Pay Structure, Job Termination and Capital Structure

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Abstract

We develop a model to analyze the links among worker pay structure, the risk of job termination, and financial leverage. Contrary to the conventional view, we show that even in the absence of any worker agency problem, variable pay can be optimal despite workers being risk averse and firms being risk neutral. We find that firms employing workers with safer projects (and thus less employment uncertainty), use more variable pay, and that leverage is strictly increasing in the amount of variable pay. Therefore, we show the more likely it is that a worker is terminated, the lower a firm's leverage. We use the model to highlight a new mechanism for why high leverage and high variable pay may be pervasive in financial relative to non-financial firms. We provide supporting evidence for the model using novel data on all Canadian financial brokers and dealers.

Keywords: Worker compensation; Job tenure; Financial leverage; Financial institutions
JEL: G32, G24, J33

*First draft: September 2015. This draft: December 20, 2016. We thank seminar participants at the Bank of Canada, Queen's University, 2016 NFA and 2016 FMA for helpful comments. We are extremely grateful to, without implicating, Nellie Gomes and Louis Piergeti at IIROC. We thank Neil Brisley, Itay Goldstein, Reint Gropp, Yrjo Koskinen, David Martinez-Miera, Ned Prescott, Josef Schroth, Dimitri Vayanos, Ed Van Wesep, Jia Xie, and Jano Zabojnik for comments. We also thank Andrew Usher for excellent research assistance. The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada.

Disclosure Statement

James Thompson reports research funding in excess of $10,000 from SSHRC Grant $435 - 2013 - 018$. Jason Allen reports no financial support for this research.

1 Introduction

When a worker is risk averse and has a project that is risky, how should a risk-neutral firm pay them? When there is an agency problem, i.e., hidden information or action related to the worker, variable pay can be used to help correct the inefficiency. In the absence of such problems, standard economic theory says that fixed pay is optimal. We re-visit this problem and show that, when the firm's capital structure problem is incorporated, variable pay can arise endogenously, even in the absence of agency problems.

To understand why the interaction of the worker compensation and firm financing problems is important, consider the following. First, variable pay can be used as a means to reduce operating leverage. Second, given a subsidization to debt and bankruptcy costs, there exists an optimal overall firm leverage. Finally, operating leverage and financial leverage can be substitutes. Our model incorporates these features and asks: what should happen to operating and financial leverage when project risk increases? Clearly, overall leverage should not increase; however, one might think that there should be a reduction in both operating and financial leverage. We show that to the contrary that our worker compensation channel actually pushes operating leverage up. Thus, financial leverage needs to decrease more than one may expect in the presence of our worker compensation channel. Firms with riskier projects have workers with a higher probability of job termination (greater employment uncertainty), less variable pay, and lower financial leverage.

The intuition behind our theoretical results is as follows. Consider workers with risky projects that can either have a high or low return but with no capital for implementation. A firm exogenously matches with workers who possess the same project, and can pay them a variable wage, which is paid only if the return is high, and a fixed wage regardless of the return. Although job termination is endogenous in the model, it is simplest to convey the intuition by assuming that workers are terminated if the return is low; the worker incurs a cost of this termination. In this environment, it is clearly optimal to pay workers with fixed pay since they are risk averse and the firm is risk neutral. The reason is that fixed pay hedges the low state in which the worker is terminated. Risk aversion implies that the worker receives more utility from fixed wages, allowing the firm to minimize its wage bill.

Now consider a firm that needs to raise money for the projects and does so through debt and equity. Assuming that debt is subsidized relative to equity, in the presence of bankruptcy costs, the firm opts to take on as much debt as possible while avoiding the possibility of bankruptcy in the low state. Fixed pay now works against debt, since it is itself a form of debt on the operation side of the firm. In choosing the amount of fixed pay to offer to workers, the firm trades off the benefit (decreased wage bill from fixed pay due to worker risk aversion) versus the cost (having to reduce debt to avoid the bankruptcy costs). Firms with safer projects, where safer means projects have a higher probability of success, will pay workers with more variable pay. This occurs because the value of fixed pay, in utility terms, is lower for these types of workers, since it is less likely that they are terminated. Thus, our model predicts that firms with safer projects (less employment uncertainty) will have more variable pay and higher financial leverage.

Up to this point the model is general. We then extend it to consider banks, which tend to have lower costs of debt (Allen et al. (2015)) and lower costs to bankers of being terminated relative to workers at non-banks (Jacobson et al. (1994)). When debt is cheaper, firms have an incentive to use more of it and do so by increasing the amount of variable pay. When the cost of job termination is low, firms use more variable pay since the benefit of fixed pay, in utility terms, is less. This in turn allows firms to take on more debt. These then combine to support two key features of banks that we observe in the real world: high variable pay (Lemieux et al. (2009)) and high leverage (Gornall and Strebulaev (2014)).

Our work is related to research on the relationship between wage structure and capital structure. Jaggia and Thakor (1994) explore the relationship between firm-specific human capital and capital structure. Managers choose to exert less effort into firm-specific human capital if their firm has a high probability of bankruptcy. This incentivizes the firm to take on less debt when they value human capital. In contrast, we uncover a relationship between worker risk and capital structure without any agency problem. As we do, Berk et al. (2010) considers all workers and the role that they can play in capital structure. Workers invest in firm-specific human capital and lose it when terminated. They show that a firm trades off the tax benefits of debt with the ex-ante costs that bankruptcy creates; higher wages for workers who endogenize the increased probability of being terminated due to an increase in debt. Empirically, Chemmanur et al. (2013) provide support for this result. In contrast, we consider a case in which the worker is terminated due to project non-performance and not due to bankruptcy, where the relationship between the worker and capital structure arises through a novel mechanism:

pay structure. In other words, we show the importance of the *composition* of wages, which these papers do not consider. Finally, Thanassoulis (2012) argues that wage structure has important implications for the probability of financial distress. Banks prefers to use variable wages to share risk with workers; however, an externality is created because of competition among banks for bankers. The essence of the risk-sharing incentive in that paper is present in our paper; however, we model heterogenous workers and explicitly consider the capital structure problem. As such, we are able to obtain predictions on what types of firms should have more/less variable wages and higher/lower leverage.

Empirically, Simintzi et al. (2014) and Serfling (2016) provide evidence that employment protection crowds out financial leverage. The main hypothesis is that higher employment protection increases financial distress costs, thereby increasing the cost of debt. Bae et al. (2010) find that firms with "friendlier" policies toward their employees also have less debt. The reason is to reduce leverage risk. In contrast to these papers, we show that those firms where workers experience lower turnover actually have higher leverage. This result, however, is not inconsistent with those papers. The reason is that we consider firms that have the same "flexibility" to terminate jobs (and do so when the project return is low). Thus, in our model, higher turnover corresponds to a higher project risk and not an increase in the ability to dismiss workers. In our context, it is through the compensation channel that operating leverage, i.e., the flexibility of operating expenses to firm conditions, affects capital structure. Agrawal and Matsa (2013) consider an exogenous change of the cost to a worker of being terminated and show that when it decreases, firms increase financial leverage. This result is consistent with our theory result that banks, who tend to have lower costs of job termination to workers, should be expected to have higher leverage. Agrawal and Matsa (2013) do not, however, consider the worker compensation channel that we analyze.

Our work is also related to the literature on worker compensation and pay-for-performance, which has largely focused on an agency environment to explain issues like risk taking; Lazear and Oyer (2012) provide a summary of the current literature. The empirical evidence is mixed, however, on the trade-off between risk and incentives implied by the standard agency model (Prendergast (1999)). It is important to note that we do not take a stand on the importance of incentives and variable pay. Although we do not model any agency problems, this is not meant to downplay the potential role they can play, but rather to better illuminate the mechanism behind our results, which do not require agency costs.

Recently, papers have examined other (non-agency) mechanisms to help explain the prevalence of variable pay. Oyer (2004) constructs a model in which variable pay is used to avoid costly renegotiation. If the outside option of a worker is dependent on firm value, then (costly) stock options can prevent a worker from leaving without the need for renegotiation. In contrast, in our model, the worker is replaceable and so the interim participation constraint does not imply variable wages. Instead, variable pay arises from the firms capital structure problem and not from the worker's problem. Bertrand and Mullainathan (2001) and Gopalan et al. (2010) rationalize CEO pay with a skimming model, and with a model of strategic sector flexibility, respectively. Again, these papers justify variable pay through a problem related to the worker (a manager in these cases), whereas we show that variable pay can originate from the firm's capital structure decision.

What further sets our theory apart is that we model potential compensation not just for management but all workers.[1] Much of the corporate finance literature on incentives and pay explores management compensation. One reason for this is that data on senior management are more widely available. It is impossible to do justice to this literature; however, three prominent examples include Jensen and Murphy (1990), Hall and Liebman (1998), and Milbourn (2003). By focusing only on management variable compensation a seemingly important piece of the compensation puzzle is missed. Aon Hewitt report that over 90% of the companies they surveyed in 2015 had some form of variable compensation, up from 47% in 1991, and that variable pay now comprises 12.7% of payrolls, accounting for almost all of the observed increase in total wages paid to workers.[2] Furthermore, Lemieux et al. (2009) use the PSID and report that 41.6% of non-management workers receive variable compensation, going as high as 75% for non-management professionals. Moreover, the authors show that it is not uncommon for an industry to have a higher percentage of non-management workers receive variable pay relative to management, for example in finance, insurance and real estate, as well as construction.[3]

Compensation to *all* workers is also important because the size of the total wage bill to non-management is large relative to that of management. The popular press

[1] In our empirical section we have information on the compensation of non-management workers, specifically the Canadian broker-dealer industry.

[2] http://ir.aon.com/about-aon/investor-relations/investor-news/news-release-details/2015/US-Organizations-Report-Highest-Compensation-Spend-in-39-Years/default.aspx

[3] A well known example of a construction company that has adopted pay-at-risk schemes is Caterpillar. See http://www.reuters.com/article/us-usa-workers-pay-analysis-idUSBRE98005N20130901.

tends to focus on the impressive wages of Russell 3000 executives. In the context of our empirical example, executives within the Russell 3000 of broker-dealers earned an average of over \$8 million per year; however, the typical chief executive in 2014 at a broker-dealer firm earned \$238,740 in wages (Bureau of Labor Statistics occupational employment statistics NAICS 523100). For the sample of Canadian broker-dealers that we study in Section 5, the average wage of chief executives in 2014 was Can\$300,828 (approximately \$270,745). However, the total wage bill (including cash bonuses) for specialists and analysts was far larger. In Canada, on average, a specialist earns Can\$131,720 and an analyst Can\$142,534 per year. Given that there were 16,795 specialists and 1,930 analysts compared with only 785 top executives, it is clear that wages to non-management can be much larger than that to management.

Our model produces clear testable implications; however, up to this point there has been little data available that could identify variable pay across firms and over time. We are fortunate to have access to detailed firm-level information on the decomposition of wages into their fixed and variable components for Canadian financial institutions. In addition, we have detailed information on financial institutions' balance sheets, income statements, and employment numbers. With this data we uncover the correlations predicted in the model, that is, variable pay and leverage are jointly determined given employment uncertainty. Clearly, a relationship between project risk and capital structure is not new. Agency based mechanisms could be producing the correlation that we uncover, since project risk and employment uncertainty are highly correlated in the data (and are perfectly correlated in the model). We provide evidence that our employment uncertainty channel is an important determinant of both variable pay and of leverage, yielding further evidence that our mechanism is active in the data.

The remainder of the paper is as follows. Section 2 presents the model of workers and firms. Section 3 provides the main comparative statics. Section 4 presents the application of the model to financial institutions. In Section 5 we present the data, while Section 6 presents the empirical tests of the model. Section 7 contains two extensions of the baseline model. Section 8 concludes.

2 Model

In this section, we first outline the worker's problem and then solve the firm problem. The model has three key empirical predictions that we test in Section 6.

2.1 Worker Problem

The model is in three periods indexed $t = 0, 1, 2$. We assume that a worker can neither save nor borrow and derives utility u_t from consumption in periods t, which is given by the exponential function

$$u_t = -\exp(-\alpha C_t), \tag{1}$$

where C_t is consumption in period t and α is the coefficient of absolute risk aversion. We assume for simplicity that total (lifetime) utility is additively separable over time and stationary. Without loss of generality (see Section 3.1), we assume that workers do not discount utility over the three periods.

A worker is penniless but can implement an investment opportunity/project that has a rate of return at $t = 1$ of $r_H(p)$ with probability p and $r_L(p)$ with probability $1 - p$, where $r_H(p) > r_L(p)$ for any p, and p is independent and identically distributed (*iid*). Clearly it makes sense to allow r_H and r_L to be a function of p, since different projects should have both different risk and returns; however, the main results of the paper can be derived under the simple case in which r_H and r_L are constant. As such, we make this assumption going forward, and show in Section 7.1 that the results carry through when it is relaxed.

A worker's decision is simple: either engage in the project or take an outside option to be discussed below. We will compare firms that hire workers with different projects. The projects differ in their probability of being in the high state. To this end, let there be a measure 1 of workers that are uniformly distributed along the continuum of project risk level p, hence, uniformly distributed on $[0, 1]$. Thus, for a given risk level p, there is a continuum of workers with the same *iid* probability of achieving the high return. We assume that, if the high state occurs, the investment returns r_H at $t = 2$ as it did at $t = 1$. If the low state occurs, then we assume that the investment returns nothing at $t = 2$. Thus, it is obvious that if the investment is in the low state at $t = 1$, it will be optimal for the firm to terminate the worker, which we assume comes with a cost ϕ to that worker.[4] For reasons of tractability, we assume that, if the investment is in the high state at $t = 1$, the worker suffers no cost of being fired; however, this is not crucial.[5] We will maintain this cost as exogenous in the model. The timing and payoffs of the investment are found in Figure 1.

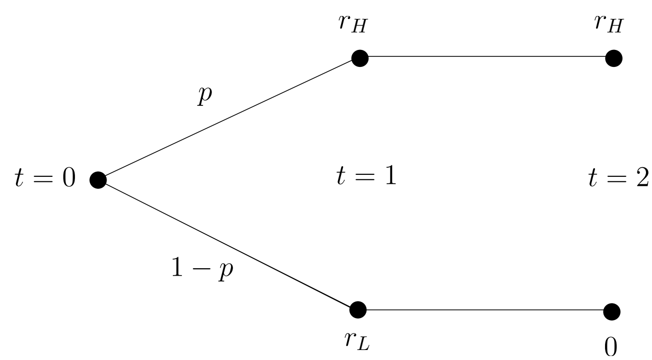

Figure 1: **Timing and payoffs of the investment**

We assume that the investment opportunity requires an amount of funding that is normalized to one at both $t = 0$ and $t = 1$. The firm provides the funding for the workers and so the firm is the owner of the project. Workers have an outside option, for example, other employment opportunities, that yields (instantaneous) utility $\underline{u}$, which will be a constraint that must be satisfied at both $t = 0$ and $t = 1$. For simplicity, we assume that a worker can be replaced without cost to the firm at $t = 1$.[6] Let the consumption that

[4]In practice, one might think it would be less costly for the firm to lower wages than terminate workers. As will become clear in Section 3.1, since a project in the low state pays zero at $t = 2$, a firm would not be willing to pay a worker anything. If the model was relaxed to allow some project value in the low state at $t = 2$, then the question of whether to simply cut wages instead of terminating the worker would be present. There is an extensive literature on downward wage rigidities that supports the difficulty firms have cutting wages. Related to our empirical example in Section 6, Bewley (1998) documents how wage cuts impact employee morale, in particular productivity and turnover. We could capture these effects by adding another period to the model in which workers can be productive.

[5]One can imagine that this arises from an (un-modelled) information environment in which worker type is revealed to the market as being high when the state of the world is high, and low when the state of the world is low. If the worker does have a cost of being fired in the high state, then this would complicate the firm problem (to be outlined below) at $t = 0$. One could get around this by adding a cost of firing to the firm, in addition to the worker. When the worker has a cost of firing in both the low and high state, then ϕ can also be interpreted as a cost of a worker losing firm-specific human capital.

[6]With a cost of replacement, the worker will, not surprisingly, simply receive more compensation in $t = 1$. This will not affect the key results in the paper to come. If there were also costs to adjusting

attains utility $\underline{u}$ be given by $\underline{C}$ such that

$$\underline{u} = -\exp(-\alpha\underline{C}). \tag{2}$$

Clearly, this problem must be solved by backward induction. Importantly, we have created a model where the second period solution is relatively straightforward. In Section 3.1, we solve for the problem between $t = 1, 2$ and show that a worker is terminated in the low state at $t = 1$. This is the only result that we require from the $t = 1, 2$ problem when analyzing the problem between $t = 0, 1$. Thus, for expositional purposes, we begin by analyzing the model at $t = 0$.

First, we rule out two cases which merit discussion. One, firms do not offer 2-period contracts wherein they commit to never terminate the worker, and thus eliminate job risk. If this were the case, workers save the cost ϕ but firms would incur the costs associated with keeping an unproductive worker. Since the firm is risk neutral and the worker risk averse, one could imagine this arising. However, this is not dynamically consistent since a worker in the low state produces nothing at $t = 2$ and the firm would always terminate (shown formally in Section 3.1). If, on the other hand, contracts could be written wherein the firm could legally commit to not terminating a worker, then a simple condition on ϕ (sufficiently small) can be derived to rule out this case, and all of the results of the paper carry through.[7] The second case which we rule out is the firm pre-committing to paying ϕ for the worker. This too, however, is not dynamically consistent. There are, however, real-world examples of firms offsetting some worker expenses. In the case in which firms can pre-commit, we interpret ϕ as costs which are not easily quantified and therefore not contractible, e.g., the loss of firm specific human capital, reputation, etc.[8]

Since workers do not own the equity in the project, they do not receive the proceeds of the investment directly; however, they receive a compensation contract from the firm that pays a fixed amount F at time $t = 1$, regardless of the state of the world, and an

compensation, then variable pay could be used in a similar way as in Oyer (2004). To maintain focus, we do not consider this mechanism here.

[7] If we were to enrich the model by adding more periods, wherein the low state worker would continue to be unproductive, then ϕ could become arbitrarily large and the firm would never commit to keep a worker in the low state since it would become increasingly expensive to do so.

[8] All of our main results to come will obtain in the even case in which $\phi = 0$, which is equivalent to the unlikely case in which all termination costs are quantifiable and the firm pre-commits to them upon termination. Only Corollary 1, wherein we perform compared statics on ϕ requires that $\phi > 0$.

amount V when the return is r_H. We think of F as fixed wages, since they are paid regardless of whether the state of the world is L or H (the return is r_L or r_H), and V as variable wages since these are contingent on state H. Both F and V will be solved in equilibrium as solutions to the firm's optimization problem outlined below. The utility of a worker for time $t = 1$ who invests in a project characterized by p is given by

$$p\left[u_1(V+F)\right] + (1-p)\left[u_1(F-\phi)\right]. \tag{3}$$

The first term represents the high state of the investment, which occurs with probability p. In the high state, the worker receives both variable and fixed wages. The second term represents the low state of the investment, where the worker receives only the fixed wage and suffers the job termination cost ϕ.

2.2 Firm Problem

For our empirical analysis in Section 6, we wish to study firms and their associated workers. We choose to model firm-worker relationships as simply as possible. One could imagine a matching process in which workers of different skills match with firms of different risks. This could create potentially interesting, but unrelated dynamics that would only complicate our analysis without offering us insight into the mechanism which we study. What is important, however, is that firms require workers to implement the projects in both time periods, i.e., workers are essential in the production process. We assume for simplicity that firms are differentiated by the types of workers that are hired. In other words, firms are differentiated by project riskiness. To this end, we assume that a firm hires a measure 1 of workers, each with identical p,[9] and raises an amount of funds normalized to 1. It chooses to raise the funds with one-period (for simplicity) debt, D, where the remainder, $1 - D$, is with one-period equity, E. The firm chooses F and V so as to induce the worker to invest in the project. We assume that firms are risk

[9]The implication of p being identical among workers within a given firm is that firm performance is perfectly correlated with worker performance. Alternatively, we could have firms hire from the entire continuum of workers so that each firm has workers with projects of all levels of risk. The key in that case is to differentiate and rank firms based on the average risk of the projects that they possess. All that we require is a positive correlation between worker and firm performance. This relationship can be justified based on results starting with Griliches (1957), in which productivity differences across firms could be explained by differences in input quality. More recently, Fox and Smeets (2011), for example, find that differences in labor quality is an important factor in explaining dispersion in firm performance.

neutral but are subject to a bankruptcy cost B, which can sensitize the firm to default risk. In addition, we make the important assumption that debt is subsidized relative to equity, which will be formalized below. This is a standard assumption in the corporate finance literature driven largely by a perceived tax advantage of debt over equity (see, for example, Graham (2000) and references therein). Since the empirical tests in Section 6 is performed with data on financial institutions, it is important to point out that this is also a standard assumption in the banking literature (Gorton and Winton (2003)).

In Assumption 3 we will restrict the parameter space to that which yields the firm positive profit in equilibrium and as a consequence, the firm does not fail in the high state. Consequently, the stark set-up of the model then implies that there are two key regions to analyze: the one in which the firm succeeds in the low state, and the one in which it fails. If the firm chooses a sufficiently small level of debt, it will always succeed; thus debt holders will always be paid. In this case, the required interest rate is constant (denoted r_D) for any amount of debt, while the required (expected) rate of return on equity is $r_E(D)$, where $r'_E(D) \geq 0$.[10] The case of no bankruptcy then occurs when $D \leq \frac{r_L - F}{r_D}$. Note that the rate of return on equity is an expected return and so is not necessarily the rate that they will actually receive. Conversely, the rate of return on debt is an interest rate, not an expected rate of return. Conversely, when $D > \frac{r_L - F}{r_D}$, the firm fails in the low state. For what follows, we wish to analyze a meaningful firm capital structure choice. As such, we consider the case in which the bankruptcy cost is sufficiently large so that the firm does not simply wish to take on debt without bounds. To ease the analysis, we make a stark assumption on the bankruptcy cost B: it wipes out all stakeholders. It should be noted that this is not a necessary assumption.

Assumption 1 $B \geq r_L$

Under Assumption 1, when $D > \frac{r_L - F}{r_D}$, the debt holders receive no payment when the firm fails and so have a constant required interest rate denoted by $\widetilde{r_D} > r_D$. Similarly, the equity holders do not receive a payoff in the failed state, so that the required (expected)

[10]Since a firm contracts with workers with the same project characteristics, it is clear that firms will not share the same risk of being in the low state. As will become clear after Assumption 1, we simplify the analysis and explore the case in which the firm opts to avoid default. Thus, the interest rate on debt will be independent of p, in other words, the interest rate is not responsive to the firm cash flow risk. So that this simplification does not unduly affect our results, we let r_E also be independent of p. This is true when, for example, equity holders are risk neutral. We can relax this to allow r_E to decrease in p without impacting our qualitative results; however, they will be needlessly obfuscated.

rate of return to equity is constant and given by $\widetilde{r_E}$. We now formalize the assumption that debt is subsidized relative to equity, which amounts to assuming that the weighted average cost of capital is decreasing in the amount of debt. To analyze the simplest case, we let the subsidy be small.[11] The following two conditions are derived by differentiating the cost of capital of a firm when it cannot fail, and when it does fail in the low state.

Assumption 2

$$r_D - Dr_E'(D) - r_E(D) = \epsilon < 0, \forall\ D \in [0, 1) \tag{4}$$

$$\widetilde{r_D} - (1/p)\widetilde{r_E} = \epsilon < 0,\ \textit{for } \epsilon \textit{ small.} \tag{5}$$

We can now write the firm payoff when it can and cannot fail. Consider first the case in which the firm cannot fail, $D \leq \frac{r_L - F}{r_D}$. The firm's payoff for a given $\{V, F, D\}$ is given by

$$p\underbrace{[r_H - V - F - r_D D]}_{\text{high state return}} + (1-p)\underbrace{[r_L - F - r_D D]}_{\text{low state return}} - \underbrace{r_E(D)(1-D)}_{\text{opportunity cost of equity capital.}} \tag{6}$$

The first term represents the high state of the investment. r_H is earned by the firm from the investment, $V + F$ is paid to the workers, $r_D D$ is paid to the debt holders. The second term represents the return when the investment is in the low state. Note that only F is paid to the workers in this case. The final term represents the opportunity cost of equity capital. Now consider the case in which the firm goes bankrupt in the low state. The firm's payoff for a given $\{V, F, D\}$ is given by

$$p\left[r_H - V - \widetilde{r_D}\right], \tag{7}$$

where again $\widetilde{r_D} > r_D$ represents the cost of debt with default risk. The key difference between (6) and (7) is that, when the investment return is low, there is no payoff for the firm when it defaults on its debt. In addition, Assumption 1 implies that, upon defaulting, there is nothing left for the workers nor the debt holders. Therefore, the firm cannot offer a fixed wage and thus restricted to only using variable wages. Note that

[11] We could instead derive a sufficient condition under which the subsidy would always be small enough; however, it would involve endogenous variables and so could be solved for after the equilibrium is established.

limited liability implies that the payoff in the low state is zero, even if $B > r_L$. We now consider the constrained optimization problem of the firm both when it can and cannot fail. Consider first the case in which it cannot fail, $D \leq \frac{r_L - F}{r_D}$.

$$\max_{V,F,D} \Pi = p\,[r_H - V - F - Dr_D] + (1-p)\,[r_L - F - Dr_D] - (1-D)r_E(D) \tag{8}$$
$$\text{subject to} \quad p\,u_1(V+F) + (1-p)\,u_1(F-\phi) \geq \underline{u},$$
$$\Pi \geq 0.$$

The first constraint represents the restriction that workers must earn at least their reservation utility. Given that a firm's payoff is strictly decreasing in V and F, the Kuhn-Tucker conditions imply that the worker constraint must hold with equality. Now consider the problem when the firm fails in the low state, $D > \frac{r_L - F}{r_D}$. Recall from Assumption 1 that, upon failure, there is nothing left for workers and so only variable pay is possible.

$$\max_{V,D} \Pi = p\,[r_H - V - D\widetilde{r_D}] + (1-p)\,[0] - (1-D)\widetilde{r_E} \tag{9}$$
$$\text{subject to} \quad p\,u_1(V) + (1-p)\,u_1(-\phi) \geq \underline{u},$$
$$\Pi \geq 0.$$

We solve this problem in two steps. First we determine D^* and then use that to solve the appropriate constrained optimization problem. As a consequence of Assumptions 1 and 2, the firm has two choices. First, it can choose the highest level of debt that will still maintain its solvency in all states. Alternatively, it can finance the investment exclusively with debt and face the bankruptcy cost in the low state. Note again that assumption 3 below permits us to restrict attention to the case in which the firm is solvent in the high state. We now show formally that Assumptions 1 and 2 imply that the firm will choose the highest amount of debt while still avoiding default.

Lemma 1 *The firm sets $D^* = \frac{r_L - F}{r_D}$ and remains solvent in both states.*

Proof. *See Appendix.*

The intuition behind this result is straightforward. Conditional on no bankruptcy, the firm payoff is increasing in the amount of debt by Assumption 2. Thus, the firm chooses the amount of debt, D^*, which just ensures it remains solvent. Conditional on bankruptcy, the firm chooses to raise the funds completely with debt. Since Assumption 1 sets bankruptcy costs high, the firm chooses to remain solvent to avoid the cost and so D^* prevails as the optimal leverage policy. It is important to point out that, although in our equilibrium the firm does not go bankrupt, we can enrich the model to allow the firm to endogenously choose to go bankrupt with some probability. In Section 7.2, we consider the project/investment with three potential states instead of two and analyze the case in which the firm chooses to fail in one of the states. We show there that the results to come still hold.

Given that the solution D^* implies that equity holders do not receive a payment in the low state, we define the required rate of return simply by r_E since it is constant. We can now rewrite the firm optimization problem given the solution for D^* from Lemma 1.

$$\begin{aligned} \max_{V,F} \; \Pi = p\left[r_H - V - F - r_D D^*\right] - r_E(1 - D^*) \\ \text{subject to} \quad p\, u_1(V+F) + (1-p)\, u_1(F-\phi) \geq \underline{u} \\ \Pi \geq 0. \end{aligned} \tag{10}$$

3 Equilibrium and Comparative Statics

We consider the problem outlined in (10) without the non-negativity constraint on the expected payoff of the firm, which we consider in Lemma 2. We obtain the following first-order conditions, where we define the Lagrange multiplier by λ:

$$V: -p - \lambda p u_1'(V+F) = 0 \tag{11}$$

$$F: -\frac{r_E}{r_D} - \lambda\left(p u_1'(V+F) + (1-p)u_1'(F-\phi)\right) = 0 \tag{12}$$

$$\lambda: p u_1(V+F) + (1-p)u_1(F-\phi) - \underline{u} = 0. \tag{13}$$

Solving the equations from the first-order conditions (using the fact that utility is exponential) yields the following solutions.

$$V^* = \frac{\log\left(\frac{r_E - p r_D}{r_D \exp(\alpha\phi)(1-p)}\right)}{\alpha}, \tag{14}$$

$$F^* = \frac{\log\left(\frac{(1-p) r_E}{r_E - p r_D}\right)}{\alpha} + \phi + \underline{C}. \tag{15}$$

We now restrict the parameter space to implement the $\Pi \geq 0$ restriction in the problem outlined in (10). In addition, we analyze the most interesting case in which the firm uses both variable and fixed pay (i.e., $V^* > 0$ and $F^* > 0$).[12] The following result derives the necessary and sufficient conditions under which $\Pi \geq 0$, $V^* > 0$, $F^* > 0$ and shows that parameters exist that satisfy these conditions.

Lemma 2

i. If $r_H \geq V^* + r_L + \frac{r_E}{p}\left(1 - \frac{r_L - F^*}{r_D}\right)$, *then* $\Pi \geq 0$, *where* V^* *and* F^* *are defined by* (14) *and* (15).

ii. If $\frac{r_E - p r_D}{(1-p) r_D} > \exp(\alpha\phi) > \frac{r_E - p r_D}{(1-p) r_E \exp(\alpha \underline{C})}$, *then* $V^* > 0$ *and* $F^* > 0$.

There exist parameters under which these conditions hold simultaneously.

Proof. *See Appendix.*

The proof shows that one set of parameters that satisfies the two conditions are $\underline{C}$ and r_H sufficiently high and ϕ sufficiently small. The first condition is relatively straightforward. The higher r_H, the higher the payoff to the firm in the high state. Clearly, a sufficiently large r_H can be chosen to ensure that the firm makes non-negative profits since r_H is an exogenously given payoff in the high state. Note that this condition also ensures that the firm does not fail in the high state. To understand the second condition, consider that, when the cost of job termination is high (ϕ is high), fixed pay is

[12]The interpretation of $V^* < 0$ is that of variable pay in the L state. In particular, the amount of variable pay in the L state is $|V^*|$ and the fixed pay would be $F - |V^*|$. Since we are interested in the most empirically relevant variable pay, we focus only on the case in which total pay is higher in the H state, $V^* > 0$.

favored since it hedges the state in which the worker is terminated. Alternatively, when the cost of job termination is low, the firm favors variable pay. It is this second case that is most interesting, since in standard models of worker compensation without agency problems, having a risk-neutral firm and a risk-averse worker implies that the worker will receive full insurance through a fixed wage (see, for example, Laffont and Martimort (2002)). To understand how variable pay can be optimal in our setting without an agency problem related to the workers, we rearrange the condition under which $V^* > 0$:

$$\frac{r_E}{r_D} > \exp(\alpha\phi)(1-p) + p. \tag{16}$$

As the subsidy to debt increases, i.e., $\frac{r_E}{r_D}$ increases, variable pay becomes more attractive for the firm. In other words, it is the capital structure decision of the firm that can allow variable pay to be optimal. The results that follow will help us understand why: the flexibility of variable pay allows the firm to carry more financial debt, which, if sufficiently subsidized, is desirable. To analyze the most interesting case in which the bank earns positive profit and both variable and fixed pay are used, we restrict attention to the conditions of Lemma 2, wherein it was shown that parameters exist to permit such a restriction.

Assumption 3 *Conditions i. and ii. of Lemma 2 are satisfied.*

We can now determine how fixed and variable pay change with the riskiness of the projects that the workers of a given firm possess (risk of job termination), p. This represents the first implication of the model, which is explored empirically in Section 6.

Lemma 3 *Variable pay relative to fixed pay is decreasing in the probability of job termination.*

Proof. *See Appendix.*

The intuition behind the result comes from the risk aversion of the worker. The more likely it is that a worker is terminated (i.e., the more likely it is that the project is of low quality), the more the worker values fixed pay. This is because fixed pay represents insurance against the cost of job termination.

We now explore the relationship between leverage and variable pay. Clearly, both of these are endogenous variables so it should be stressed that this is a correlation result, which is explored empirically in Section 6.

Lemma 4 *Debt is negatively correlated with the amount of fixed pay, and positively correlated with the amount of variable pay relative to fixed pay.*

Proof. *See Appendix.*

We show this result by analyzing the relationship between every exogenous variable that affects both the amount of debt and the worker compensation. In each case, the sign of the derivative is the opposite for debt versus that of fixed pay, and the same for debt versus that of variable pay relative to fixed pay. Note that there is one exogenous variable, r_L, that affects only the amount of debt. To understand this result, it is illuminating to consider the bankruptcy costs of debt, and the fact that debt is subsidized relative to equity. Given these two features, the firm wishes to take on the most debt that it can, while avoiding bankruptcy. Fixed pay is essentially debt on the operating side of the firm. The more fixed pay that the firm uses, the less financial debt that the firm can sustain. Thus, if the relative amount of fixed pay decreases (due to a change in an exogenous parameter of our model), the firm can take on more financial debt. It is now straightforward to give the main implication of our model, which will be explored empirically in Section 6. The following result gives the relationship between the probability of job termination and the capital structure of the firm.

Proposition 1 *The higher the probability of job termination, the less debt a firm will employ.*

Proof. *See Appendix.*

The intuition behind this result is found easily by considering Lemmas 3 and 4. The higher the probability of job termination, the more fixed pay relative to variable pay (and the more fixed pay in absolute terms) that workers will be paid. The more fixed pay, the less debt a firm can employ. Thus, since the probability of job termination is perfectly correlated with the firm project risk, it follows that firms with riskier projects will have lower debt. This of course should not be too surprising. What is noteworthy is that operating leverage actually goes up when project risk goes up. It is worthwhile defining overall leverage (OL) as being the amount of fixed pay and interest payments relative that a firm has, relative to the payoff in the low state.

$$OL = \frac{r_D D + F}{r_L}. \tag{17}$$

Plugging D^* into (17) yields the result that overall leverage is constant and equal to 1. This follows easily from the fact that all firms choose the amount of debt such that they do not default. This better illuminates the mechanism behind our result: when project risk increases, the firm increases operating leverage, and as a result, must decrease financial leverage to offset the effect that this would otherwise have on overall leverage. This intuition holds even when r_L is a function of p, which we pursue in Section 7.1.

3.1 The Optimal Decision at $t = 1$

The firm decision between $t = 1$ and $t = 2$ differs based on whether the worker's investment is in the high or low state. Recall that we assumed that a worker is essential at both time periods, so that the firm must continue to employ workers to realize any payoff at $t = 2$. Define V_H^2 (F_H^2) as variable (fixed) wage at time $t = 2$ if the state is H, r_D^2 as the required rate of return to debt, and r_E^2 as the required rate of return to equity. If the investment is in the high state, then it returns r_H with certainty. Given debt is assumed to be subsidized, the firm optimally sets the amount of debt to 1 since it cannot go bankrupt.[13] The firm problem becomes

$$\max_{V_H^2, F_H^2} r_H - V_H^2 - F_H^2 - r_D^2 \quad \text{subject to:} \quad u_2(V_H^2 + F_H^2) \geq \underline{u}. \tag{18}$$

It is straightforward to show that the choice between fixed and variable pay is irrelevant since variable pay is not actually variable. Thus, the solution is simply given by the firm paying the worker $C_2 = \underline{C}$ with certainty, namely the outside option. If the investment

[13]Given the subsidy to debt, it is simplest to assume that profits earn between $t = 0$ and $t = 1$ are paid out as a dividend at $t = 1$, since they would not be used for re-investment. Note that as in the $t = 0$ problem, we assume that r_H is sufficiently large that the firm is solvent in the high state. Given the amount of debt is 1, the condition under which this is true is $r_H > V_H^2 + F_H^2 + r_D^2 > 0$, where the fixed and variable pay are given as the solution to the optimization problem (18).

is in the low state, there is no further payoff for the firm, and thus the budget constraint cannot hold since the firm would lose money by paying $\underline{C}$. Thus, it is optimal to terminate the worker.[14]

It is important to recognize that this decision is made at $t = 1$ and therefore has no bearing on the decision at $t = 0$ (other than the knowledge that workers will be terminated in the low state at $t = 1$). If we relaxed the assumption that the worker does not discount utility over the three periods, it will have no effect on the solution at $t = 0$.

4 Applications to Financial Institutions

Our empirical application in Section 6 analyzes the results outlined in Section 3 using financial institutions data. It is worth exploring additional theoretical implications of our model as they apply to these types of firms. Our model is able to rationalize two key features of financial institutions. First, a typical debt-to-assets ratio for non-financial corporations is around 20% to 30%, whereas for financial institutions it is closer to 87% to 95% (Gornall and Strebulaev (2014)). Second, Lemieux et al. (2009) for the U.S. and Célérier and Vallée (2015) for France show that, on average, financial institutions pay 65% of a worker's salary as variable compensation. This compares with 33% to 41% in non-financial firms. We show that these two features can arise endogenously through each of two parameters: the cost of job termination and the cost of debt. We consider below that both the cost of job termination and the cost of debt is, on average, lower in financial institutions versus non-financial institutions.

4.1 The Cost of Job Termination

Consider the cost of job termination within financial institutions; Jacobson et al. (1994) report that, in the U.S., the financial sector is among the lowest in terms of future losses to the worker upon job displacement. Morissette et al. (2007) find similar evidence for Canada. Explanations of why the financial industry has a lower cost to a worker of being displaced typically revolve around the lack of unionization (for example according to Statistics Canada, the rate of unionization in finance in Canada is around 7.5%) and

[14] Note that a worker still receives the outside option $\underline{C}$ when terminated; however, it is not received from the firm in question.

the relatively portable skills that finance employees have when moving within industry.[15] The following result formalizes the relationship in the model.

Corollary 1 *The lower the cost of job termination*

i. The more variable pay relative to fixed pay a firm will use.
ii. The more debt that a firm will employ.

Proof. *See Appendix.*

The result is due to the low cost of job termination resulting in a higher level of variable wages, which consequently lead to higher levels of leverage. Therefore, since financial institutions have on average a lower cost of job termination, we should expect to see more variable wages relative to fixed wages and a higher leverage in financial institutions relative to non-financial institutions. Note that part ii) of this corollary is consistent with Agrawal and Matsa (2013) who show that as the cost of workers being terminated decreases, firms will increase financial leverage.

4.2 The Cost of Debt

There are a number of reasons why financial firms can enjoy better borrowing rates than those for non-financial firms. Banks that hold deposits receive a subsidy through deposit insurance (see, for example, Allen et al. (2015)). Broker-dealers, which will the focus of the empirical investigation in Section 6, receive this subsidy indirectly when they are owned by a deposit-taking institution. Financial institutions also tend to have highly liquid debt (Diamond and Dybvig (1983)). The broker-dealers in the data to be introduced in Section 5 have on average approximately 90% of their liabilities classified as liquid. In our model, the cost of debt is affected by the bankruptcy cost since that cost directly affects recovery rates.[16] In addition, financial institutions have highly

[15]For example, Morris and Wilhelm (2007) argue that investment bankers posses largely industry-specific human capital and, if there is any firm-specific human capital that exists, it is largely a cultural difference between firms. Even then, investment bankers have reduced the cost by sometimes migrating as teams. Many financial institutions will also penalize bankers who leave voluntarily (but importantly, not when they are terminated) by confiscating vested options (thereby increasing switching costs).

[16]It is important to note that, although Assumption 1 implies that recovery rates are always zero, it is not a necessary assumption. We can obtain all the results in the paper when recovery rates are positive so that an increase in bankruptcy costs causes the cost of debt to increase.

liquid assets in case of fire sales.[17] Finally, financial institutions tend to have better contract re-enforcement than non-financial institutions (Hölmstrom and Tirole (1997)). The following result relates the cost of debt to variable pay.

Corollary 2 *The lower the cost of debt*

i. The more variable pay relative to fixed pay the firm will use.
ii. The more debt a firm will employ.

Proof. *See Appendix.*

The second part of the result is straightforward: the lower the cost of debt, the more debt a firm wishes to take on. To take advantage of the lower cost of debt, however, the firm lowers the amount of fixed pay it uses to compensate workers to avoid the potential bankruptcy costs. Of course, if fixed pay is lower, the firm must increase variable pay so as to keep the worker at least as well off. Thus, a lower cost of debt works in the same way as a lower cost of job termination: we should expect to see financial institutions employ more debt and more variable pay relative to non-financial institutions.

5 Data

The data set we rely on to examine the model predictions is a complete proprietary panel of investment brokers and dealers in Canada from January 1992 to December 2010. This includes banks as well as large and small institutional and retail investors. Regulatory financial reports are collected by the Investment Industry Regulatory Organization of Canada (IIROC).[18] Income and balance sheet data are reported monthly although we aggregate annually; bonuses are accrued monthly but paid annually, and what is accrued might not actually be awarded. Therefore using monthly data would not be appropriate for analyzing questions related to compensation. IIROC's membership grew from 119 in

[17]In the broker-dealer data to be introduced, liquid assets include cash, loans receivables, securities borrowed and resold, securities owned by the firm and their clients, and clients accounts. Other allowable assets include receivables and recoverable and overpaid taxes. Non-allowable (illiquid) assets include receivables, fixed assets, capitalized leases, and investments in subsidiaries, among other items. Non-allowable assets make up, on average 10% of assets.

[18]The blank report schedules are publicly available. `http://tinyurl.com/llst4v4`.

1992 to 201 by 2010 but also experienced exits and several mergers. We drop firms that appear for fewer than 5 years and keep track of all mergers.[19]

IIROC is a self-regulatory organization that oversees investment dealer activity in Canadian debt and equity markets as well as personal and wholesale investing. In terms of prudential requirements, IIROC enforces minimum capital requirements and requires that members hold more margin for assets that are riskier and less liquid. IIROC is also the market-conduct regulator, monitoring dealer behavior, and ensures members follow a set of Market Integrity Practices that govern issues like front-running and client priority.

IIROC classifies its members into six categories. The criteria of the groups are outlined in Table I and are based on size and business orientation.[20] Table II presents summary statistics for the main variables of interest. Given that the model predictions are cross-sectional we only use the cross-sectional variation in the data to analyze if our worker compensation mechanism is significant. Few firms are publicly traded; therefore, we do not use market value of equity to measure leverage but instead book value of liabilities over assets. In addition, we introduce a second measure of leverage that incorporates a portion of a financial institutions' subordinated debt. Broker-dealers have two types of subordinated debt on their balance sheet: subordinated loans within the industry and subordinated loans from non-industry investors. We treat the latter as debt and the former as equity; the former is often from the parent (although we cannot distinguish the exact amount) and therefore closer to equity than debt.[21]

Our results are qualitatively similar when non-industry-subordinated debt is included; however, leverage is substantially higher in some cases.[22] Nevertheless, the average

[19]Many small firms first start off trading only mutual funds and are MFDA members and not IIROC members. In order to trade securities, they join IIROC. However, after several years they terminate their IIROC membership, either returning to trading only mutual funds with their MFDA membership or succumbing to failure. We do not observe the reason for exit.

[20]Excluded from the analysis are what is known as Introducing brokers (group A). Introducing brokers advise clients but must perform transactions through another broker.

[21]To prevent the dealers from taking out subordinated debt and simply depositing unused funds at the provider of the debt (likely their parent), IIROC introduced a provider of capital concentration charge in January 2000. Standby subordinated loans for the most part found their way into subordinated loans from industry investors where "Industry Investors" refer to individuals who own a beneficial interest in an investment in the Dealer Member or holding company (of the Dealer Member) (IIROC, accessed 2011). By analyzing the capital charges, we are able to determine that within-industry subordinated loans are almost exclusively from the parent.

[22]Average leverage would be higher still if we included subordinated loans within the industry as debt and not equity. Post-IFRS, IIROC members moved all subordinated debt from capital to debt on their balance sheet, even though for regulatory capital purposes it still counts as capital. We could

Table I: **Groups of investment dealers in Canada**

Group	Regulatory Capital	Clients	Example
B	>$400 million	Retail and Institutional	BMO Nesbitt Burns
C	>$5 million	Institutional	Barclays Capital Can.
D	>$5 million	Retail	HSBC Securities Can.
E	<$5 million	Institutional	Bloomberg Tradebook Can.
F	<$5 million	Retail	yourCFO Advisory Group

broker-dealer leverage is around 63% while median leverage is 72%. The 90th-percentile firm leverage is 94%. Leverage as we define it is slightly lower, on average, in our sample relative to what is reported for the United States in Gornall and Strebulaev (2014). This might be due to a number of regulatory and structural factors (Ratnovski and Huang (2009)). It is more likely, however, stemming from the substantial heterogeneity in the set of broker-dealers in our sample relative to the typical set of bank holding companies studied in the literature. More than two-thirds of the broker-dealers with leverage below 50 are group F, i.e., small retail firms. These firms are in the bottom decile of firm size, both in terms of assets and number of employees, and rely on retained earnings. The benefit of having a wide cross-section of firms is being able to compare the compensation structures of vastly different capital structures, even within the same industry.

Our measure of job termination is firm-specific and meant to capture employment uncertainty. A firm is given a 1 if, between $t-1$ and t, it laid off at least 5% of its workforce and 0 otherwise.[23] Our interpretation is that workers in firms with high turnover are more likely to experience job termination. On average, 20% of firms experience job termination of at least 5%. Note that, in the data, we cannot separately identify firing from voluntary departures. There are a number of reasons why job termination in this industry, however, might not be considered voluntary. First, almost all firms have a no-competitor clause, typically 6 months to 1 year if an employee leaves a firm voluntarily. This introduces important switching costs. In addition, bonuses are often deferred, especially any stock

therefore use post-2010 rules and count all subordinated debt as debt rather than capital. This does not materially impact our results. We use our current definitions based on the accounting definitions of capital and debt at the time our data was collected, while at the same time experimenting with the possibility that non-industry-subordinated debt might be miss-classified.

[23]For robustness, we also look at 7.5% and 10% and have qualitatively similar results. The idea is to capture firms with significant turnover.

Table II: **Summary statistics**

The sample is from 1992 to 2010 and on average 179 firms. We present the mean, standard deviation, 10th, 50th, and 90th percentile after collapsing the data in the cross-section. L is total liabilities and A is total assets. SD is subordinated debt. VW is contractual variable wage and $Bonus$ is purely discretionary bonuses, which include bonuses payable to shareholders in accordance with share ownership. TVW denotes total variable wages. Total wages are denoted TW. Fixed wages are denoted FW. ROA is return on assets. I(dividend) is an indicator variable equal to 1 if the firm issued a dividend and 0 otherwise. I(trading revenue) is an indicator variable equal to one if a bank generated trading revenue. Non-allowable assets are those deemed illiquid by IIROC. EBITW is earnings before interest, taxes, and wages. All dollar amounts are in 2002 CAD.

Variables	**mean**	**sd**	**p10**	**p50**	**p90**
Leverage ((L+SD)/A)	0.63	0.29	0.17	0.72	0.94
Leverage (L/A)	0.60	0.29	0.15	0.69	0.92
Job termination (%)	20.30	17.27	0	17.65	42.86
Bonus/TW (%)	14	18	0	6	44
VW/TW (%)	39	28	0	45	73
TVW/TW (%)	53	25	9	61	79
TVW/FW	2.19	2.17	0.12	1.69	4.47
Fixed wage/employee ($)	83,529	89,537	26,490	59,321	169,663
Bonus/employee ($)	52,882	129,786	0	8,468	165,618
VW/employee ($)	69,413	74,280	0	57,957	15,4274
TVW/employee ($)	122,296	163,344	12,202	84,154	231,906
Number of employees	223	638	6	34	388
ROA	5.5	20.6	-3.1	1.8	14.2
Revenue/employee ($)	471,140	1,299,080	118,110	233,600	823,100
Profits/employee ($)	132,472	874,086	-6,118	15,451	127,262
Revenue/assets	0.89	1.06	.07	0.40	2.41
EBITW/assets	0.62	0.96	0.47	0.68	0.83
I(dividend) (%)	30	32			
I(trading revenue) (%)	81	34			
Non-allowable assets/assets (%)	11	14	1	6	26

options, which can further lead to large switching costs (Morris and Wilhelm (2007)).[24] Third, investment bankers do rotate across institutions, but this occurs only when there is strong signalling about their job prospects at their current placement.

[24] Aldatmaz et al. (2014) finds turnover falls temporarily following broad-based employee stock options.

Wages are decomposed into three segments.[25] First is fixed wages (FW). Fixed wages are included in total operating expenses. For 12 financial institutions we have the breakdown of operating expenses into wages and other expenses through access to the confidential Canadian tri-agency database managed by the Bank of Canada, the Office of the Superintendent of Financial Institutions, and the Canada Deposit Insurance Corporation. Wages are consistently 50% of operating expenses; therefore, we apply this rule for all financial institutions. This is admittedly ad hoc, but given that we observe little to no variation in the composition of operating expenses we believe reasonable. In addition, there are two types of bonuses. Variable compensation (VW) includes all other bonuses, such as commissions and other bonuses of a contractual nature. Importantly, these are payouts only to registered representatives and institutional and professional trading personnel. Bonuses to management are excluded, both discretionary and contractual. Second, there are discretionary bonuses (Bonus), which is self-explanatory, but also includes dividends to employees.

Total wages is the sum of its three components. In Canadian dollars (deflated using the 2002 consumer price index deflator), the average base (or fixed) wage per employee is approximately $83,529 (or approximately $104,127 in 2014). Discretionary bonuses are on average $52,882 per employee. However, about 10% of firms never pay a discretionary bonus. Variable wages are on average $69,413 per employee and, similar to discretionary bonuses, about 10% of firms do not pay variable wages. Interestingly, these are not necessarily the same 10% as those that do not pay discretionary bonuses. Firms that do not pay discretionary bonuses tend to be in group F, i.e., small retail firms. Firms that tend not to pay contractual bonuses tend to be an equal mix of firms in group F and firms in group C, i.e., large institutional firms. On average, total wages are similar to those reported in the introduction for analysts and specialists. Importantly, the theoretical model relates leverage and job separation to TVW/FW, which is on average 2.19, i.e. total variable wages are more than twice base wages. This is the variable we use in our specifications.

The average return on assets is an impressive 5.5, but with substantial variation. The

[25] Wages are based on average wages for all non-executive broker-dealers in the firm, irrespective of hierarchy. Efing et al. (2014) do not find that the correlation between variable pay and trading volume/volatilty is overly sensitive to whether or not wages are equally weighted or weighted by hierarchy within their set of European banks. This provides some assurance that our approach, which is used because of the lack of information on job titles, is a good approximation to capture the cross-section heterogeneity in firms' wages.

ROA for the broker-dealers in this sample is substantially higher than that reported for the banking sector, which is closer to 1. We report a median ROA of 1.8, however, which is closer to what one would expect in the banking sector. Given the extreme outliers that generate the large differences in the mean and median, we winsorize the data at the 1% level before estimating our econometric specifications. We also report revenue per employee and revenue per asset. Each employee, on average, generates $471,140 per year (approximately $586,098 in 2014 dollars) with substantial variation across firms and time. Net profits are approximately $132,472 per year per employee. Average net profits are higher than the 90th percentile; however, highlighting the fact that a few firms are generating very large profits compared to most firms. An average firm has 223 employees, where employee includes only registered representatives of the firm. A dollar of assets generates about 89 cents of revenue. We also report a new measure-EBITW, or earnings before interest, taxes, and wages. This is important because in our model, the risk of job termination and project risk are perfectly correlated. Thus, we require a measure of project risk, as opposed to firm risk which would be affected by both the capital structure and wage structure. Finally, about 81% of firms are involved in trading.

6 Empirical Results

Our model of capital and pay structure has three testable implications. First is Lemma 3: variable pay relative to fixed pay is decreasing in the probability of job termination. Second is Lemma 4: debt is negatively correlated with the amount of fixed pay and positively correlated with the amount of variable pay relative to fixed pay. Finally, Proposition 1—the main result of the paper—the higher the probability of job termination, the less debt a firm will employ. In this section we study the model's predictions in the context of the Canadian broker-dealer industry. All three empirical predictions are cross-sectional therefore we use a between estimator, averaging the within-firm information. Ideally one would use exogenous variation in project riskiness or job separation rates across firms to structurally estimate the model and determine the quantitative impact of employment uncertainty on leverage and worker compensation. We do not have this, and so the empirical analysis is not meant to be stand-alone, rather, it is meant to provide the best evidence possible for our new theory model, given data limitations. We therefore focus on whether or not the correlations in the data between variable pay, job termination and leverage are consistent with those that arise from the model.

Our first regression has total variable wages (variable wage plus discretionary bonuses) divided by fixed wages as the dependent variable and the main independent variable is the probability of job termination. The prediction from Lemma 3 is that $\beta < 0$.

$$TVW/FW_i = \alpha + \beta \text{pr(job termination)}_i + \gamma X_i + \delta_j + \epsilon_i. \tag{19}$$

Included in the Xs are log of total assets (size), log of revenue per employee, non-allowable assets/assets, an indicator variable for whether or not the firm paid dividends and an indicator variable for whether or not the firm generated any trading income; δ captures group fixed effects where the groups are B-F defined in Section 5. This captures retail versus institutional firms as well as being highly correlated with whether firms use subordinated debt or not. We include size as a control for several reasons. The main reason is that there is evidence that firms offer increasing wage profiles to loosen the effects of financial constraints (Michelacci and Quadrini (2008)). In our context, this implies smaller firms would have a larger fraction of their wage flexible relative to that of the larger firms. We use revenue per employee to capture potential productivity differences across firms.

Results from estimating equation (19) are presented in column (1) of Table III. Firms with high employment uncertainty are less likely to use variable wages and therefore more likely to use fixed wages. This result provides supporting evidence for Lemma 3. How much less? A firm with high employment uncertainty pays 57% less variable pay relative to fixed pay than a firm with low employment uncertainty. In addition to our main variable of interest, we find a negative correlation between size and wage structure. Larger firms tend to offer wage contracts that are skewed towards fixed wages, which is consistent with Michelacci and Quadrini (2008). We also find total variable compensation and dividend pay-outs are positively correlated and document a negative correlation with non-allowable assets (illiquidity). The more illiquid a banks' portfolio the higher the fraction of pay that is fixed. Finally, we point out that the correlation between variables wages as a fraction of total wages and revenues per employee is not statistically significant. The reason is, at least in our sample of firms, more productive firms pay employees both higher fixed and variable wages. This diminishes the effect of the standard incentive channel, which would suggest a positive correlation between

Table III: **Lemma 3: variable pay relative to fixed pay is decreasing in the probability of job termination**

The dependent variable in column (1) is total variable wage, defined as discretionary bonuses plus contractual bonuses, divided by fixed wages. The dependent variable in columns (2)-(3) is one of two within firm-specific measures: (i) standard deviation of revenue per assets, and (ii) standard deviation of EBITW/assets. Firm size is measured by total assets. I(dividend) is an indicator equal to 1 if the firm pays out a dividend and 0 otherwise. Non-allowable assets is the fraction of a bank's assets that are illiquid. I(trading income) is an indicator variable equal to 1 if the firm generates trading income and 0 otherwise. Data are by firm-year. There are on average 178 firms and therefore 1,783 observations. Standard errors are calculated using the bootstrap. The levels of significance are *** p<0.01, ** p<0.05.

VARIABLES	(1) TVW/FW	(2) vol(rev/assets)	(3) vol(EBITW/assets)
Pr(job termination)	-2.706***	0.202**	0.192**
	(0.961)	(0.0943)	(0.0823)
I(dividend)	0.964*	0.191**	0.0911*
	(0.499)	(0.0958)	(0.0542)
I(trading income)	0.712	0.117**	0.101**
	(0.492)	(0.0522)	(0.0431)
Nonallowable assets	-2.641***	0.843***	0.697***
	(0.973)	(0.248)	(0.209)
log(size)	-0.193***		
	(0.0640)		
log(revenue/employee)	0.333		
	(0.308)		
Constant	1.288	0.0135	0.0174
	(3.303)	(0.0498)	(0.0387)
R^2	0.120	0.146	0.167

variable wages and productivity.

In columns (2)-(3) we show that job termination and asset/project risk, measured by volatility in firm revenue/assets and by volatility of EBITW/assets is positive.[26] Impor-

[26] As discussed in Section 3, the model features a positive correlation between job termination and project risk. Therefore, we need to avoid a measure of risk that incorporates either the risk from wages

tantly, these results act as a check on our theory. The model is constructed such that workers with riskier projects are more likely to be terminated. Thus, we should expect to see a positive relationship in the data between project risk and employment uncertainty. The volatility of firm's assets is also positively correlated with the illiquidity of those assets. Note that we do not include firm size or revenue per employee as controls given that revenue is in the numerator and assets in the denominator of our dependent variables.

Although Lemma 4 is a theory result purely about correlations, we consider two estimating equations. First, with leverage as the dependent variable and fixed wages as the main independent variable of interest. The model prediction is that $\beta_1 < 0$. Second, with leverage as the dependent variable and total variable wages over fixed wages as the main independent variable of interest. The model prediction is that $\beta > 0$. Note that the Xs and δ_j are as before.

$$\begin{aligned} L_i &= \alpha_1 + \beta_1 \log FW_i + \gamma_1 X_i + \delta_j + \epsilon_i, & (20) \\ L_i &= \alpha_1 + \beta (TVW/FW)_i + \gamma X_i + \delta_j + \epsilon_i. & (21) \end{aligned}$$

Consistent with Lemma 4 fixed wages are negatively correlated with leverage and total variable compensation is positively correlated with leverage. In addition, leverage is positively correlated with size but negatively correlated with non-allowable (illiquid) assets as well as trading income. Leverage is also negatively correlated with log revenue per employee. That is, firms with more productive employees have less leverage. This result is largely mechanical. Higher revenues leads to higher asset values, implying lower leverage by construction.

The final estimating equation tests Proposition 1. The dependent variable is leverage as in equation (20) and the main independent variable of interest is the probability of job termination. Proposition 1 states that the coefficient $\beta < 0$.

$$L_i = \alpha + \beta \Pr(\text{job termination})_i + \gamma X_i + \delta_i + \epsilon_i. \qquad (22)$$

The results are shown in Table V and support Proposition 1. Firms with higher probabilities of job termination have lower leverage. Note that the impact of employment

or capital structure. Accordingly, we measure volatility in revenues/assets, and EBITW/assets.

uncertainty is in addition to the obvious impact of size on leverage and what one might expect to be the impact of size on employment uncertainty. Given two firms with an average leverage of approximately 63, our results suggest that the firm with high turnover has a leverage ratio closer to 50.

In the model, the probability of job termination and project (cash flow) risk are interchangeable, i.e., are perfectly positively correlated. This is because a firm is endowed with a continuum of workers with the same p, where $1 - p$ represents of the risk of job termination and the risk that the project is in the low state, since workers are always terminated in the low state. In terms of the empirics, the volatility of revenue or EBITW should explain variables wages and leverage in exactly the same way as job termination. One may argue, however, that the relationship between cash flow risk and leverage should arise naturally in any reasonable model (for example, a model with agency problems) without the mechanism that we propose in this paper. Therefore, it is important that we establish that the worker job termination-variable pay channel that our theory explores is relevant. In other words, we wish to show that variations in the volatility of revenue (or EBITW) do not have explanatory power above which risk of job termination has on leverage or wages. In our model the correlation between job termination and the ratio of variable to fixed wages is negative (Lemma 3) and the correlation between job termination and leverage is also negative. In Table VI we present results for two sets of regressions. First, in columns (1)-(4) we show results from repeating regression (22) using the volatility of revenue and EBITW as regressors in addition to our measure of job termination. Second, in columns (5)-(6) we show results from repeating regression (19) but using our two aforementioned measures of cash flow risk in addition to our measure of job termination. In the first case we see that cash flow risk is highly correlated with leverage, but that job termination remains significant. In the second case, cash flow risk is not significantly correlated with V/F, controlling for job termination. Although this does not imply that other mechanisms, such as agency costs are not active for the set of firms we examine, it does show that the employment uncertainty channel we highlight in this paper is an additional, plausible mechanism.

Table IV: **Lemma 4: debt is negatively correlated with fixed pay and debt is positively correlated with the amount of variable pay relative to fixed pay**

TVW/FW is defined as discretionary bonus plus contractual variable compensation over fixed wage. L/A is total liabilities over total assets. $(L + SD)/A$ is total liabilities plus subordinated loans from non-industry investors. Excluded from our definition of sub-debt is subordinated loans from industry investors, including the parent. We treat this as equity. Firm size is given by total assets. I(dividend) is an indicator equal to 1 if the firm pays out a dividend and 0 otherwise. Non-allowable assets is the fraction of a bank's assets that are illiquid. I(trading income) is an indicator variable equal to 1 if the firm generates trading income and 0 otherwise. There are on average 178 firms and therefore 1,783 observations. Standard errors are calculated using the bootstrap. The levels of significance are *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	(1) (L+SD)/A	(2) L/A	(3) (L+SD)/A	(4) L/A
log(fixed wage)	-0.0211	-0.0511**		
	(0.0310)	(0.0249)		
TVW/FW			0.0144***	0.0171***
			(0.00424)	(0.00395)
log(size)	0.0733***	0.0732***	0.0751***	0.0747***
	(0.00751)	(0.00597)	(0.00743)	(0.00589)
I(dividend)	-0.0438	-0.00353	-0.0513	-0.00392
	(0.0406)	(0.0389)	(0.0391)	(0.0368)
Nonallowable assets	-0.793***	-0.998***	-0.763***	-0.963***
	(0.183)	(0.0967)	(0.177)	(0.0912)
log(revenue/employee)	-0.0704**	-0.0397	-0.0911***	-0.0853***
	(0.0324)	(0.0263)	(0.0217)	(0.0186)
I(trading income)	-0.0388	-0.0414	-0.0436	-0.0394
	(0.0384)	(0.0376)	(0.0374)	(0.0371)
Constant	0.615***	0.547***	0.582***	0.484**
	(0.218)	(0.202)	(0.214)	(0.193)
R^2	0.656	0.746	0.665	0.755

Table V: **Proposition 1: the higher the probability of job termination, the less debt that a firm will employ**

L/A is total liabilities over total assets. $(L + SD)/A$ is total liabilities plus subordinated loans from non-industry investors. Excluded from our definition of sub-debt is subordinated loans from industry investors, including the parent. We treat this as equity. Firm size is given by total assets. I(dividend) is an indicator equal to 1 if the firm pays out a dividend and 0 otherwise. I(trading income) is an indicator variable equal to 1 if the firm generates trading income and 0 otherwise. Non-allowable assets is the fraction of a bank's assets that are illiquid. There are on average 178 firms. Standard errors are calculated using the bootstrap. The levels of significance are *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) (L+SD)/A	(2) L/A
Pr(job termination)	-0.129**	-0.139**
	(0.0557)	(0.0681)
log(size)	0.0710***	0.0701***
	(0.00741)	(0.00654)
I(dividend)	-0.0387	0.0113
	(0.0400)	(0.0352)
Nonallowable assets (%)	-0.819***	-1.026***
	(0.164)	(0.0884)
log(revenue/employee)	-0.0836***	-0.0768***
	(0.0166)	(0.0162)
I(trading income)	-0.0351	-0.0290
	(0.0336)	(0.0324)
Constant	0.611***	0.517***
	(0.213)	(0.193)
R^2	0.660	0.747

Table VI: **Robustness Checks**

L/A is total liabilities over total assets. $(L + SD)/A$ is total liabilities plus subordinated loans from non-industry investors. Excluded from our definition of sub-debt is subordinated loans from industry investors, including the parent. We treat this as equity. V/F is total variable wages over fixed wages. I(dividend) is an indicator equal to 1 if the firm pays out a dividend and 0 otherwise. I(trading income) is an indicator variable equal to 1 if the firm generates trading income and 0 otherwise. Non-allowable assets is the fraction of a bank's assets that are illiquid. There are on average 178 firms. Standard errors are calculated using the bootstrap. The levels of significance are *** p<0.01, ** p<0.05, * p<0.1

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	(L+SD)/A	L/A	(L+SD)/A	L/A	TVW/FW	
Pr(job separation)	-0.247***	-0.258***	-0.237***	-0.250***	-2.481***	-2.590***
	(0.0867)	(0.0850)	(0.0839)	(0.0827)	(0.788)	(0.797)
vol(revenue/assets)	-0.219***	-0.199***			1.125	
	(0.0687)	(0.0648)			(0.720)	
vol(EBITW/assets)			-0.318***	-0.285***		1.982*
			(0.0745)	(0.0697)		(1.020)
I(dividend)	-0.00464	0.0437	0.00432	0.0513	0.811	0.710
	(0.0421)	(0.0377)	(0.0414)	(0.0373)	(0.528)	(0.532)
Nonallowable assets	-1.165***	-1.378***	-1.128***	-1.346***	-2.056**	-2.491**
	(0.192)	(0.126)	(0.193)	(0.124)	(0.996)	(1.048)
I(trading income)	0.0360	0.0406	0.0417	0.0455	0.485	0.421
	(0.0457)	(0.0452)	(0.0455)	(0.0446)	(0.461)	(0.457)
Constant	0.844***	0.815***	0.841***	0.812***	1.920***	1.935***
	(0.0520)	(0.0488)	(0.0521)	(0.0487)	(0.540)	(0.538)
R^2	0.440	0.529	0.459	0.543	0.111	0.138

7 Robustness

7.1 Project Returns and p

In this section we consider the case in which r_H and r_L are both functions of p, $r_H(p)$ and $r_L(p)$. Similar the base model in which r_H and r_L are constant, we assume that if a firm received $r_H(p)$ at $t = 1$, it receives $r_H(p)$ at time $t = 2$. Conversely, if a firm receives $r_L(p)$ at $t = 1$, it receives nothing at $t = 2$. Clearly, it is reasonable to assume that firms with workers implementing riskier projects should have higher expected returns to those projects. However, as it turns out, to obtain our previous results we do not require any assumptions on $r_H(p)$, and only a minimal assumption on $r_L(p)$. We make the sufficient but not necessary assumption that $r'_L(p) \geq 0$. In other words, firms with safer projects have a (weekly) higher return in the low state. We begin by modifying Assumption 1.

Assumption 4 $B \geq r_L(p)$

We continue to assume the conditions from Assumption 2 hold. The optimal amount of debt is determined in similar fashion as in the base model.

Lemma 5 *The firm sets* $D^* = \frac{r_L(p)-F}{r_D}$ *and remains solvent in both states.*

Finally, the optimal F^* and V^* are unchanged since they are neither a function of r_H nor r_L. We can now consider the three main results of the paper. First, the results of Lemma 3 are similar, since F^* and V^* are unchanged. However, since r_L is now different for each firm, we need to normalize the amount of fixed pay relative to $r_L(p)$. This is because firms with higher r_L can have more fixed wages (or debt) and still remain solvent in the low state. It is straightforward to show that the results of Lemma 3 hold when we consider the relative fixed wage using the assumption that $r'_L(p) \geq 0$. Next, it follows that the results of Lemma 4 hold noting D^* in Lemma 5, and again using the assumption that $r'_L(p) \geq 0$. As in the base model, our main result, Proposition 1 then follows as a consequence of the previous 2 lemmas. Importantly, the intuition is unchanged and so it is again noteworthy that operating leverage actually increases when project risk increases. As in the base model, we define overall leverage (OL) as the amount of fixed pay and interest payments that a firm has; however now it must be relative to the payoff in the low state.

$$OL = \frac{r_D D + F}{r_L(p)} \tag{23}$$

Plugging D^* into equation (23) again yields the result that overall leverage is constant and equal to 1. Thus, as in the base case, when project risk increases, the firm increases operating leverage, and as a result, must decrease financial leverage to offset the change in overall leverage.

7.2 Positive Probability of Bankruptcy

We modify the model to show that, in equilibrium, the firm can have a positive probability of bankruptcy. To accomplish this in the simplest way possible, we add one new element to the model. In addition to the H and L states at time $t = 1$, we add a state M. Let the probability that state H occurs be p_H, the probability of state L be p_L and, consequently, the probability of state M, p_M, is $1 - p_H - p_L$. Let the return in state M be r_M where $r_H > r_M > r_L$. The ultimate goal of this section is to show that the subsidy to debt can be high enough that the firm wishes to default with positive probability, but not too high that they wish to default any time a low state is realized. Thus, as in Assumption 2, we assume that debt is subsidized, however we no longer assume that ϵ must be small Furthermore, we let $B \geq r_M$. The firm offers a compensation contract that promises to pay F in all states, and V only in state H. As before, let r_D represent the interest rate on debt without default, and r_E represent the cost of equity in that case. As in the base model, if the firm does not default, the debt holders receive the same regardless of the probabilities of the states, thus r_D is constant. If a firm chooses not to default on debt in any state, the subsidy to debt implies that it sets $D = \frac{r_L - F}{r_D}$, and the firm payoff for a given {V,F} in this case is

$$p_H(r_H - V - r_L) + p_M(1 - p)(r_M - r_L) - r_E\left(1 - \frac{r_L - F}{r_D}\right). \tag{24}$$

Next, consider the case in which the firm defaults on the debt only in state L. Let $\widetilde{r_D} \geq r_D$ ($\widetilde{r_E} \geq r_E$) be the interest rate (cost of equity) in the presence of bankruptcy costs B with failure only in state L. Given $B \geq r_M$, debt holders receive nothing upon default. Additionally, debt holders receive the same when the firm does not fail, regardless of the probability, thus $\widetilde{r_D}$ is constant. Given that debt is subsidized, the firm sets $D = \frac{r_M - F}{\widetilde{r_D}}$ so as to remain solvent in state M. The firm's payoff for a given {V,F} is

$$p_H(r_H - V - r_M) - \widetilde{r_E}\left(1 - \frac{r_M - F}{\widetilde{r_D}}\right). \tag{25}$$

Finally, the firm may default on its debt in both states M and L. Define $\widehat{r_D} \geq \widetilde{r_D}$ as the cost of debt, given that the firm defaults in states M and L, where as before, $\widehat{r_D}$ is constant. In this case, the firm sets $D = 1$. The firm's payoff for a given {V,F} is

$$p_H(r_H - V - F - \widehat{r_D}). \tag{26}$$

The following result shows that (25) can yield the highest payoff for a firm.

Lemma 6 *There exist parameters such that a firm with workers characterized by projects with risk defined by p_H, p_M, and p_L sets debt equal to $\frac{r_M - F}{\widetilde{r_D}}$ and defaults with probability p_L.*

Proof. *See Appendix.*

The intuition behind this result is that a firm chooses to default in state L because the benefits of using more debt (i.e., the subsidy to debt) outweighs the bankruptcy costs associated with the failure. Conversely, the firm chooses not to default on the debt in state M because the cost of bankruptcy in that state outweighs the benefit of increased debt. To show that the results of the paper do not change when a firm can go bankrupt, we are left with defining a worker's problem. Importantly, we need to consider time $t = 2$. When the return to the project is zero at $t = 2$ in both states M and L, then the problem is identical to the base model, where $1 - p$ is replaced by $1 - p_H$. Thus, all the results remain unchanged. Conversely, if in state M there is a sufficient return at $t = 2$ so that the worker is not terminated (i.e., the return is sufficiently high such that it is optimal to pay workers their outside option), then the worker problem, which constitutes the constraint in (10), involves another distinct term. Consequently, the new V^* and F^* are slightly altered; however, they share the same properties as before and, consequently, the results of the paper still hold.

8 Conclusion

We provide a new model that links worker job termination, pay structure (variable versus fixed), and the capital structure of the firm. The model produces three testable implications, for which we find empirical support using a novel data set composed of all Canadian investment brokers and dealers. We show that firms that are less likely to dismiss workers pay more variable wages. This is despite there being no agency problems. Once we take into account the firm's capital structure decision, variable pay arises endogenously. We find that firms paying more variable wages have higher leverage, and so firms that are more likely to dismiss workers have lower leverage. We then use the model in the context of financial institutions and uncover a new justification for why banks may be highly levered, and why their wage structure may be more skewed toward variable pay relative to non-financial institutions. What drives both of these results is the fact that banks tend to have lower costs of debt, and lower costs to workers of termination.

Although this paper does not model any agency problems, such issues likely play a role in many firms. An interesting future direction is to embed agency costs into the model and to differentiate between management and workers. As data availability improves, we can then disentangle the use of variable pay into its role in ameliorating agency conflicts and its use in enhancing financial flexibility as shown in this paper. Another future direction is to consider stock options versus variable pay. Although stock options may be relegated to management in many organizations, there are firms, such as financial firms, that pay workers partly with such options. In the context of our model, if stock options are granted ex ante with an exercise price such that they pay off in the H state, but not in the L state, then the results will be qualitatively similar to those from our model. If stock options are granted ex post, then the model would need to consider additional periods to capture how the option value evolves. Interestingly, if our model was relaxed to allow heterogeneity among workers, the payoff of stock options could, for example, be high at the same time a worker's project is in the L state. In that case, stock options would actually be a hedge against the state in which the worker is dismissed, thus performing the same function as fixed pay. In any case, the operating flexibility that stock options would create could allow more debt through the same mechanism explored in this paper.

9 Appendix

Proof of Lemma 1

Define V_{ND} and F_{ND} as variable and fixed wages, respectively, when the firm does not default. Define V_D as variable wages when the firm does default. We first show that, in any equilibrium, $V_D > V_{ND} + F_{ND}$. From problem (8), the worker constraint that binds in equilibrium is

$$pu_1(V_{ND} + F_{ND}) + (1-p)u_1(F_{ND} - \phi) = \underline{u}. \tag{27}$$

From problem (9), the worker constraint is

$$pu_1(V_D) + (1-p)u_1(-\phi) = \underline{u}. \tag{28}$$

Since $u_1' > 0$, it follows that $V_D > V_{ND} + F_{ND}$. Assumption 2 implies that the optimal debt level conditional on no default is $D^*_{ND} = \frac{r_L - F}{r_D}$, while $D^* = 1$ is optimal when the firm defaults in the low state. Using the above definitions and the solution for D^*_{ND} we plug in and compare (6) and (7), which yields the following condition under which the payoff to the bank with no default exceeds that with default:

$$-p(V_D - V_{ND} - F_{ND}) \leq -r_E(D^*_{ND})(1 - D^*_{ND}) + p\widetilde{r_D}. \tag{29}$$

Since both $\widetilde{r_D}$ and $\widetilde{r_E}$ are constant, and neither debt nor equity holders receive anything in the low state, the only difference between the required rates is the subsidy to debt. Assumption 2 implies that as $\epsilon \to 0$, $\widetilde{r_D} \to (1/p)\widetilde{r_E}$. Since equity holders receive nothing in the low state with or without default, it follows that $r_E(D^*_{ND}) = \widetilde{r_E}$. Thus, (30) becomes

$$-p(V_D - V_{ND} - F_{ND}) \leq r_E(D^*_{ND})D^*_{ND}, \tag{30}$$

which holds since $V_D - V_{ND} - F_{ND} > 0$ and $r_E(D^*_{ND})D^*_{ND} > 0$.

■

Proof of Lemma 2

Condition i. is derived by substituting D^* into the objective function of the optimization problem (10), and setting it greater than or equal to zero. Condition ii. comes directly from setting (14) and (15) greater than zero. To show that parameters exist that satisfy conditions i. and ii., let $\phi \to 0$ so that $\exp(\alpha\phi) \to 1$. Consequently, the left hand inequality of condition ii. is satisfied since $\frac{r_E - pr_D}{r_D - pr_D} > 1$. The right hand inequality of condition ii. is then satisfied whenever the following holds.

$$\underline{C} \geq \frac{\left(\frac{r_E - pr_D}{(1-p)r_E}\right)}{\alpha} \tag{31}$$

Where the right hand side of (31) is finite. Let $\underline{C} = (\frac{r_E - pr_D}{(1-p)r_E})/\alpha + \epsilon$ for ϵ positive and finite. Therefore, the right hand side of condition i. is finite and so there must exist an r_H sufficiently large and finite so that condition i. is satisfied.

■

Proof of Lemma 3

$$\frac{dF^*}{dp} = -\frac{r_E - r_D}{\alpha(1-p)(r_E - pr_D)} < 0,$$

where the inequality follows from $r_E > r_D$.

$$\frac{dV^*}{dp} = \frac{r_E - r_D}{\alpha(1-p)(r_E - pr_D)} > 0,$$

where the inequality follows from $r_E > r_D$. It then follows that $\frac{d(V^*/F^*)}{dp} > 0$ since $F^* > 0$ and $V^* > 0$ by Assumption 3.

■

Proof of Lemma 4

We consider how all parameters change with F^*, V^*/F^*, and D^*. The proof to Corollary 1 shows that $\frac{dF^*}{d\phi} = 1 > 0$, $\frac{d(V^*/F^*)}{d\phi} < 0$, and $\frac{dD^*}{d\phi} < 0$. The proof to Corollary 2 shows that $\frac{dF^*}{dr_D} < 0$, $\frac{d(V^*/F^*)}{dr_D} < 0$, and $\frac{dD^*}{dr_D} > 0$. The proof to Lemma 3 shows that $\frac{dF^*}{dp} < 0$,

$\frac{d(V^*/F^*)}{dp} > 0$. Since $D^* = \frac{r_L - F^*}{r_D}$, it follows that $\frac{dD^*}{dp} > 0$. Next, it is trivial to see that $\frac{dF^*}{d\underline{C}} > 0$, $\frac{d(V^*/F^*)}{d\underline{C}} < 0$ and, since $D^* = \frac{r_L - F^*}{r_D}$, it follows that $\frac{dD^*}{d\underline{C}} < 0$. Now consider α:

$$\frac{dF^*}{d\alpha} = -\frac{log(\frac{r_E - pr_E}{r_E - pr_D})}{\alpha^2} > 0 \tag{32}$$

$$\frac{dV^*}{d\alpha} = -\frac{log(\frac{r_E - pr_D}{r_D - pr_D})}{\alpha^2} < 0, \tag{33}$$

where the inequality in (32) follows since $\frac{r_E - pr_E}{r_E - pr_D} < 1$, and the inequality in (33) follows since $\frac{r_E - pr_D}{r_D - pr_D} > 1$. It follows that $\frac{d(V^*/F^*)}{d\alpha} < 0$. Since $D^* = \frac{r_L - F^*}{r_D}$, it follows that $\frac{dD^*}{d\alpha} < 0$. Next consider r_E:

$$\frac{dF^*}{dr_E} = -\frac{pr_D}{\alpha r_E(r_E - pr_D)} < 0 \tag{34}$$

$$\frac{dV^*}{dr_E} = \frac{1}{r_E - pr_D} > 0. \tag{35}$$

It follows that $\frac{d(V^*/F^*)}{d\alpha} > 0$. Since $D^* = \frac{r_L - F^*}{r_D}$, it follows that $\frac{dD^*}{dr_E} > 0$. Finally, F^* and V^* are independent of r_L while it is trivial to see that D^* is increasing in r_L. It follows that, for every parameter in V^* and F^*, F^* is negatively correlated with D^*, and V^*/F^* is positively correlated with D^*.

■

Proof of Proposition 1

$$\frac{dD^*}{dp} = \frac{dD^*}{d(V^*/F^*)} \frac{d(V^*/F^*)}{dp} > 0, \tag{36}$$

where the inequality follows from Lemma 3 and Lemma 4.

■

Proof of Corollary 1

Part 1: $\frac{dV^*}{d\phi} = -1 < 0$, $\frac{dF^*}{d\phi} = 1 > 0$; therefore $\frac{d(V^*/F^*)}{d\phi} < 0$ since $F^* > 0$ and $V^* > 0$ by Assumption 3.
Part 2: Since $\frac{d(V^*/F^*)}{d\phi} < 0$, Lemma 4 implies $\frac{dD^*}{d\phi} = \frac{dD}{dV}\frac{dV}{d\phi} < 0$.

■

Proof of Corollary 2

Part 1: It is straightforward to show that $\frac{dV^*}{dr_D} > 0$, $\frac{dF^*}{dr_D} < 0$ and so $\frac{d(V^*/F^*)}{dr_D} < 0$ since $V^* > 0$ and $F^* > 0$ by Assumption 3.
Part 2: Since $D^* = \frac{r_L - F}{r_D}$ and both r_D and F decrease, it is clear that debt increases.

■

Proof of Lemma 6

Let $\widetilde{r_D^{NB}}$ be the interest rate that a firm pays when there are no bankruptcy costs and the firm defaults in the state L. $\widetilde{r_E^{NB}}$ is then the corresponding cost of equity.

$$(p_H + p_M + p_L)(r_L - F) + r_E\left(1 - \frac{r_L - F}{r_D}\right) \geq (p_H + p_M)(r_M - F) + \widetilde{r_E^{NB}}\left(1 - \frac{r_M - F}{\widetilde{r_D^{NB}}}\right) \tag{37}$$

The first terms on both sides of the above inequality are the payments to debt holders where, for example, with no failure, the amount received by debt holders in all states is $\frac{r_L - F}{r_D} r_D$. Now consider the environment with bankruptcy costs. Comparing (25) with (24) and (25) with (26) yields the following two conditions under which a firm chooses to default only in state L:

$$(p_H + p_M)(r_M - r_L) \leq p_H(V_{D1}^* - V_{ND}^*) + r_E\left(1 - \frac{r_L - F_{ND}^*}{r_D}\right) - \widetilde{r_E}\left(1 - \frac{r_M - F_{D1}^*}{\widetilde{r_D}}\right) \tag{38}$$

$$p_H(\widehat{r_D}) \geq p_H(V_{D1}^* - V_{D2}^* + r_M) + \widetilde{r_E}\left(1 - \frac{r_M - F_{D1}^*}{\widetilde{r_D}}\right). \tag{39}$$

Where V^*_{ND} (F^*_{ND}) is the equilibrium variable (fixed) wage when the firm does not default, V^*_{D1} (F^*_{D1}) is the equilibrium variable (fixed wage) when the firm defaults in the low state. Note that a fixed wage in this context is one that pays in the high and medium states only. Finally, V^*_{D2} is the variable wage if the firm defaults in both the medium and low states. Note that no fixed wage can be paid in this case. To show that parameters exist such that (38) and (39) can be satisfied, let $p_L \to 0$; thus $\widetilde{r_D} \to \widetilde{r_D^{NB}}$, $\widetilde{r_E} \to \widetilde{r_E^{NB}}$, $\widetilde{r_D^{NB}} \to r_D$, $\widetilde{r_E^{NB}} \to r_E$, and it is straightforward to show that in equilibrium, $V^*_{D1} \to V^*_{ND}$. Using these, conditions (38) and (37) collapse to the same inequality and so (38) must be satisfied. From (39) we get

$$\widehat{r_D} \geq V^*_{D1} - V^*_{D2} + r_M + \frac{\widetilde{r_E}}{p_H}\left(1 - \frac{r_M - F^*_{D1}}{r_D}\right), \tag{40}$$

which holds when the subsidy to debt is sufficiently small so that $\widehat{r_D}$ is sufficiently close to $\frac{1}{p_H}\widetilde{r_E}$. ■

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