Taylor 2013). Their research proposes the idea of sweat equity as a path to ownership as a solution to the agency problem of misreporting information to a supplier of operating capital. In their model an agent reports costs of production to a principal who compensates the agent for these costs. The optimal contract involves increasing the agents equity when she reports low costs and decreasing it when she reports high costs, thus incentivizing the agent to not over report. In the case of continual good reports, the agent will eventually reach an absorbing state at which the principal gives her a vested stake in the firm. In this paper we use this idea of an absorbing state and sweat equity. Our agent works until they reach an equilibrium level of promised equity at which she is properly incentivized to avoid inefficient risk.

3 Model

3.1 Introduction

An agent who is risk-neutral but protected by limited liability can choose one of three actions $a \in \{L, H, R\}$ (low, high, or risky) on a discrete time infinite horizon project. The agent discounts future cash flows according to β and the principal discounts future income at δ. Both β and δ are discount factors between 0 and 1. If the agent selects $a = L$, then she incurs no cost and the project yields a payoff of 0 to the principal with certainty. If she selects $a = H$, then she incurs cost C and the project delivers a payoff of 1 to the principal with probability p and 0 with probability $1 - p$. Finally, if the agent selects $a = R$, then she incurs cost C and the project delivers 1 to the principal with probability q and $-D$ with probability $1-q$, where $q > p > C$ and $D > 0$ (a disaster). We will also assume that $q - (1 - q)D < p$ i.e. R is inefficient relative to H. The agent is signed to a contract infinite in length but has an exogenous probability of $\sigma > 0$ that she will not be terminated (or otherwise separated from her employment). In other terms she has a probability of $1 - \sigma$ of her employment terminating. Thus her contract will end in finite time with certainty. If she is terminated she will receive a normalized sum of 0 as the present value of her future wages. Likewise, the firm will receive a normalized sum of 0 as the present value of their future income after her termination.

Let v be the present value of her retained wages. We conjecture that the optimal contract involves an optimal level of retained wages v* at which we can use current wage payments to disincentivize inefficient risk taking such that:

$$w(v) > 0 \iff v \geq v^* \tag{1}$$

Where $w(v^*)$ is paid to the agent in the case of success. The expected benefit of working must outweigh the cost C. In order to incentivize the agent to work and not shirk at $v \geq v*$ the following incentive constraint must be met.

$$pw(v^*) \geq C \tag{2}$$

Therefore at $v \geq v^*$ the agent has the following expected value of wages should she work:

$$v^* = \frac{pw(v^*) - C}{1 - \beta\sigma} \tag{3}$$

In order to incentivize the agent to choose $a = H$ rather than the inefficient risk $a = R$ the following condition must be met:

$$v^* \geq q(w(v^*) + \beta\sigma v^*) - C \tag{4}$$

Solving the system of equations we find that when $v \geq v^*$:

$$w(v^*) = H\frac{C}{p} \tag{5}$$

$$v^* = (H - 1)\frac{C}{1 - \beta\sigma} \tag{6}$$

where:

$$H = \frac{1}{1 - \frac{(1-\beta\sigma)(q-p)}{\beta\sigma p(1-q)}} \tag{7}$$

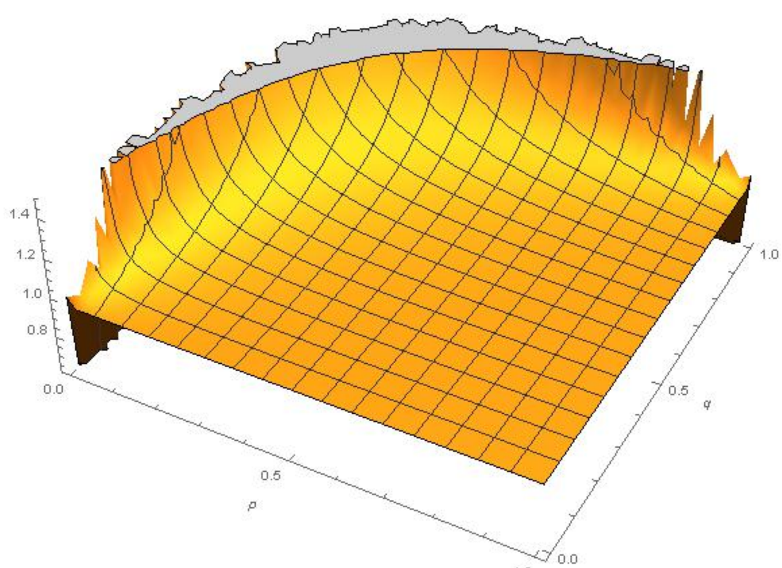

Figure 2: Plot of the value of H relative to p and q using $\beta\sigma = 0.95$

For this model to work, the denominator of H must be strictly positive. H represents the multiplier by which the principal must multiply the agent's wage in order to incentivize her not to risk. Note that as $p \to q$, $H \to 1$. In other words, as p and q converge, the cost of incentivizing the agent against risk approaches 0 (Her wage approaches $\frac{C}{p}$ or the minimum wage required to prevent shirking). As the gap between the two probabilities increases, the agent's temptation to risk increases and she must be paid more to compensate her for working. Also worth noting is that H is decreasing in $\beta\sigma$. This means that patient agents need to be compensated less to keep them from risking.

The principal's value function when $v \geq v^*$ is the following:

$$\Pi^* = \frac{p - HC}{1 - \delta\sigma} \tag{8}$$

$H \geq 1$ so we know that the possibility of a risky action increases agency cost for the firm. In this part of the contract, the firm's expected value is increasing in $\delta\sigma$ but is decreasing in $\beta\sigma$. Nonetheless, this contract will deter both risk and shirking for an agent if her promised utility is greater than v^*. The firm now needs a method of compensating the agent in order to get her promised equity up to v^*. We now propose a number of solutions the principal can use when $v < v^*$.

3.2 Building up equity

One option is for the principal to allow the agent to risk (choose $a = R$) until she reaches an owed compensation $v \geq v^*$. During this period, the agent will not be paid, but rather her pay will be deferred until $v \geq v^*$. One can think of this part of the contract as the agent building up equity. The firm is able to align the agent's incentives by establishing owed utility in the agent while the agent is willing to work because she will receive future compensation. In this scenario, we have only one constraint. The agent must be incentivized to work in each period rather than shirk. This means that the present value of expected compensation must be greater than the implicit cost of effort. We must also maximize the principal's value function. In this model, we will refer to a wage that has been deferred as u. We will discount the payment of v^* by $(\beta\sigma q)^t$ where t is the expected amount of time remaining that it will take for v to reach v^*. t can be calculated as follows:

$$t(v) = \frac{v^* - v}{\sigma u} \tag{9}$$

t is a decreasing function in v, thus the strongest binding condition will occur when $v = 0$ as this is the point at which the discount factor will be the strongest. If the agent's incentive constraint is met at $v = 0$ when t is maximized, it will also be met at any point $v > 0$. We also know that if the agent experiences a return of 0, she must have shirked and thus the principal should fire her. We actually should not fire the agent in the case of disaster because a disaster is a perfect signal that the agent behaved as the principal intended. Therefore, firing her in the case of a disaster is more expensive and provides no incentive power. The principal will pay the agent a deferred u in the case of success or disaster but not in the case of 0 return (the deferred payment will go towards v). The agent's incentive constraint for working rather than shirking when $v = 0$ is thus:

$$(\beta\sigma)^{t(0)} v^* \geq C \tag{10}$$

or:

$$(\beta\sigma)^{\frac{v^*}{\sigma u}} v^* \geq C \tag{11}$$

Rearranging terms, this constraint can be seen as:

$$u \geq I v^* \tag{12}$$

where:

$$I = \frac{log(\beta\sigma)}{\sigma log(\frac{C}{v^*})} \tag{13}$$

Both of these logarithmic terms will be less than zero and the resulting u will be a positive value that we must delegate to v^*. I is increasing in $\beta\sigma$, so impatient agents must be paid more quickly than more patient agents. u is increasing in C but it is increasing at a slower rate than v^* ($\frac{C}{log(C)}$ vs C). This means that increasing implicit costs of working for the agent implies increasing compensation but also increasing t, the expected time for which we initially delay the agent's payment.

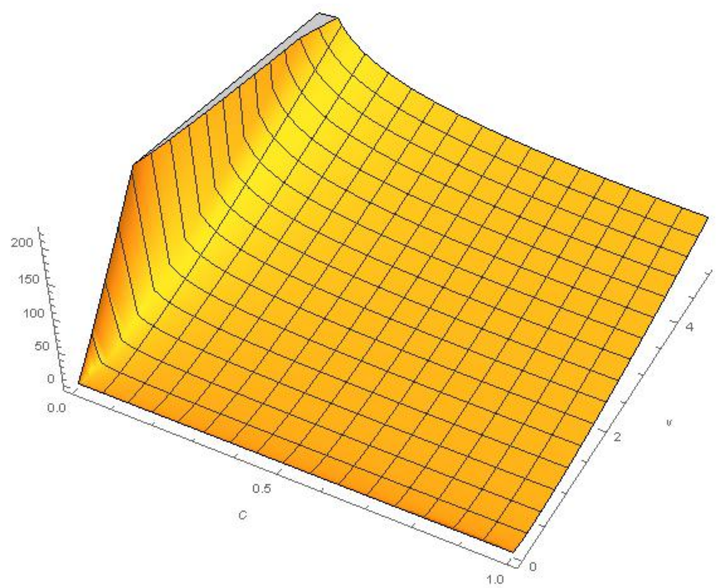

Figure 3: Plot of the value of t relative to C and v^* using $\beta = 0.95$ and $\sigma = 0.95$

The firm's value function is the following:

$$\Pi(u) = (1 - (\delta\sigma)^{\frac{v^*}{\sigma u}})\Delta + (\delta\sigma)^{\frac{v^*}{\sigma u}}\Pi^* \tag{14}$$

where:

$$\Delta = \frac{q - (1-q)D}{1 - \delta\sigma} \tag{15}$$

Δ is the perpetuity obtained by the principal from allowing the agent to risk.

The derivative of this function with respect to u is:

$$\frac{\delta \Pi}{\delta u} = (\Pi^* - \Delta)(-log(\delta\sigma)\frac{v^*}{\sigma}(\delta\sigma)^{\frac{v^*}{\sigma u}}\frac{1}{u^2}) \tag{16}$$

The choice of u, therefore depends on the sign of the first of these terms $\Pi^* - \Delta$. The latter terms will always be positive, meaning the derivative of this function is always either positive or negative. Without the possibility of $\frac{\delta \Pi}{\delta u} = 0$ only corner solutions are possible. Thus if $\Pi^* - \Delta > 0$, the firm wants to choose the highest u possible. As $u \to \infty$, $t \to 0$. So if $\Pi^* > \Delta$, the firm should immediately give the agent a promised utility of v^* and proceed according to the contract laid out above. In this case the principal's value function is:

$$\Pi = \Pi^* \tag{17}$$

If $\Pi^* - \Delta < 0$, the firm will want to choose the lowest u possible. There is a lower bound set on u by the agent's incentive constraint. The principal will allow this constraint to bind and choose $u = Iv^*$. In this case the firm's value function is:

$$\Pi = (1 - (\delta\sigma)^{\frac{1}{\sigma I}})\Delta + (\delta\sigma)^{\frac{1}{\sigma I}}\Pi^* \tag{18}$$

The size of Δ depends heavily on the probability of disaster and the size of the disaster should it occur. If for example, D was insurmountably large, Δ would be small or negative and the firm would be best off promising the agent all of v^* up front. However, if the possible disaster is small or the chances of it occuring are low, the firm may allow the agent to choose $a = R$ for a while until the agent builds up equity. This model demonstrates the basic

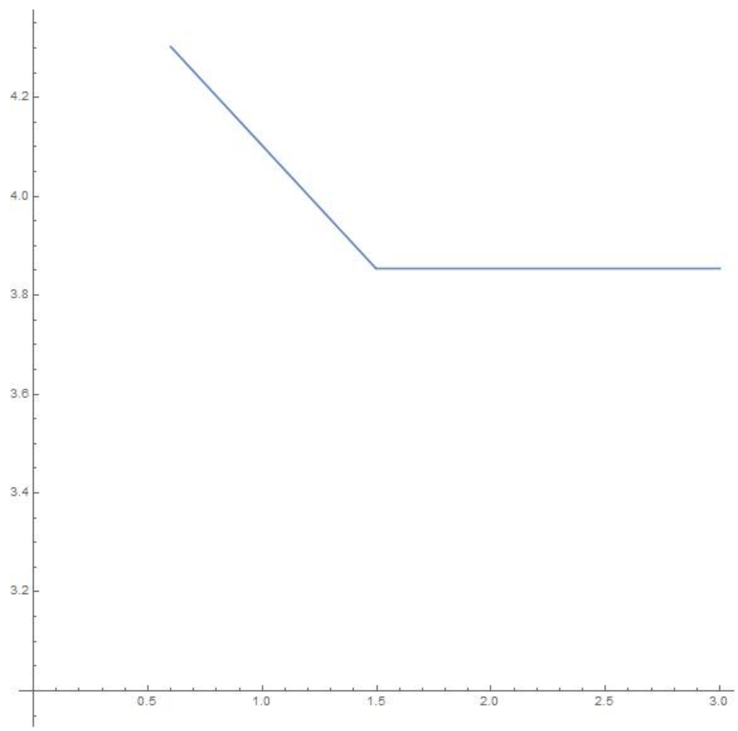

Figure 4: Plot of the value of Π relative to D using $\beta = 0.95$, $\sigma = 0.95$, $p = 0.6$, $q = 0.75$ and $C = .2$

parameters the firm must consider. Moving forward using this framework will allow us to model more realistic scenarios.

3.3 Costly monitoring/Risk-free probation

Consider the existence of a costly monitoring technology that can perfectly detect risky behavior at a cost of M. This technology can perfectly detect when the agent chooses $a = R$ but is unable to differentiate between $a = H$ and $a = L$. If we can perfectly detect risk (and can fire the agent if she chooses $a = R$) our only concern is the agent shirking. Thus we can pay the agent $\frac{C}{p}$ for every success. The principal will never choose to delay monitoring if the agent will be monitored for the entire length of the contract. It would be inefficient to delay the agent's pay if the moral hazard problem of risk is perfectly handled by the monitoring. We also know that the principal will never allow the agent to risk for a period of time and then switch to monitoring. In this case, the principal would still have to promise the agent a premium for delaying her payment, defeating the purpose of monitoring. The principal thus has four options (which we will refer to as Contracts 1-4):

1. Immediately and permanently promise the agent v^* and pay her $w(v^*)$ for each success.

2. Allow the agent to risk and earn equity until she has reached v^*. Then pay her $w(v^*)$ for each success.

3. Immediately and permanently use monitoring. Pay the agent $\frac{C}{p}$ for each success.

4. Monitor the agent until she has earned equity and reached v^*. Then stop monitoring and pay her $w(v^*)$ for each success.

The principal's value functions for Contracts 1 and 2 are presented in the previous section. For Contract 3, the principal's value function is:

$$\Pi = \Pi_M = \frac{p - C - M}{1 - \delta\sigma} \tag{19}$$

In Contract 4 the principal will receive a payment of $\Delta_M = \frac{p-M}{1-\delta\sigma}$ until the agent reaches $v \geq v^*$. Unlike Contract 2, however, the principal will not increase v in each period. Instead, we will only increase it in the case of success in order to incentivize working instead of shirking (we can no longer fire the agent in the case of failure). This will change the expected value of t in the agent's incentive constraint to the following:

$$t(v) = \frac{v^* - v}{p\sigma u} \tag{20}$$

Thus her incentive constraint is:

$$(\beta\sigma)^{\frac{v^*}{p\sigma u}} v^* \geq C \tag{21}$$

Rearranging terms, we know that the agent will behave properly if:

$$u \geq Jv^* \tag{22}$$

where:

$$J = \frac{log(\beta\sigma)}{p\sigma log(\frac{C}{v^*})} \tag{23}$$

If Contract 4 is optimal we know that the principal will allow this constraint to bind and will delay the agent's payment as long as possible. Therefore the principal's value function if Contract 4 is optimal is:

$$\Pi = (1 - (\delta\sigma)^{\frac{1}{\sigma J}})\Delta_M + (\delta\sigma)^{\frac{1}{\sigma J}}\Pi^* \tag{24}$$

We therefore need to compare the values of these four contracts. In the previous section we discussed how to compare Contracts 1 and 2. We can now compare Contract 1 to 3. Both of these contracts have value functions of a single term so if $\Pi^* \geq \Pi_M$, the principal prefers Contract 1 to Contract 3. If $\Pi^* < \Pi_M$ the converse is true.

The next step is to compare 1 to 4. This is the same comparison as 1 vs 2 but with Δ_M instead of Δ. Thus if $\Pi^* \geq \Delta_M$, the principal prefers contract 1 to 4. We have now compared Contract 1 to the three others. If all of these comparisons are in Contract 1's favor, the principal will choose Contract 1. If not, the principal will compare the contracts that were preferred to Contract 1.

The remaining comparisons can not be simplified to single term inequalities. However the comparisons of Contract 2 vs 3, 2 vs 4, and 3 vs 4 are listed below.

- *Contract 2 vs 3* - $(1-(\delta\sigma)^{\frac{1}{\sigma I}})\Delta + (\delta\sigma)^{\frac{1}{\sigma I}}\Pi^* > \Pi_M$
- *Contract 2 vs 4* - $(1-(\delta\sigma)^{\frac{1}{\sigma I}})\Delta + (\delta\sigma)^{\frac{1}{\sigma I}}\Pi^* > (1-(\delta\sigma)^{\frac{1}{\sigma J}})\Delta_M + (\delta\sigma)^{\frac{1}{\sigma J}}\Pi^*$
- *Contract 3 vs 4* - $\Pi_M > (1-(\delta\sigma)^{\frac{1}{\sigma J}})\Delta_M + (\delta\sigma)^{\frac{1}{\sigma J}}\Pi^*$

Once an order of preference has been decided, the principal will pick the corresponding contract. Depending on the evaluation of these inequalities outlined above, the principal will choose one of the four contract structures. There are many parameters that interact in these constraints but a greatly simplified explanation of the decision can be seen below.

1. *Costly Disaster, Expensive Monitoring* - **Contract 1**: Immediately and permanently promise the agent v^* and pay her $w(v^*)$ for each success.

2. *Cheap Disaster, Expensive Monitoring* - **Contract 2**: Allow the agent to risk and earn equity until she has reached v^*. Then pay her $w(v^*)$ for each success.

3. *Costly Disaster, Cheap Monitoring, High H* - **Contract 3**: Immediately and permanently use monitoring. Pay the agent $\frac{C}{p}$ for each success.

4. *Costly Disaster, Cheap Monitoring* - **Contract 4**: Monitor the agent until she has earned equity and reached v^*. Then stop monitoring and pay her $w(v^*)$ for each success.

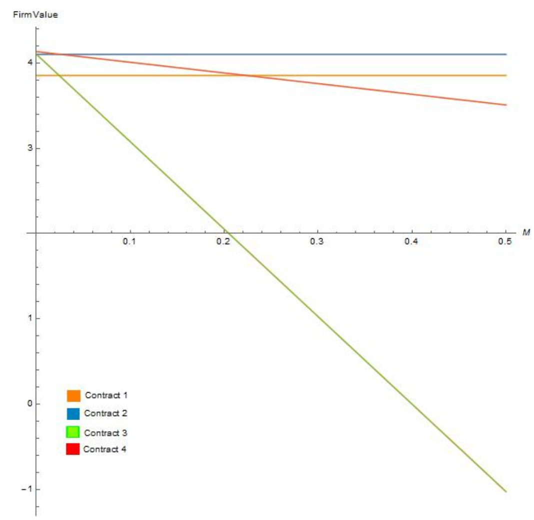

Figure 5: Plot of the firms value function under the 4 contracts against the cost of monitoring under a low cost disaster scenario D=1

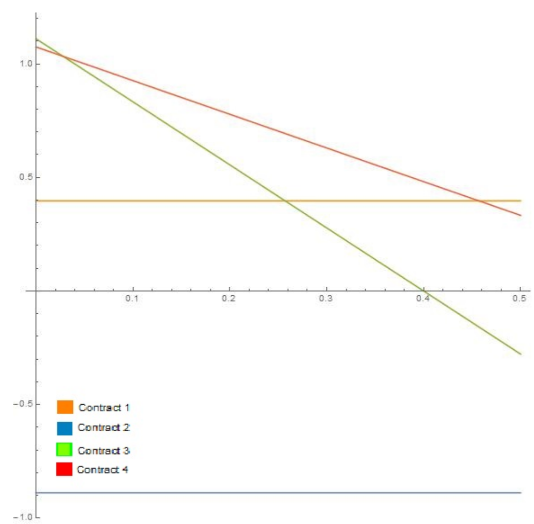

Figure 6: Plot of the firms value function under the 4 contracts against the cost of monitoring under a high cost disaster scenario D=5. β and σ were both adjusted to 0.8 to increase H relative to M to demonstrate a situation in which Contract 3 is optimal

An alternative method of framing this version of Contract 4 is the idea of a no-risk probationary period. Consider instead the existence of a secondary project that only has two possible actions $a = H$ and $a = L$. This project has no possibility for a risky choice. If the agent shirks ($a = L$), the principal receives a return of 0. If the agent works ($a = H$), the principal receives a return of $R < 1$ with probability p and 0 with probability $1 - p$ while the agent faces an implicit cost of C. When modeled, this scenario is theoretically identical to one in which the principal can apply a costly monitoring technology that costs $M = 1 - R$.

These latter two contract possibilities seem to represent the realities of risk management in corporations fairly accurately. Most financial institutions that participate in quantifiably risky activities, such as the trading of securities, have in depth risk management controls. The large banks have entire departments whose function is to model the risk of bank activities and to put systems in place such that risk-taking agents like traders or portfolio managers cannot take on excessive levels of risk. These systems require expensive proprietary software as well as talented employees to manage risk. Thus the idea of a costly monitoring system is a reasonable theoretical abstraction.

Likewise, it is rare for firms to immediately give employees control over business areas that are capable of taking excessively risky positions. Beginning traders are often expected to provide a research support role for their teams before they are able to execute trades, allowing them to both learn from other traders and to build up equity while performing a risk-free task.

4 Discussion

While this model is built upon high-level abstractions, it explains the basic incentive constraints that firms and agents face in scenarios of variable risk. It demonstrates the tradeoffs inherent in the deferral of compensation and shows that it is an effective method of risk prevention. It also shows that the agent must have a certain level of expected future income to deter her from gambling. It confirms what many other studies have shown in alternative formulations of the model regarding the exogenous parameters of the model. It also provides an explanation for why firms do not always attempt to deter risk, even when the risk is inefficient. Finally, it provides an alternative framework that can be extended to investigate any financial tradeoffs surrounding agents who control the risk of a project.

This new model reiterates what intuition and previous studies have demonstrated regarding the influence of exogenous variables on the decision faced by the firm. The most obvious, yet the most important, is that the gap between success rates of risky and safe strategies is positively correlated with the cost of deterring risk. If the risky strategy is incredibly lucrative, it is difficult to deter the agent from pursuing it. The magnitude of the negative outcome the firm receives in the case of a disaster is also a critical factor. This cost of deterring an agent from engaging in risky behavior explains why a firm might allow risk if the disaster is relatively minor.

This explanation is especially valuable to financial regulators. A firm allowing its agents to take an inefficient risk is not inherently problematic. If the costs of deterring the risk outweigh the cost of not acting safely and the risky project is still profitable, then allowing the agent to act riskily is the socially optimal policy. Problems arise, however, when the cost of a disaster is not entirely placed on risk taking firms. If the parameter D from our model is small relative to the social cost of the disaster. It is entirely possible to formulate a situation under this model in which the firms optimal strategy is to allow inefficient risk until the agent earns enough equity, yet in which a disaster would cause great harm to society. In fact, it is possible that real world scenarios resemble this scenario. In the 2007-08 financial crisis, firms were deemed to be too big to fail and were bailed out by government programs. Thus, the negative payout, D, was diverted away from the principals. Regulators must therefore work to align the incentives of society, firms and agents by encouraging risk deterring compensation schemes and other methods such as the use of mandatory risk monitoring technology.

While many of these factors have been explained by previous studies, our model offers an additional framework to explain the inefficient risk moral hazard problem. An interesting further study using this model would be to investigate the effects of labor market tightness on risk deterrence. In this paper, we assume that both the agent and the firm have expected future incomes of zero upon termination of the contract. By creating variables for these two values, one could investigate how the existence of other opportunities for agents and other possible employees for firms affect the cost of deterring inefficient risk. We speculate that a slack labor market would imply cheaper deterrence of risk. If the agent had fewer options, the relative value of her expected payments would be greater. She would then be more likely to choose the less risky action.

Another interesting possible expansion of our model would be to allow risk to exist on a spectrum. For the sake of simplicity and clarity, we allowed the agent to choose between the binary options: risky or safe. Real life projects, especially those in the financial markets, are rarely this discrete. Creating a risk parameter that increases the expected return but also decreases the Sharpe ratio of the project would reconcile our model with the non-binary nature of realistic risky projects. The Sharpe ratio is the ratio of expected excess return to variance of returns, so the project's expected return would be increasing in this risk parameter but its variance would increase even more sharply. This should theoretically produce similar conclusions but the model would resemble real world projects more closely.

Works Cited

Bernanke, Ben S. "Remarks on "The Squam Lake Report: Fixing the Financial System"" Squam Lake Conference. New York. 6 June 2010. Speech.

Crotty, J. "Structural Causes Of The Global Financial Crisis: A Critical Assessment Of The 'new Financial Architecture'" Cambridge Journal of Economics 33.4 (2009): 563-80. Web. 16 Apr. 2015.

DeMarzo, Peter M. and Livdan, Dmitry and Tchistyi, Alexei, Risking Other People's Money: Gambling, Limited Liability, and Optimal Incentives (September 12, 2013).

French, Kenneth R. The Squam Lake Report: Fixing the Financial System. Princeton: Princeton UP, 2010. Print.

Jensen, Michael C., and William H. Meckling. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." Journal of Financial Economics 3.4 (1976): 305-60. Social Science Research Network. Web. 16 Apr. 2015.

Krishna, R. V., Lopomo, G. and Taylor, C. R. (2013), Stairway to heaven or highway to hell: Liquidity, sweat equity, and the uncertain path to ownership. The RAND Journal of Economics, 44: 104127. doi: 10.1111/1756-2171.12013

Leroy, Steven. "Convex Payoffs: Implications for Risk-Taking and Financial Reform." FRBSF Economic Letters (2010): n. pag. Federal Reserve Bank of San Francisco. Web. 16 Apr. 2015

"M&A Activity: Number & Value of Announced Transactions." Institute of Mergers, Acquisitions and Alliance. Institute of Mergers, Acquisitions and Alliance, 2015. Web. 16 Apr. 2015.

Tirole, Jean. The Theory of Corporate Finance. Princeton, N.J.: Princeton UP, 2006. Print.

White House. Office of the Press Secretary. Declaration of the Summit on Financial Markets and the World Economy. White House of President George W. Bush. United States of America, 15 Nov. 2008. Web. 16 Apr. 2015.