

NBER WORKING PAPER SERIES

HUMAN CAPITAL, BANKRUPTCY AND CAPITAL STRUCTURE

Jonathan B. Berk  
Richard Stanton  
Josef Zechner

Working Paper 13014  
<http://www.nber.org/papers/w13014>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
April 2007

Address correspondence to the authors at [berk@haas.berkeley.edu](mailto:berk@haas.berkeley.edu) (Berk), [stanton@haas.berkeley.edu](mailto:stanton@haas.berkeley.edu) (Stanton), or [josef.zechner@univie.ac.at](mailto:josef.zechner@univie.ac.at) (Zechner). The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

© 2007 by Jonathan B. Berk, Richard Stanton, and Josef Zechner. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Human Capital, Bankruptcy and Capital Structure  
Jonathan B. Berk, Richard Stanton, and Josef Zechner  
NBER Working Paper No. 13014  
April 2007  
JEL No. G3,G32,G33,J24,J3

**ABSTRACT**

We derive a firm's optimal capital structure and managerial compensation contract when employees are averse to bearing their own human capital risk, while equity holders can diversify this risk away. In the presence of corporate taxes, our model delivers optimal debt levels consistent with those observed in practice. It also makes a number of predictions for the cross-sectional distribution of firm leverage. Consistent with existing empirical evidence, it implies persistent idiosyncratic differences in leverage across firms. An important new empirical prediction of the model is that, *ceteris paribus*, firms with more leverage should pay higher wages.

Jonathan B. Berk  
Haas School of Business  
University of California  
545 Student Services  
Berkeley, CA 94720-1900  
and NBER  
berk@haas.berkeley.edu

Josef Zechner  
Department of Finance  
University of Vienna  
josef.zechner@univie.ac.at

Richard Stanton  
Haas School of Business  
University of California, Berkeley  
Berkeley, CA 94720  
stanton@haas.berkeley.edu

# 1 Introduction

Ever since Modigliani and Miller (1958) first showed that capital structure is irrelevant in a frictionless economy, financial economists have puzzled over exactly what frictions make the capital structure decision so important in reality. Several compelling arguments for the optimality of debt financing have been proposed, the most important by Modigliani and Miller themselves: Dividends are subject to corporate taxation while interest payments are not, so firms can potentially realize significant tax savings by maintaining high levels of debt. However, in practice, firms maintain only modest levels of debt. As Miller (1988) pointed out in a 30 year retrospective on his own work:

“In sum, many finance specialists, myself included, remain unconvinced that the high-leverage route to corporate tax savings was either technically unfeasible or prohibitively expensive in terms of bankruptcy or agency costs.” (p. 113)

Miller goes on to argue that corporate debt levels result from sub-optimal decision making, and points to two innovations that were happening at the time of the retrospective – the growth in junk bond markets and an explosion in the number of LBOs – as evidence of employees changing behavior and movement towards more “optimal” debt levels. However, subsequent developments have not borne out Miller’s prediction. In a recent study, Graham (2000) finds (p. 1903) that “...even extreme estimates of distress costs do not justify observed debt policies.” Why, then, do many firms appear to have too little debt?

Clearly, an opposing friction must exist. However, economists have struggled to identify it. Direct bankruptcy costs are one candidate: High levels of debt increase the probability of bankruptcy, so any costs associated with bankruptcy will be a disincentive to issue debt (see Kraus and Litzenberger (1973)). However, in an important paper, Haugen and Senbet (1978) point out these costs cannot exceed the cost of negotiating around them (otherwise debt holders would have an incentive to avoid them by recapitalizing the firm outside bankruptcy). This argument significantly limits the potential role of direct bankruptcy costs as an effective counterweight to the large benefit of the tax shield.

In response to Haugen and Senbet’s critique, Titman (1984) argues that another possible explanation for existing debt levels is the *indirect* costs of bankruptcy — costs precipitated by the bankruptcy filing that affect stakeholders other than debt and equity holders. Although an extensive literature documenting and studying these costs has developed since Titman’s insight, researchers have nevertheless struggled to identify a specific indirect bankruptcy cost large enough to offset the benefits of debt.<sup>1</sup> In this paper we argue that the cost borne by the firm’s employees is just such a cost.

---

<sup>1</sup>See, for example, Andrade and Kaplan (1998).

An interesting characteristic of the existing literature on bankruptcy costs is the apparent disconnect between the costs that researchers study and those identified in the popular press. During a corporate bankruptcy, a major focus of the popular press is on the *human* costs of bankruptcy, yet these have received minimal attention in the research literature. It is not difficult to understand why. If employees are being paid their competitive wage, it should not be very costly to find a new job at the same wage. For substantial human costs of bankruptcy to exist, employees must be entrenched — they must incur costs associated either with not being able to find an alternative job, or with taking another job at substantially lower pay. At first blush, such entrenchment seems difficult to reconcile with optimizing behavior: Even if labor markets are inefficient, why do shareholders ignore this inefficiency, and instead overpay their employees, especially at times when the firm is facing the prospect of bankruptcy?<sup>2</sup>

In this paper we argue, extending an insight in Harris and Holmström (1982), that this intuition is wrong. In an economy with perfectly competitive capital and labor markets, one should *expect* employees to face large human costs of bankruptcy. It is precisely these indirect costs that limit the use of corporate debt.

In a setting without bankruptcy, Harris and Holmström (1982) show that the optimal employment contract guarantees job security (employees are never fired), and pays employees a fixed wage that never goes down, but rises in response to good news about employee ability. Consequently, most employees eventually become entrenched. The intuition behind this result is that, while employees are averse to their own human capital risk, this risk is idiosyncratic, so equity holders can costlessly diversify it away. Optimal risk sharing then implies that the shareholders will bear all of this risk by offering employees a fixed wage contract. However, employees cannot be forced to work under such a contract. Employees who turn out to be better than expected will threaten to quit unless they get a pay raise. This leads to the optimal contract derived by Harris and Holmström (1982).<sup>3</sup>

In Harris and Holmström (1982), firms have no debt, and equity holders have unlimited liability (to credibly commit to the terms of the contract, equity holders must make the wage payments even when the firm cannot). In principle, there is no reason why the optimal equity contract requires limited liability. However, such contracts would be very difficult to trade in anonymous markets. Without the ability to trade, equity holders would no longer

---

<sup>2</sup>Firm-specific human capital is one possible explanation (see Neal (1995)). Yet, in an efficient labor market, it is not clear that employees are necessarily paid for their investments in human capital. Even if they are, in a competitive economy like the United States it is hard to argue that most employees' skills are not easily transferable, or that wages could not be lowered during financial distress.

<sup>3</sup>Several other papers in labor economics have studied optimal wages when the firm is risk neutral but the workers are risk averse. See, for example, Holmström (1983), Bester (1983), or Thomas and Worrall (1988).

be able to diversify costlessly, and so the underlying assumption that they are not averse to human capital risk would be difficult to support. Hence, allowing for limited liability equity is important.

Our first contribution is to derive the optimal compensation contract in a setting that includes both (limited liability) equity and debt. We find that the optimal employment contract in this setting is similar to that in Harris and Holmström (1982): Unless the firm is in financial distress, wages never fall, and they rise whenever employees turn out to be more productive than expected. However, if the firm cannot make interest payments at the contracted wage level, the employee takes a *temporary* pay cut to ensure full payment of the debt. If the financial health of the firm improves, wages return to their contracted level. If it deteriorates further, and the firm cannot make interest payments even with wage concessions, it is forced into bankruptcy, where it can abrogate its contracts. Employees can be terminated, and more productive employees can be hired to replace them. As a result, entrenched employees face substantial costs — they are forced to take a wage cut and earn their current market wage, either with the current firm or with a new firm.

The form of this optimal employment contract has important implications for capital structure. As in Harris and Holmström (1982), most employees are likely to become entrenched. Because such employees are being paid more than the value they create, investors in the firm actually benefit from a bankruptcy filing. Investors thus have no incentive to avoid bankruptcy by, for example, injecting more capital, and Haugen and Senbet's critique does not apply. Implications for the optimal debt level occur *ex ante*. The amount of risk sharing between investors and employees depends on the level of debt — higher debt levels imply a higher probability of bankruptcy and thus less risk sharing. With corporate taxes a theory of optimal capital structure emerges that trades off the benefits of risk sharing against the benefits of the tax shields, and can resolve the apparent puzzles in the data. Firms optimally issue only modest levels of debt, and in fact, in some cases, will maintain cash balances despite the associated tax disadvantages.

Our model identifies a number of determinants of the cross-sectional distribution of firm leverage that have not previously been investigated. Perhaps most interesting, given the empirical evidence, is our result that firms' capital structure decisions should be influenced by effects idiosyncratic to the firm. Because the capital structure decision trades off the risk aversion of employees against the benefits of debt, firms that happen to have more risk averse employees will have lower levels of debt. But because such firms have lower levels of debt, they will represent attractive employment opportunities for relatively more risk averse employees. The effect is thus self-reinforcing. Ultimately, heterogeneity in risk aversion in the labor market should result in a clientele effect, implying persistent heterogeneity in

the average risk aversion of employees, and in capital structure choices amongst otherwise identical firms. Our model may thus help to explain the persistent heterogeneity in firms' capital structures that has puzzled financial economists.

Our model makes several other empirical predictions. *Ceteris paribus*, higher wages should be associated with higher leverage. Further, imposing the additional assumption that capital is less risky than labor, labor intensive firms should have lower leverage than capital intensive firms. In addition, because capital intensive firms tend to be larger (especially if accounting numbers are used as a measure of firm size), a cross-sectional relation between debt levels and firm size should exist — large firms will be more highly levered.<sup>4</sup> Finally, our model also predicts a positive relation between firm size and wages. This relation has been documented empirically, and is regarded as a puzzle by labor economists (see Brown and Medoff (1989)).

The rest of the paper is organized as follows. In the next section we review the related literature. In Section 3 we describe the model and derive the optimal labor contract in our setting. In Section 4 we derive the empirical implications of the optimal contract for the firm's capital structure. We then parameterize the model and illustrate its implications. Section 5 discusses a number of existing studies that bear directly on the implications of the model. Section 6 concludes the paper.

## 2 Review of the Literature

In response to the Haugen and Senbet (1978) critique, Titman (1984) introduces the idea of indirect bankruptcy costs. He argues that stakeholders not represented at the bankruptcy bargaining table, such as customers, can suffer material costs resulting from the bankruptcy. Because the claimants at the bargaining table (the debt and equity holders) do not incur these costs, they have no incentive to negotiate around them, so such costs can be substantial. We argue in this paper that the cost borne by employees, although it has received limited attention in the literature, is potentially the single most important indirect cost of bankruptcy.

Several papers have analyzed the interaction between capital structure choice and the firm's employees' compensation and incentives. Like us, Chang (1992) analyzes the optimal contract between investors and employees, but with a very different focus. He does not model either the ability of the employees or the role of labor markets. Instead, in his

---

<sup>4</sup>This prediction is supported by the existing empirical evidence. Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2002) all document a positive cross-sectional relation between leverage and firm size.

model, investors can force a value enhancing restructuring that is costly for employees in bankruptcy. Issuing more debt makes bankruptcy, and the associated restructuring, more likely. Optimal leverage is determined by maximizing firm value subject to this tradeoff. In a related paper, Chang (1993) focuses on the interaction between payout policy, capital structure and compensation contracts. Managers are induced to pay dividends through their compensation contracts; bankruptcy serves as an opportunity for investors to get information on the optimal payout level and hence to restructure the firm. By issuing the right amount of debt ex ante, bankruptcy occurs in states when new information about the optimal payout level is likely to be available. Our paper shares a key insight with both Chang (1992) and Chang (1993), namely, that bankruptcy triggers recontracting. However, although this recontracting is value-enhancing ex post in both models, it represents an ex-ante cost of debt in our model (because it reduces risk sharing) but an ex-ante benefit in Chang's models (because it allows managers to precommit). Chang (1992) and Chang (1993) therefore identify new benefits of debt that reinforces its tax advantages. In contrast, our model identifies a disadvantage of debt that can serve to counterbalance these tax advantages.

Berkovitch, Israel, and Spiegel (2000) also study the relation between managerial compensation and capital structure, but their focus is different. In their paper, compensation policy is designed to incentivize managers to exert costly effort; risk-sharing differences between employees and investors are ignored. We do the opposite, ignoring incentive issues and concentrating on risk. Interestingly, like us, that paper derives the empirical prediction that leverage and wages should be positively correlated in the cross-section.

In an early contribution, Baldwin (1983) models a firm in which employees can appropriate the return to capital after capital costs have been sunk. Issuing a sufficient amount of debt may mitigate this hold-up problem, but bankruptcy is assumed to be costly for workers. Perotti and Spier (1993) emphasize a similar role of debt. In their model equity holders may issue junior debt, thereby creating an underinvestment incentive. This can then be used to obtain wage concessions from employees to restore incentives to invest. Stulz (1990) analyzes a firm where shareholders cannot observe either the firm's cash flows or the employee's investment decisions. Management always wants to invest as much as possible. Because shareholders know this, they will not always fully satisfy the employee's demand for capital. Therefore the employee cannot take all positive NPV projects when the firm's cash flows are low and its investment opportunities are good, and will overinvest when the firm's cash flows are high and its investment opportunities are poor. It is shown that it is optimal for investors to design a capital structure consisting of debt and equity to reduce the costs of over- and underinvestment.

More recently, Cadenillas, Cvitanić, and Zapatero (2004) model a firm with a risk averse

manager, who is subject to moral hazard. It is assumed that the manager receives stock as his only source of compensation. Equityholders can choose to lever the firm, thereby changing the manager's compensation. When choosing the optimal leverage, they take into account that the employee applies costly effort and selects the level of volatility, both of which affect expected returns. DeMarzo and Fishman (2006) derive both the optimal capital structure and labor contract in a different moral hazard setting. In their model a risk-neutral agent with limited capital seeks financing for a project that pays stochastic cash flows, which are observable to the agent but unobservable to the investor. It is shown that the optimal mechanism can be implemented by a combination of equity, long-term debt and a line of credit.

Common to the papers discussed so far is their assumption that rents generated by the choice of a particular capital structure accrue to equity holders or other investors. If managers are entrenched, however, then they will receive at least some of the rents generated by a particular choice of capital structure. Our paper is thus closely related to the literature that examines capital structure in the presence of management entrenchment.

Zwiebel (1996) provides a formal model of an employee's capital structure choice when ownership is separated from control, and managers are entrenched. In this paper, an employee determines the firm's capital structure, recognizing that he can only be fired if the firm is taken over or if the firm goes bankrupt. Because the employee derives extra utility from keeping his job, he wishes to avoid being replaced. In equilibrium, managers with low abilities issue debt, and avoid being replaced by not taking on negative NPV projects. Novaes and Zingales (1995) derive results in a similar setting but extend the analysis to show how capital structure choices of the firm's equityholders differ from those made by entrenched managers.

Morellec (2004) proposes a continuous-time model of an entrenched employee, who derives utility from control, and may therefore find it optimal to issue debt to avoid a hostile takeover. He allows for a tax advantage of debt, so that there exists an optimal debt level even in the absence of agency problems. The paper shows how the employee's capital structure choice deviates from the firm value maximizing capital structure. Subramanian (2002) also analyzes a firm where the employee makes capital structure and investment decisions, taking his personal bankruptcy costs and risk aversion into account. In each period, the employee's income is derived by a bargaining process with the equityholders. Neither paper considers the effect of a competitive labor market.

Our analysis differs in several important ways from the literature discussed above. The existing literature provides an additional advantage to debt. It takes managerial entrenchment as exogenous, relying on specified managerial characteristics, such as empire building



preferences or effort aversion, that destroy shareholder value, and cannot be eliminated by appropriate compensation contracts. In contrast, one of our main contributions is to derive managerial entrenchment as an optimal response to labor market competition. This optimal response, in turn, has capital structure implications. In particular, debt is costly in our model. The level of risk employees face determines the likelihood of employee entrenchment, which then determines the firm's leverage. We analyze this role of capital structure without relying on moral hazard or asymmetric information, and solve for the optimal employees' compensation under fairly mild contracting restrictions. Because we have no moral hazard in our model, and we assume that both labor markets and capital markets are competitive, *ex ante* the employee captures all the economic rents and makes the capital structure choice that maximizes his utility. Consequently there is no inefficiency associated with entrenchment in our model — the only friction is the inability of employees to insure their human capital, which is not a focus of the prior literature on entrenchment and capital structure.

Berens and Cuny (1995) provide an important alternative explanation for low leverage ratios in the absence of significant bankruptcy costs. They point out that interest payments can only be deducted up to the amount of current income. For growing firms with relatively low current cash flows, there is little to shield, so the usefulness of debt is limited. Their point is relevant even for firms with relatively modest growth rates. For example, using historical estimates and assuming a zero real growth rate (so all growth in cashflows results from inflation), Berens and Cuny (1995) show that the optimal debt ratio of a riskless firm is 40%.<sup>5</sup> Although this insight certainly explains why firms might limit their use of debt, it cannot be the full story: Graham (2000) provides evidence that firms could increase leverage substantially before the effective corporate tax rates start to decrease. Thus, even relative to their low initial earnings, growth firms still seem to under-utilize debt.

In a recent paper, Hennessy (2005) develops a model of indirect bankruptcy costs that, like us, relies on the ability to abrogate contracts in bankruptcy, but his focus is different. He assumes the input quality delivered by the firm's suppliers is unobservable. Incentives must therefore be provided through implicit contracts, where bonus payments or refunds from the supplier are discretionary. If the firm issues too much debt, then the supplier can no longer be induced to produce optimal quality. The credibility of both firms declines, and profits fall.

Our paper is also related to the literature in labor economics that focuses on the risk-sharing role of the firm. Gamber (1988) considers bankruptcy in a setting similar to Harris and Holmström's, and derives as an implication that real wages should respond more to

---

<sup>5</sup>Tserlukevich (2005) expands the analysis of Berens and Cuny (1995) by explicitly modeling corporate growth options when real investment is irreversible.

permanent shocks than temporary shocks. He also finds empirical support for this prediction. More recently, Guiso et al. (2005) test this implication using firm-level wage data. They also find strong support for the risk-sharing role of the firm. Our paper adds to this literature by deriving another testable implication — leverage and wages should be inversely related.

### 3 Optimal Labor Contract

In this section, we derive the optimal contract for a risk-averse employee working for a firm with risk-neutral investors. We extend the results of Harris and Holmström (1982) by allowing for debt, limited liability equity and bankruptcy.

The economy contains a large number of identical firms, each of which begins life at time 0, and lasts forever. Firms require two inputs to operate: Capital in the amount  $K$ , and an employee who is paid a wage  $c_t$  and produces, at time  $t$ , the fully observable (and contractible) cash flow,  $KR + \phi_t$ .  $R$  is the pretax return on capital, which we assume to be constant, and  $\phi_t$  is the fully observable stochastic productivity of the employee, which is assumed to follow a Markov process. Firms make their capital structure decision once, at time 0, raising the required capital by issuing debt,  $D$ , and equity,  $K - D \geq 0$ . The debt is perpetual, and will turn out to be riskless (the firm will always be able to meet its interest obligations), so it has a coupon rate of  $r$ , the risk free rate of interest. The firm must pay corporate taxes at rate  $\tau$  on earnings after interest expense, so the debt generates an interest tax shield of  $Dr\tau$ .<sup>6</sup> There are no personal taxes, so capital earns the risk free return, i.e.,  $R \equiv \frac{r}{1-\tau}$ . Thus, the firm produces after tax cash flows of  $(\frac{Kr}{1-\tau} - Dr + \phi_t - c_t)(1 - \tau) + Dr$  at time  $t$ ,  $Dr$  of which is paid out as interest on debt, and the rest is paid out as a dividend,  $\delta_t$ , given by

$$\delta_t = Kr - Dr(1 - \tau) + (\phi_t - c_t)(1 - \tau). \quad (1)$$

We assume that capital markets are perfectly competitive. The only source of risk in the model is volatility in the employee’s output, which we assume is idiosyncratic to the employee, and thus to the firm. Investors can therefore diversify this risk away, so the expected return on all invested capital is the risk-free rate,  $r$ . We assume that capital investment is irreversible, and that there is no depreciation.

Bankruptcy occurs at the stopping time  $T$  when the firm cannot meet its cash flow obligations. At that point, we assume all contracts can be unilaterally abrogated, so the firm is no longer bound by the employee’s labor contract, and instead hires a new employee, who

---

<sup>6</sup>Although we focus on taxes, other advantages of debt examined in the literature include the unobservability of cash flows (see Townsend (1979) and Gale and Hellwig (1985)) or the inability of an entrepreneur to commit human capital to the firm (see Hart and Moore (1994)).

immediately puts the capital to productive use. Because there are no costs of bankruptcy, the firm is restored to its initial state (and hence its initial value) and thus can meet its interest obligations, which explains why the firm's debt is riskless (and perpetual).

A bankruptcy filing therefore creates value in our model. For simplicity, we assume that equity holders are able to hold onto their equity stake, and hence capture this value. In fact, the assumption that equity holders remain in control reflects the reality of Chapter 11 bankruptcy protection in the U.S.,<sup>7</sup> but most of the results in this paper would remain valid even if debt holders were to capture some or all of this value.

Because of our assumption that the firm can unilaterally abrogate all contracts in bankruptcy, it will not make payments after a bankruptcy filing to any fired employee. The firm thus cannot commit to severance payments, or to a corporate pension, after a bankruptcy filing. In addition, we also assume that a firm cannot make severance payments to a fired employee prior to bankruptcy. Although allowing such payments in our simple model would be Pareto improving, they are suboptimal in a world with moral hazard, where the employee can intentionally lower his productivity. We comment further on the implications of this assumption in the conclusion.

There is a large, but finite, supply of employees with time separable expected utility, and a rate of time preference equal to the risk free rate:  $E_t [\int_t^\infty \beta^s u(c_s) ds]$ , where  $u'(\cdot) > 0$ ,  $u''(\cdot) < 0$ , and  $\beta \equiv e^{-r}$ . Following Harris and Holmström (1982), we assume that employees are constrained to consume their wages. They cannot borrow or lend,<sup>8</sup> and can only earn wage-based compensation. In particular, they cannot be paid in the form of securities issued by the firm. This is not a strong assumption with regard to equity or stock options: Because we place no restriction on the form of the wage contract, it includes the possibility of a contract that matches the payoff on any corporate security prior to bankruptcy. The important restriction this assumption imposes is that it rules out compensation contracts that *survive* bankruptcy. For example, we do not allow employees to be paid with corporate debt.

To derive the optimal labor contract, we maximize the employee's expected utility subject to the constraints that the firm operates in a competitive capital and labor market. Under

---

<sup>7</sup>Equity holders can maintain control even in countries without Chapter 11 protection (see Strömberg (2000)).

<sup>8</sup>As Harris and Holmström explain, if employees could borrow *without an option to declare personal bankruptcy*, the first best contract where the employee earns a fixed wage forever is achievable, so as in Harris and Holmström (1982) this constraint is binding. However, unlike Harris and Holmström (1982), in our setting the savings constraint is also binding — employees have an incentive to save to partially mitigate the effects of a bankruptcy filing. Relaxing this assumption would significantly complicate the analysis, and would not change the form of the optimal contract, but it would affect the tradeoff between the benefits of the tax shield and the amount of insurance.

these constraints, the market value of equity at time  $t$ ,  $V_t$ , is the present value of all future dividends,

$$\begin{aligned}
V_t &= E_t \left[ \int_t^T \beta^{s-t} \delta_s ds + \beta^{T-t} V_T \right], \\
&= E_t \left[ \int_t^T \beta^{s-t} ((K - D)r + (\phi_s - c_s)(1 - \tau) + Dr\tau) ds + \beta^{T-t} V_T \right], \\
&= E_t \left[ (K - D) (1 - \beta^{T-t}) + \beta^{T-t} V_0 + \right. \\
&\quad \left. \int_t^T \beta^{s-t} ((\phi_s - c_s)(1 - \tau) + Dr\tau) ds \right], \tag{2}
\end{aligned}$$

where  $V_T = V_0$  because, at the point of bankruptcy, the firm is restored to its initial state. The initial value of equity must equal the value of the capital supplied,  $V_0 = K - D$ , so

$$V_t = K - D + E_t \left[ \int_t^T \beta^{s-t} ((\phi_s - c_s)(1 - \tau) + Dr\tau) ds \right]. \tag{3}$$

Thus, at time 0, we have

$$E_0 \left[ \int_0^T \beta^t ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] = 0. \tag{4}$$

Firms compete to hire finitely many employees of a given ability in a competitive labor market. As a result, the firm cannot pay the employee less than his market wage (because otherwise he would quit and work for another firm). So, at any subsequent date,  $\nu$ , the value of equity cannot exceed its time 0 value,  $V_\nu \leq V_0$ , (because if it did, the employee would be making less than his market wage). Hence,

$$E_\nu \left[ \int_\nu^T \beta^{t-\nu} ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] \leq 0, \quad \forall \nu \in [0, T]. \tag{5}$$

Prior to bankruptcy, the firm must be able to meet its interest obligations. Thus, because the dividend received by shareholders is never negative, the employee's wages cannot exceed the total cash generated by the firm less the amount required to service the debt, i.e.

$$c_t \leq \phi_t + r \left[ \frac{K}{1 - \tau} - D \right]. \tag{6}$$

For now we assume that bankruptcy occurs when the firm cannot make interest payments

even when the employee gives up all of her wages, that is, when

$$Kr + \phi(1 - \tau) - Dr(1 - \tau) = 0, \quad (7)$$

or equivalently, when

$$\phi_t = \underline{\phi} \equiv \left[ D - \frac{K}{1 - \tau} \right] r. \quad (8)$$

so

$$T \equiv \min \{ t \mid \phi_t < \underline{\phi} \}.$$

In principle, the employee could force bankruptcy to occur earlier by not giving up all her wages, but we shall show later that this is not optimal.

At time 0, the optimal contract maximizes the employee's utility while he is employed with the firm, subject to (4)–(6):<sup>9</sup>

$$\max_c E_0 \left[ \int_0^T \beta^t u(c_t) dt \right] \quad (9)$$

$$\text{s.t.} \quad E_0 \left[ \int_0^T \beta^t ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] = 0, \quad (10)$$

$$E_\nu \left[ \int_\nu^T \beta^{t-\nu} ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] \leq 0, \quad \forall \nu \in [0, T], \quad (11)$$

$$(c_t - \phi_t)(1 - \tau) - r[K - D(1 - \tau)] \leq 0, \quad \forall t \in [0, T]. \quad (12)$$

Note that, while the first two constraints are similar to those in Harris and Holmström (1982), the last, reflecting equityholders' limited liability and the presence of debt, is new. We now show that the optimal contract is an extension of that in Harris and Holmström (1982).

First define the *market wage contract*:

**Definition 1** *The market wage contract initiated at time  $t$  is a contract, together with an associated market wage function,  $c^*(\phi, t)$ , under which an employee, hired at date  $t$ , is paid at any date  $s \in [t, T]$  the amount*

$$c_{t,s}^* = \min \left\{ \phi_s + r \left[ \frac{K}{1 - \tau} - D \right], \max_{t \leq \nu \leq s} \{ c^*(\phi_\nu, \nu) \} \right\}, \quad (13)$$

---

<sup>9</sup>Because the bankruptcy date does not depend on the choice of contract, the contract that maximizes utility until bankruptcy also maximizes lifetime utility.

where the function  $c^*(\phi_\nu, \nu)$  is chosen to ensure that the employee's pay satisfies

$$E_\nu \left[ \int_\nu^T \beta^{s-\nu} ((\phi_s - c_{\nu,s}^*)(1 - \tau) + Dr\tau) ds \right] = 0, \quad (14)$$

for all  $\nu \in [t, T]$ .

At date  $s$ , define the *promised wage* to be  $\max_{t \leq \nu \leq s} \{c^*(\phi_\nu, \nu)\}$ , and the *financial distress wage* to be  $\phi_s + r \left[ \frac{K}{1-\tau} - D \right]$ . Lemma 2 in the appendix shows that the initial wage under this contract is always equal to the promised wage. Subsequently, the promised wage never falls, but rises when necessary to match the wage a newly hired employee with the same ability level would earn. However, after the initial date the employee does not always receive the promised wage because the firm may not have enough cash left over after making its debt payments. In these states, which we term financial distress, the employee takes a temporary pay cut, receiving whatever cash is left after the debt payments have been made (the financial distress wage), so that the firm can meet its interest obligations and avoid bankruptcy.

For some ability levels,  $c^*(\phi, t)$  might not be positive. For example, for very low levels of  $\phi$ , it may be impossible to pay the employee any positive amount and still satisfy Equation (14). Note, however, that by the definition of the market wage and the point of bankruptcy, if  $c^*(\phi_t, t) \geq 0$  then  $c_s \geq 0$  for any  $s \in [t, T]$ .

Define a *feasible* market wage contract at time  $t$  for an employee of ability  $\phi_t$  as a contract such that  $c^*(\phi_t, t) > 0$ , that is, a contract that guarantees positive wages at all times prior to bankruptcy. The following proposition (with proof in the appendix) shows that if the market wage contract is feasible, it is optimal.

**Proposition 1** *If the market wage contract is feasible at time 0, it is the optimal contract for an employee hired at time 0, that is, it is the unique solution to the program defined by Equations (9)–(12).*

Proposition 1 shows that as long as the firm can meet its interest obligations without cutting the employee's wage, the optimal contract is similar to that in Harris and Holmström (1982): Wages never fall, and they rise in response to positive shocks in employee ability. The main difference occurs when the firm is in financial distress, and the firm's revenues, less the promised wage,  $\bar{c}_t \equiv \max_{0 \leq \nu \leq s} \{c^*(\phi_\nu, \nu)\}$ , do not cover the interest owed:

$$\frac{Kr}{1-\tau} + \phi_t - \bar{c}_t \leq Dr,$$

or equivalently when  $\phi_t < \phi^*$ , where

$$\phi^* \equiv \bar{c}_t - \left[ \frac{K}{1-\tau} - D \right] r. \quad (15)$$

The firm pays zero dividends when it is in distress, and the employee takes a temporary pay cut, receiving all cash left over after making the debt payments. That is, in financial distress,

$$\begin{aligned} c_t &= \frac{Kr}{1-\tau} + \phi_t - Dr, \\ &\leq \bar{c}_t. \end{aligned}$$

If the employee gives up all his wages and the firm still cannot make interest payments, it is forced into bankruptcy. An earlier bankruptcy filing cannot make the employee better off because, by Lemma 1, an employee can never make more money at any point in the future by accepting a new competitive wage contract (at another firm). So the employee cannot be made worse off by delaying bankruptcy to the last possible moment, justifying our initial assumption on  $T$ .

Note that when the employee loses his job at time  $T$ , he cannot find another job at a positive wage because  $0 = c_T \geq c^*(\phi_T, T)$ . Hence, we assume that the employee chooses not to work, and receives zero forever (effectively, the reservation wage in this model).

## 4 Implementing the Optimal Contract

The inability of employees to fully insure their own human capital risk implies that firms will have preference for equity. In reality, the tax deductibility of interest creates a strong incentive to issue debt. In this section we derive testable implications of this tradeoff.

We first solve explicitly for the optimal contract offered by the firm to the employee for a given debt level. Because we assume that the supply of capital is infinite, but the number of employees is finite, firms that do not choose a level of debt that maximizes the employee's utility will not be able to hire an employee. Consequently, all firms that are in business will pick the debt level that maximizes the employee's utility. We therefore derive an explicit expression for the employee's indirect utility as a function of the level of debt under the optimal employment contract, and then optimize this function to find the optimal debt level.

## 4.1 Wage Contract

To derive closed form expressions for firm value and employee utility requires making further restrictive assumptions. The first is that  $\phi_t$  follows a random walk,

$$d\phi_t = \sigma dZ. \quad (16)$$

With this assumption, the variance of  $\phi_t$  remains constant, and neither the value of the firm nor the optimal contract depends explicitly on  $t$ . The optimal labor contract can now be written in the more compact form:

$$c_t = \min \left\{ \phi_t + r \left[ \frac{K}{1-\tau} - D \right], c^*(\bar{\phi}_t) \right\}, \quad (17)$$

where

$$\begin{aligned} \bar{\phi}_t &\equiv \max_{0 \leq s \leq t} \phi_s, \\ c^*(\bar{\phi}_t) &\equiv c^*(\bar{\phi}_t, \cdot). \end{aligned}$$

Furthermore, because the value of equity,  $V_t$ , does not depend on  $t$ , we will henceforth write  $V(\phi_t, \bar{\phi}_t) \equiv V_t$ .

To ensure that  $c_0 > 0$  we assume that

$$\phi_0 > \frac{\sigma}{\sqrt{2r}} - \frac{Dr\tau}{1-\tau}. \quad (18)$$

The following proposition (with proof in the appendix) derives expressions for the value of the firm's equity and the employee's optimal wage contract for a given level of debt:

**Proposition 2** *The value of the firm's equity at time  $t$  is*

$$V(\phi_t, \bar{\phi}_t) = \begin{cases} H(\bar{\phi}_t)e^{\sqrt{2r}\phi_t/\sigma} + M(\bar{\phi}_t)e^{-\sqrt{2r}\phi_t/\sigma} + \frac{(\phi_t - c^*(\bar{\phi}_t))(1-\tau)}{r} + K - D(1-\tau) & \text{if } \phi_t \geq \phi^* \\ Q(\bar{\phi}_t)e^{\sqrt{2r}\phi_t/\sigma} + G(\bar{\phi}_t)e^{-\sqrt{2r}\phi_t/\sigma} & \text{if } \phi_t < \phi^* \end{cases}$$

and the functions  $H(\cdot)$ ,  $M(\cdot)$ ,  $Q(\cdot)$ , and  $G(\cdot)$  are given in the appendix. The competitive market wage,  $c^*(\bar{\phi})$ , is uniquely defined implicitly via

$$c^*(\bar{\phi}) \equiv \left\{ c \mid \Delta(\phi, D, c) = 0, \bar{\phi} + \frac{Dr\tau}{1-\tau} - \frac{\sigma}{\sqrt{2r}} \leq c < \bar{\phi} + \frac{Dr\tau}{1-\tau} \right\},$$



where

$$\Delta(\phi_t, D, c) \equiv \left( 2\sqrt{2} \left( \frac{D-K}{1-\tau} \right) r^{3/2} + \left( e^{-\frac{\sqrt{2r}c}{\sigma}} - e^{\frac{\sqrt{2r}c}{\sigma}} \right) \sigma \right) e^{\frac{\sqrt{2r} \left( \left( \frac{K}{1-\tau} - D \right) r + \phi_t \right)}{\sigma}} - \sigma - \sqrt{2r} \left( \phi_t - c + \frac{Dr\tau}{1-\tau} \right) + e^{\frac{2\sqrt{2r} \left( \left( \frac{K}{1-\tau} - D \right) r + \phi_t \right)}{\sigma}} \left( \sigma - \sqrt{2r} \left( \phi_t - c + \frac{Dr\tau}{1-\tau} \right) \right).$$

To plot the value of equity, we use the parameters listed in Table 1. The model is far too simple to capture all the complexities of actual capital structure decisions, but we can use it to evaluate whether, for economically realistic parameters, human capital risk can effectively counterbalance the tax advantage of debt. We use a risk aversion coefficient of 2, consistent with values derived from experiments, and a tax rate of 20% (lower than the U.S. corporate income tax rate) to compensate for the tax advantage of equity at the personal level. We pick an initial  $\phi_0 = \bar{\phi} = 1$ , and  $K = 50$ . With  $r = 3\%$ , this implies that the revenue attributable to capital is  $Kr = 1.5$ , so the revenue attributable to labor is two thirds the revenue attributable to capital.<sup>10</sup>

Variable	Symbol	Value
Capital	$K$	50
Initial $\phi$	$\bar{\phi}$	1
Risk Aversion	$\gamma$	2
Interest Rate	$r$	3%
Tax Rate	$\tau$	20%
Standard Deviation	$\sigma$	20%

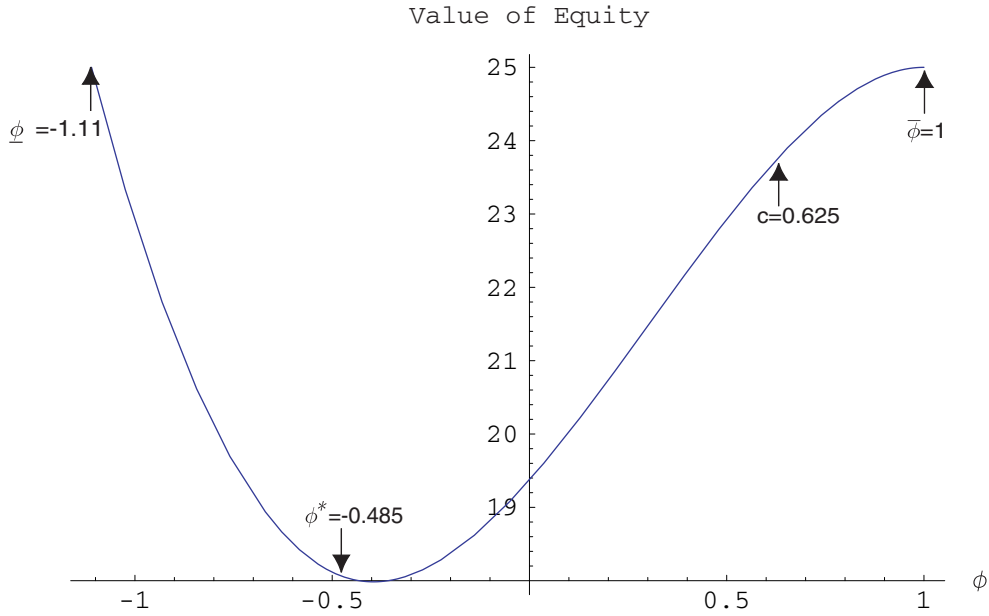
Table 1: **Parameter Values**

Figure 1 plots the value of equity under the optimal wage contract as a function of the employee's ability for the parameter values listed in Table 1 and a debt-to-equity ratio of 1.04 (we shall show presently that this level of debt is optimal). The value of equity equals the initial equity investment any time the employee earns his competitive market wage, and at bankruptcy. At all other points, the value of equity is below the amount of the initial equity investment. This implies that the value of the firm can never exceed its value were its human capital to be replaced. This is the opposite of what  $q$  theory predicts about physical capital. There, the value of the firm is never lower than the replacement value of physical

<sup>10</sup>At first glance this choice might seem at odds with the empirical estimate of labor's share of income of about 75%, (see, for example, Krueger (1999)), but that estimate is derived from the national income accounts and is unlikely to be representative of labor's share of revenue of a publicly traded corporation. A reason firms choose to go public is access to capital markets, so capital intensive firms are much more likely to go public.

capital. Note that equity holders always receive a fair market return because, when the employee is hired, she is hired at a wage below her ability —  $c = 0.625$  in this case, and her initial ability is  $\bar{\phi} = 1$ . This difference, plus the tax shield, generates a positive cash flow (dividend) to equity holders that compensates for the drop in the value of equity, and guarantees equity holders the competitive market expected return.

Figure 1: **Value of Equity:** The plot shows the value of equity as a function of employee ability ( $\phi$ ) between  $\underline{\phi} = -0.96$  and  $\bar{\phi} = 1$ . The parameter values are listed in Table 1 with a debt-to-equity ratio of 1.04, which is optimal.



## 4.2 Employee's Utility

The employee's expected utility is given by

$$J(\phi, \bar{\phi}) \equiv E \left[ \int_0^{\infty} e^{-rt} u(c_t) dt \mid \phi_0 = \phi \right],$$

where  $c_t$  follows the optimal wage policy derived in Proposition 2 until bankruptcy, and is equal to zero thereafter. The following proposition (with proof in the appendix) derives an explicit expression for  $J$ , under the assumption that the employee's preferences are given by

$$u(c) = -e^{-\gamma c}.$$

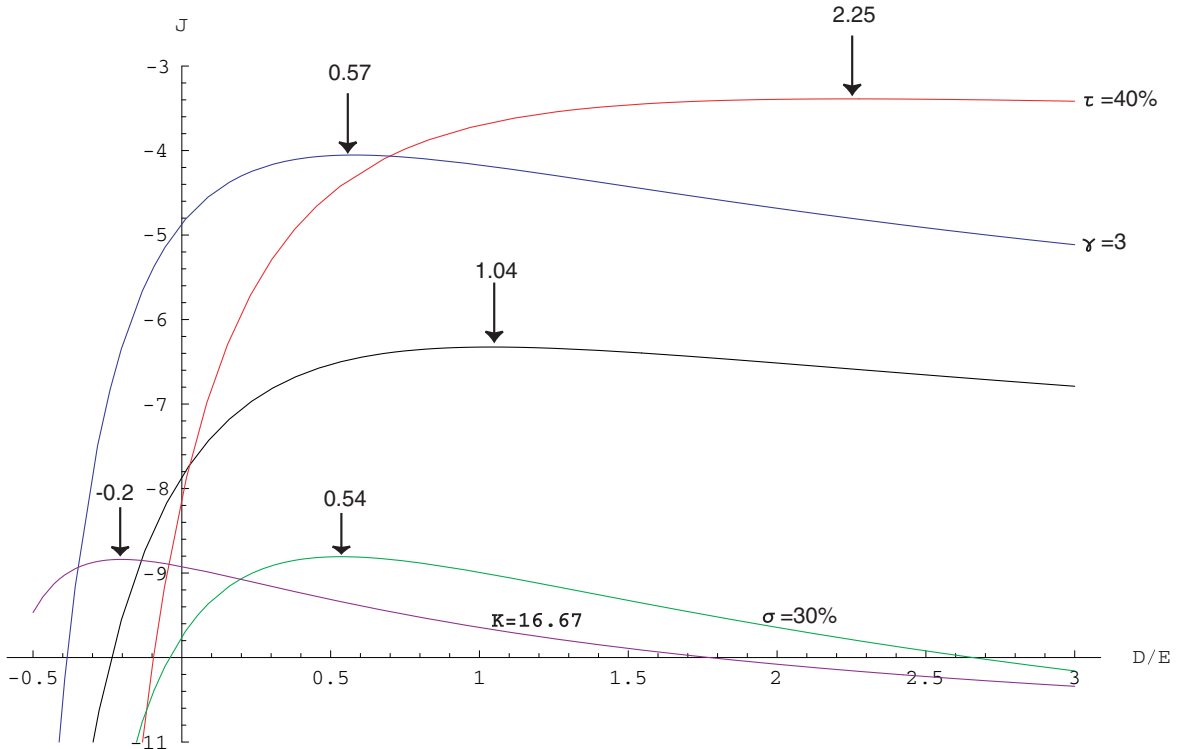
**Proposition 3** *The employee's expected utility at time  $t$  is*

$$J(\phi_t, \bar{\phi}_t) = \begin{cases} A(\bar{\phi}_t)e^{\sqrt{2r}\phi_t/\sigma} + B(\bar{\phi}_t)e^{-\sqrt{2r}\phi_t/\sigma} - \frac{e^{-\gamma c^*(\bar{\phi})}}{r} & \text{if } \phi_t \geq \phi^* \\ C(\bar{\phi}_t)e^{\sqrt{2r}\phi_t/\sigma} + F(\bar{\phi}_t)e^{-\sqrt{2r}\phi_t/\sigma} - \frac{e^{-\gamma(\phi_t - \bar{\phi})}}{r - \frac{\gamma^2 \sigma^2}{2}} & \text{if } \phi_t < \phi^* \end{cases}$$

where the functions  $A(\cdot)$ ,  $B(\cdot)$ ,  $C(\cdot)$ , and  $F(\cdot)$  are given in the appendix.

The black line in Figure 2 shows the derived utility function,  $J$ , as a function of the debt-to-equity ratio for the parameters in Table 1. Note the utility is maximized when the debt-to-equity ratio is 1.04, the ratio we used to generate Figure 1.

Figure 2: **Employee's Derived Utility:** The black curve shows the employee's utility,  $J$ , as a function of the debt-to-equity ratio for the parameters in Table 1. The colored curves show the employees utility with just the indicated parameter changed to the value indicated on the curve. The arrows mark the maximum value of each function, that is, the optimal debt-to-equity ratio.



To illustrate the cross-sectional implications of our model, Figure 2 also plots the derived utility function for different parameter values. Each line is the derived utility function with parameter values given in Table 1 with one parameter changed — this parameter takes the value indicated on each curve. As the plot makes clear, the model is capable of generating

large cross-sectional dispersion in debt-to-equity ratios. If the tax rate is doubled to 40%, the optimal debt-equity ratio rises to 2.25. On the other hand, if either the volatility of the firm’s cash flows or the risk aversion of the employee is increased by 50%, the optimal debt-equity ratio is cut approximately in half. Similarly, if the labor intensity of the firm is increased by reducing the amount of capital to 16.67, so that only one third of revenue is attributable to capital, the debt-equity ratio drops to -0.2, that is, the firm holds cash, despite its tax disadvantages (the firm must pay tax on the interest earned, whereas investors do not because there are no personal income taxes in this model).

### 4.3 The Optimal Level of Debt

The optimal level of debt is chosen to maximize the employee’s derived utility function. Writing  $J$  as an explicit function of  $D$ ,  $J(\phi, \bar{\phi}, D)$ , the optimal level of debt therefore solves

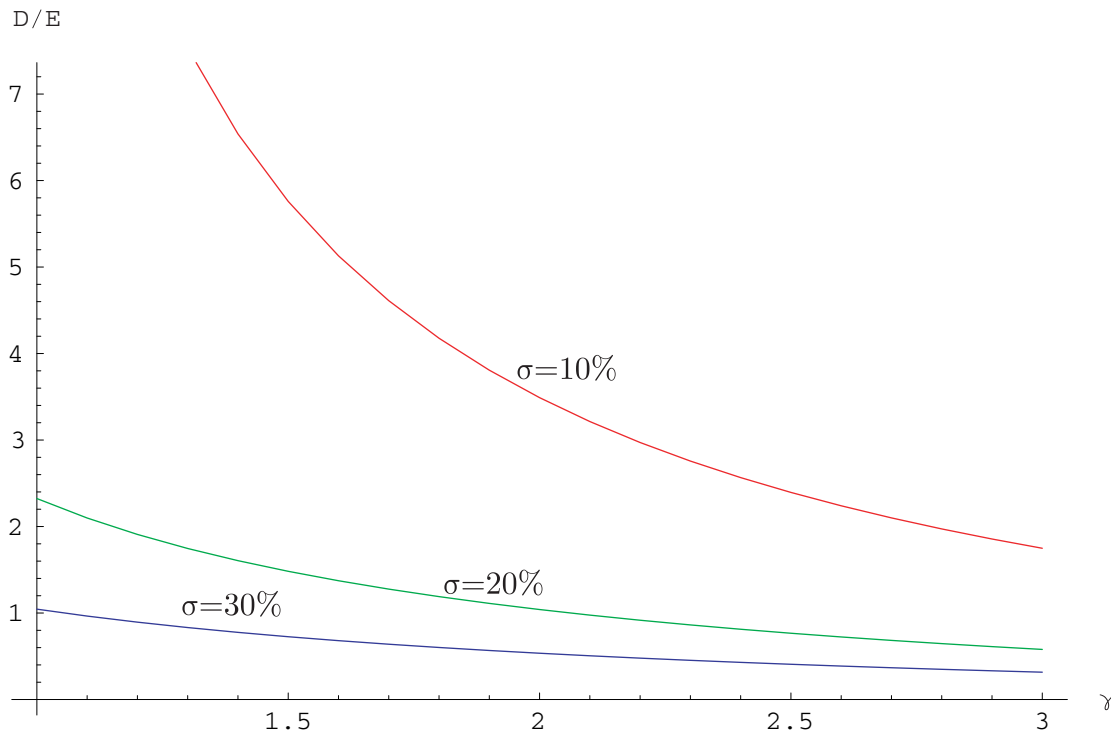
$$\frac{\partial}{\partial D} J(\bar{\phi}, \bar{\phi}, D) = 0.$$

Given our explicit expression for  $J$  in Proposition 3, this equation is relatively straightforward to solve numerically, the only complication being that  $c^*(\bar{\phi})$  is only defined implicitly (in Proposition 2).

We begin by exploring the relation between risk aversion and leverage. Figure 3 plots the optimal debt-to-equity ratio as a function of the level of employee risk aversion,  $\gamma$ , for three different levels for the volatility of employee productivity,  $\sigma$ . It confirms what is intuitively clear in our model — leverage is related to employees’ willingness to bear risk. Firms with more risk averse employees optimally have lower levels of leverage, as do firms with more volatile labor productivity. When employees value human capital insurance more (either because they are more risk averse, or because their productivity is more volatile), firms optimally respond by reducing debt (and thus give up tax shields) to enhance risk sharing. These results suggest two empirical implications of our model. All else equal, firms with more idiosyncratic volatility should hold less debt, as should firms with more risk averse employees. This relation between leverage and employee risk aversion is, to our knowledge, an inference unique to this model, and has not yet been investigated.

At first blush, risk aversion might appear to be an unlikely driver of cross-sectional variation in firm leverage. The corporations that comprise most studies have thousands of employees; if differences in risk aversion amongst employees are uncorrelated with each other, the average risk aversion of a typical employee in different firms will be about the same. However, an important implication of our model is that differences in risk aversion are unlikely to be uncorrelated within a firm. To understand why, first note from Figure 3

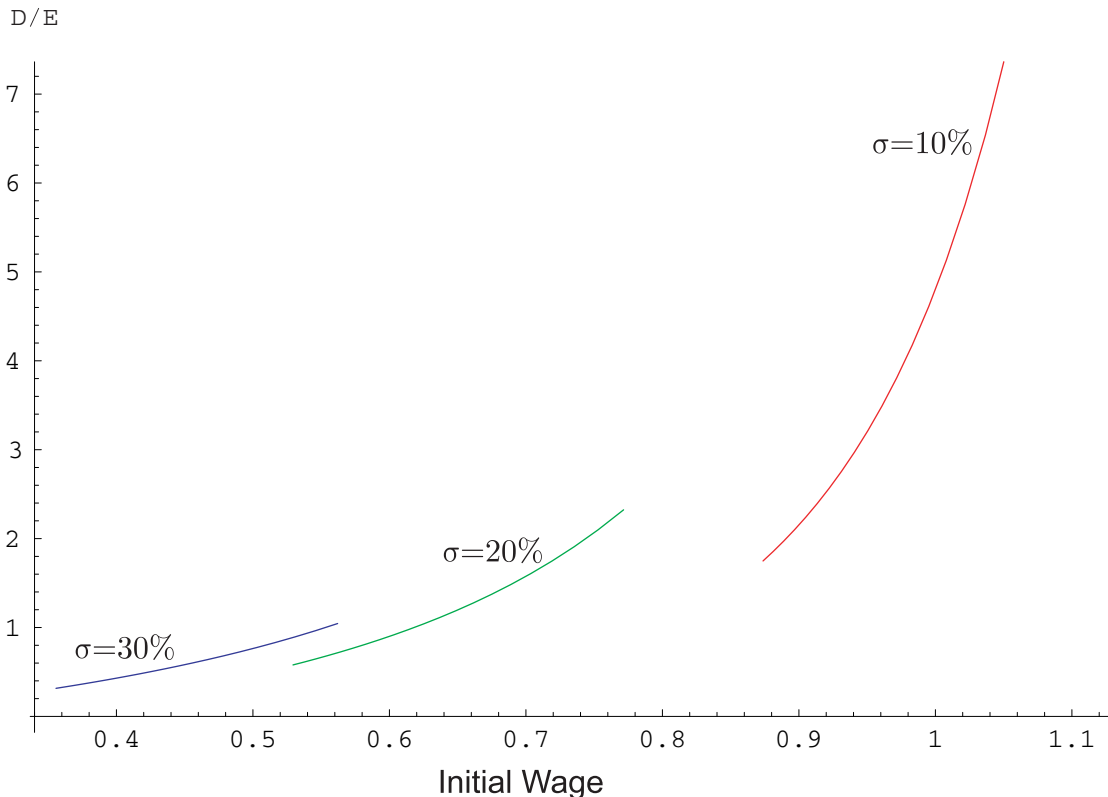
Figure 3: **Optimal D/E as a Function of Employee Risk Aversion:** The plot shows the optimal debt-to-equity ratio as a function of the level of risk aversion,  $\gamma$ , at three different levels of volatility in labor productivity,  $\sigma$ . The values of the remaining parameters are listed in Table 1.



that the firm's optimal leverage is related to the risk-aversion of its employees. This implies that it is not optimal for all (otherwise identical) firms to have the same leverage in an economy in which employees have different levels of risk aversion. Less risk averse employees are better off working for firms with higher leverage, and more risk averse employees are better off working for firms with lower leverage. Hence, because new hires will select firms based on their leverage (and offered wages), they will prefer to work for firms with employees that have similar levels of risk aversion. Firms therefore preferentially hire employees with similar preferences, and so cross-sectional differences in risk aversion, and thus leverage, should persist.

Because employee risk aversion is unobservable, its role in capital structure cannot be directly tested. However, as Figure 4 demonstrates, the relation between wages and leverage can be used as an indirect test of the importance of employee risk aversion in explaining cross-sectional variation in firm capital structure. As is evident from the plot, higher leverage is associated with higher wages, even after controlling for other sources of wage differentials such as cash flow volatility. Thus, wages should have explanatory power in explaining firm leverage. Although controlling for other sources of wage differentials is difficult, this result

Figure 4: **Firms with Higher Leverage Pay Higher Wages:** The plot shows the cross-sectional distribution of initial wages,  $c_0$ , and debt levels for firms that vary in their employee risk aversion (as plotted in Figure 3). Each line corresponds to different levels of volatility in labor productivity.

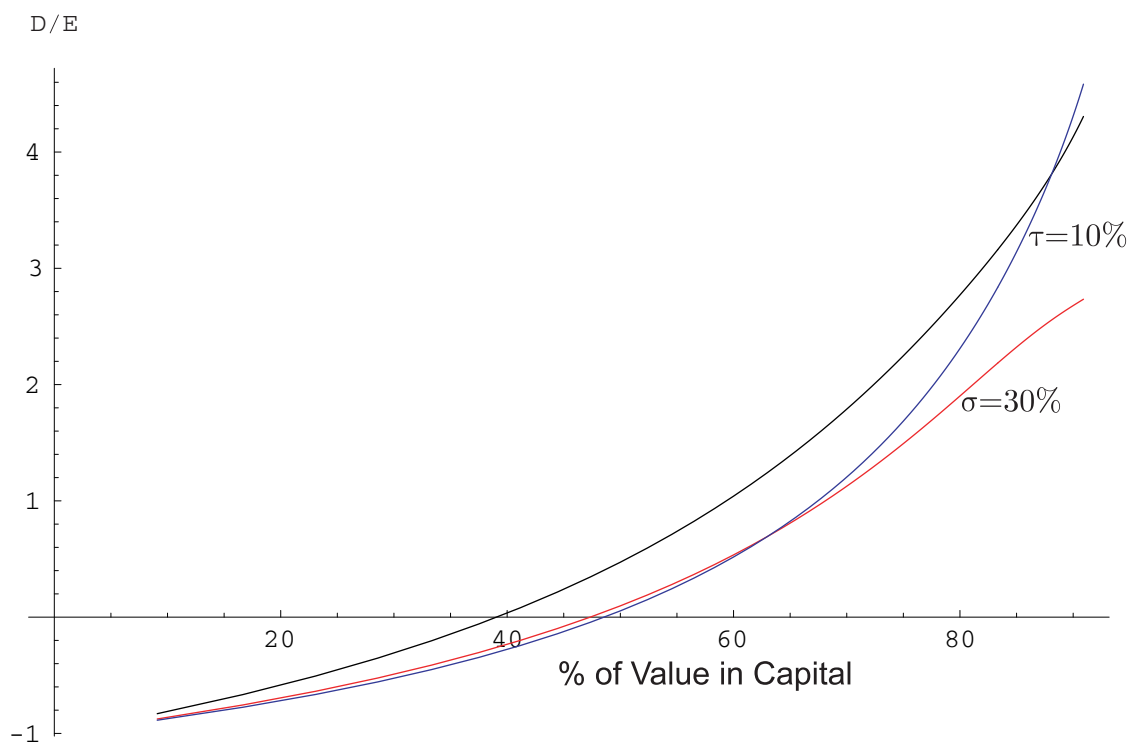


has the potential to explain at least some of the large unexplained persistent cross-sectional variation in leverage within industries documented in Lemmon et al. (2006).

Figure 5 plots the optimal debt-to-equity ratio as a function of the fraction of revenues attributable to capital, for a tax rate of 20%. Keeping  $\phi_0 = 1$ , the amount of capital,  $K$ , is varied from 3 to 333, corresponding to a variation in the fraction of revenue attributable to capital from 9% to 91%. From the figure, labor intensive firms have lower levels of debt, something that is, at least anecdotally, characteristic of the economy. In support of the anecdotal evidence, Rajan and Zingales (1995) find that the ratio of fixed assets to book value of assets is significantly positively related to leverage in almost every country they study. Because this ratio is likely to be higher for capital intensive firms, their result is consistent with the predictions of our model. Furthermore, as the figure makes clear, at low tax rates or high levels of productivity volatility, even firms that are not labor intensive may hold significant levels of cash, despite its tax disadvantages. Finally, the fact that capital intensive firms tend to be large (especially if accounting numbers are used as a measure

of firm size), also implies that larger firms should have higher leverage, which is consistent with the empirical evidence.<sup>11</sup> An interesting question is what the cross-sectional variation

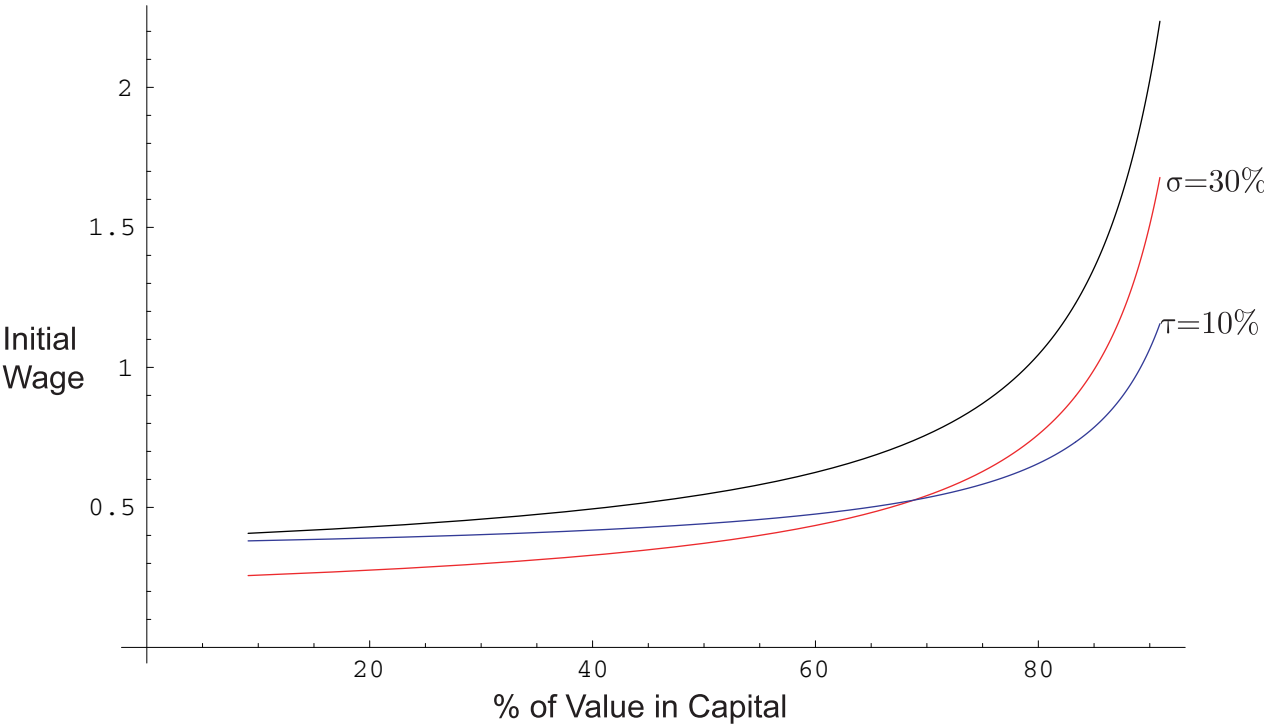
Figure 5: **Firm Size and Debt Levels:** The plot shows the optimal debt-to-equity ratio as a function of the amount of capital  $K$ , expressed as a percentage of revenue attributable to capital ( $K$  is varied from 3 to 333). The black curve uses the values of the parameters listed in Table 1. The colored curves plot the optimal debt-to-equity ratio with the indicated parameter set equal to the value indicated on the curve and the remaining parameters set equal to the values listed in Table 1.



in the capital versus labor intensity of firms implies about wages. For a given level of debt, labor intensive industries have a higher probability of bankruptcy, so one would expect higher wages in these industries. However, these firms endogenously respond by issuing less debt (or even holding cash), thus decreasing the probability of bankruptcy. Figure 6 shows that this endogenous response is enough to reverse the initial effect: Holding the initial productivity of labor fixed, capital intensive firms, and hence larger firms, pay *higher* wages. This relation between firm size and wages is a robust characteristic of the data, and is regarded as a puzzle by labor economists (see Brown and Medoff (1989)).

<sup>11</sup>See, for example, Rajan and Zingales (1995)

Figure 6: **Physical Capital Intensive Firms Pay Higher Wages:** The plot shows the cross-sectional distribution of initial wages,  $c_0$ , (at optimal debt levels) for different levels of physical capital ( $K$  is varied from 3 to 333). The black curve uses the values of the parameters listed in Table 1. The colored curves plot wages for the indicated parameter set equal to the value indicated on the curve and the remaining parameters set equal to the values listed in Table 1.





It is important to emphasize that the relation between leverage and capital intensity depends on our assumption about the relative risks of labor and capital. If we had instead assumed that capital was risky and labor riskless, these inferences would be reversed. However, there are good reasons to suppose that, in general, labor is indeed riskier than capital. First, note that the benefits of risk sharing between the corporation and the employee are related only to *idiosyncratic* risk — there is no obvious reason to share systematic risk. Clearly, capital uncertainty is likely to have large systematic components, while labor uncertainty, because it depends on the employee’s own ability, is likely to be mainly idiosyncratic. Second, key employees, such as the CEO, can make idiosyncratic decisions that have large consequences for the firm. Third, given the assumptions in our model, the observed positive correlation between wages and firm size is, by itself, evidence that labor is riskier than capital.

## 5 Discussion

An implication of this paper is that employees should care about the firm’s likelihood of bankruptcy. However, in many cases, employees may not be able to calculate the precise relation between leverage and bankruptcy, so other more readily interpretable variables are likely to play a role in capital structure decisions. One such variable is the firm’s credit rating. Although most employees are unlikely to be able to relate leverage levels to bankruptcy probabilities, rating agencies perform this mapping for them and publish their results. Hence, a firm’s credit rating should be an independent determinant of its capital structure, an empirical result documented in Kisgen (2006).

Because the likelihood of entrenchment is greater in firms with less debt, our model predicts an inverse relation between leverage and entrenchment. Berger, Ofek, and Yermack (1997) and Kayhan (2003) both find that firms with employees who appear more entrenched have low leverage. Bebchuk and Cohen (2005) investigate the effect of managerial entrenchment on market valuation. Consistent with the predictions of our model, they find that firms with managers that are more likely to be entrenched display lower Q-ratios. They leave as a puzzle why shareholders would voluntarily engage in what they identify as suboptimal behavior. A contribution of our model is the insight that it is not necessarily suboptimal to let employees become entrenched, even if, *ex post* this entrenchment leads to lower Q-ratios.

There is also empirical evidence consistent with our assumption that bankruptcy can benefit the investors in a firm because existing employees are fired or their wages are reset to competitive levels. Gilson and Vetsuypens (1993) find that almost 1/3 of all CEOs are replaced after bankruptcy. Those who keep their job experience large salary cuts (35%

or so). Further, when new outside managers are hired, they are paid 36% more than the fired managers, consistent with our prediction that employees take pay cuts when the firm is in distress. Finally, Kalay et al. (2007) find that firms experience significant improvements in operating performance during Chapter 11 bankruptcy, suggesting that, by firing old employees and hiring new ones at their market wage, value is created.

A key insight that emerges from our analysis is the role of bankruptcy in limiting the potential to write explicit or implicit contracts with employees. Although bankruptcy is probably the most important mechanism that allows firms to abrogate existing contracts, other mechanisms, such as takeovers, also exist. When a firm is merged into another company, it becomes easier to fully or partially abrogate implicit (and possibly also explicit) contracts. Consistent with this view, Pontiff, Shleifer, and Weisbach (1990) find that hostile takeovers are followed by an abnormally high incidence of pension asset reversions, which account for approximately 11% of takeover gains. That hostile takeovers may create value gains *ex post* is widely recognized. What this paper adds is that they also limit the risk sharing possibilities *ex ante*, which potentially might explain why the majority of firms have adopted anti-takeover provisions. Our analysis also suggests that the use of anti-takeover devices may be systematically related to firms' human capital and leverage characteristics.

A risk-sharing view of capital structure is also in accordance with survey results reported by Graham and Harvey (2001). They find that the most important determinant of capital structure choice is financial flexibility and maintaining a good credit rating. By contrast, they find little evidence for asset substitution or asymmetric information as important factors for capital structure choice. Clearly, firms with good credit rating and financial flexibility can share human capital risk more effectively with employees than firms with poor ratings and low financial flexibility. This might explain why managers focus on these particular determinants.

## 6 Conclusion

According to the dominant corporate finance paradigm, capital structure choice is a tradeoff between the costs and benefits of debt. Although there is broad agreement amongst academics and practitioners on the benefits of debt, identifying its costs remains one of the biggest puzzles in corporate finance. Most existing papers on capital structure require firms (or their investors) to bear sizeable bankruptcy costs, but the empirical evidence does not support this. In contrast, there is evidence that bankruptcy costs borne by employees of the firm are significant, yet these have not received much attention in the finance literature. Our analysis demonstrates that, at reasonable parameter values, the bankruptcy costs borne by

employees do, in fact, provide a first-order counterbalance to the tax benefits of debt.

Analyzing the human cost of bankruptcy generates a rich set of empirical predictions. First, the model produces moderate leverage ratios, implying an apparent “underutilization” of debt tax shields if these costs are ignored. Second, the model predicts variation in the average risk aversion of employees across firms, and that this variation should result in persistent variation in leverage ratios. Third, highly levered firms should pay higher wages to their employees. Fourth, capital intensive firms in our model have higher optimal leverage ratios and pay higher wages. Finally, riskier firms choose lower leverage ratios.

An important simplifying assumption in our model is that we do not allow firms to make severance payments to fired employees prior to bankruptcy. Relaxing this assumption would complicate the analysis appreciably, but would not qualitatively change the results. Although the optimal contract would allow a firm to fire an employee prior to bankruptcy, it would still require that the firm continue to pay this employee the contracted wage. A new replacement employee would be hired at a competitive wage, and the firm would now pay wages to current and all past employees. At the point of bankruptcy the firm stops making all wage payments (to both past and newly fired employees), so employees still continue to trade off the benefits of insurance against the benefits of the tax shield. Moreover, such a contract is Pareto improving only if moral hazard concerns are ignored. In reality, the moral hazard benefits employees derive from being fired (they continue to earn an above market wage from their old employer and they can then supplement this income with a new job at the market wage) most likely explain why such contracts are uncommon.

Key to our results is the assumption that employment contracts do not survive bankruptcy. Given the costs imposed by the bankruptcy process on the employees of the firm, it is perhaps surprising that in reality firms do not write employment contracts that survive the bankruptcy process. For example, one solution, that is in principle available, would be for firms to issue zero coupon senior perpetual debt to its employees. The only effect this debt would have would be in bankruptcy, when it ensures that the employees gain control of the firm because they hold the most senior claims. The most likely reason we do not see such contracts is the associated moral hazard — in this case employees would have an incentive to drive the firm into bankruptcy. Indeed, as DeMarzo and Fishman (2006) show, this kind of moral hazard can, by itself, be a determinant of firms’ capital structures.

Relaxing some of our simplifying assumptions would lead to interesting extensions of the model. Both dividend policy and dynamic capital structure decisions are exogenous in our model — the firm pays out all excess cash as dividends, and never changes the level of debt. Allowing a manager to choose an optimal dynamic dividend policy, or change the amount of debt and equity outstanding, is likely to yield interesting new insights. More generally, we

believe that recognizing the interaction between labor and capital markets opens a new and exciting path for future research in corporate finance. Analyzing the resulting implications could significantly improve our understanding of corporate behavior.

# Appendix

## A Lemmas

**Lemma 1** *The market wage contract initiated at time  $\nu$  cannot pay a lower wage than the market wage contract initiated at any later time:  $c_{\nu,s}^* \geq c_{\hat{\nu},s}^*$  for all  $s \geq \hat{\nu} \geq \nu$ .*

**Proof:** The result follows immediately from the definition of the wage  $c^*$  in the market wage contract because for any  $\hat{\nu} \geq \nu$ ,

$$\min \left\{ \phi_t + r \left[ \frac{K}{1-\tau} - D \right], \max_{\nu \leq s \leq t} \{c^*(\phi_s, s)\} \right\} \geq \min \left\{ \phi_t + r \left[ \frac{K}{1-\tau} - D \right], \max_{\hat{\nu} \leq s \leq t} \{c^*(\phi_s, s)\} \right\}.$$

■

**Lemma 2** *At initiation, the market wage contract pays the promised wage, that is,  $c_{t,t}^* = c^*(\phi_t, t)$ .*

**Proof:** Assume not, that is, assume that the initial wage is the financial distress wage, and let  $\nu$  be the first time

$$c_{t,\nu}^* = \max_{t \leq s \leq \nu} \{c^*(\phi_s, s)\}.$$

If this condition is not met before time  $T$ , then define  $\nu = T$ . By Lemma 1, iterated expectations, and the definition of the market wage contract,

$$\begin{aligned} 0 &= E_t \left[ \int_t^T \beta^{s-t} ((\phi_s - c_{t,s}^*)(1-\tau) + Dr\tau) ds \right] \\ &= E_t \left[ \int_t^\nu \beta^{s-t} ((\phi_s - c_{t,s}^*)(1-\tau) + Dr\tau) ds \right] + E_t \left[ \int_\nu^T \beta^{s-t} ((\phi_s - c_{t,s}^*)(1-\tau) + Dr\tau) ds \right] \\ &\leq E_t \left[ \int_t^\nu \beta^{s-t} ((\phi_s - c_{t,s}^*)(1-\tau) + Dr\tau) ds \right] + E_t \left[ \int_\nu^T \beta^{s-t} ((\phi_s - c_{\nu,s}^*)(1-\tau) + Dr\tau) ds \right] \\ &= E_t \left[ \int_t^\nu \beta^{s-t} ((\phi_s - c_{t,s}^*)(1-\tau) + Dr\tau) ds \right] + E_t E_\nu \left[ \int_\nu^T \beta^{s-t} ((\phi_s - c_{\nu,s}^*)(1-\tau) + Dr\tau) ds \right] \\ &= E_t \left[ \int_t^\nu \beta^{s-t} ((\phi_s - c_{t,s}^*)(1-\tau) + Dr\tau) ds \right] \\ &= E_t \left[ \int_t^\nu \beta^{s-t} (-r(K-D)) ds \right] < 0, \end{aligned}$$

the last line following by replacing  $c_{t,s}^*$  with the financial distress wage. ■

## B Proof of Proposition 1

We wish to prove that the optimal compensation policy is to set

$$c_t = \min \left\{ \phi_t + r \left[ \frac{K}{1 - \tau} - D \right], \max_{0 \leq s \leq t} \{c^*(\phi_s, s)\} \right\}, \quad (19)$$

the market wage contract at time 0. The proof of this proposition closely follows that of Proposition 1 in Harris and Holmström (1982). We first show the policy in (19) is feasible.

Equation (12) is automatically satisfied by our definition of  $c_t$  in Equation (19). Equation (10) is satisfied by the definition of the market wage contract at time 0. In addition, by Lemma 1,

$$\begin{aligned} E_t \left[ \int_t^T \beta^{s-t} ((\phi_s - c_{0,s}^*)(1 - \tau) + Dr\tau) ds \right] &\leq E_t \left[ \int_t^T \beta^{s-t} ((\phi_s - c_{t,s}^*)(1 - \tau) + Dr\tau) ds \right] \\ &= 0, \end{aligned}$$

the last line following from the definition of the market wage contract initiated at date  $t$ . Thus the market wage contract at time 0 satisfies Equation (11), and is hence feasible.

Next, we define specific Lagrange multipliers, and show that this compensation policy, together with those Lagrange multipliers, maximizes the Lagrangian and satisfies the complementary slackness conditions for the program (9)–(12). The Lagrangian can be written (after first multiplying the constraints (11) and (12) by the unconditional probability of the respective  $\phi^t$ , multiplying (12) by powers of  $\beta$ , and then collecting terms) as follows:

$$E_0 \int_0^T \beta^t \left[ u(c_t) + \lambda^t ((\phi_t - c_t)(1 - \tau) + Dr\tau) + \mu_t ((c_t - \phi_t)(1 - \tau) - r [K - D(1 - \tau)]) \right] dt, \quad (20)$$

where

$$\lambda^t \equiv \int_{s=0}^t d\lambda_s(\phi^s), \quad (21)$$

$\mu_t \leq 0$  is the Lagrange multiplier corresponding to Equation (12), and  $d\lambda_s(\phi^s) \leq 0$  is the Lagrange multiplier corresponding to Equation (11). The first order conditions take the form

$$\frac{u'(c_t)}{1 - \tau} = \lambda^t - \mu_t. \quad (22)$$

Assume that the Lagrange multipliers are given by

$$\lambda^t = \frac{u'(\max_{0 \leq s \leq t} \{c^*(\phi_s, s)\})}{1 - \tau}, \quad (23)$$

$$\mu_t = \frac{u'(\max_{0 \leq s \leq t} \{c^*(\phi_s, s)\}) - u'(\min\{\phi_t + r[\frac{K}{1-\tau} - D], \max_{0 \leq s \leq t} [c^*(\phi_s, s)]\})}{1 - \tau}. \quad (24)$$

When  $c_t$  is given by (19) the first order conditions given by Equation (22) with these Lagrange multipliers are satisfied. Because the maximum inside the bracket in Equation (23) is always increasing, we have immediately that

$$d\lambda^t \begin{cases} \leq 0 & \text{when } c^*(\phi_t, t) = \max_{0 \leq s \leq t} \{c^*(\phi_s, s)\}, \\ = 0 & \text{otherwise.} \end{cases} \quad (25)$$

In words,  $d\lambda^t$  is only non-negative when the employee earns his competitive market wage (because, by Lemma 2 the firm can never be in distress when the employee earns his competitive wage) or equivalently when (11) binds. Thus,  $d\lambda^t = 0$  whenever (11) does not bind. Equation (24) immediately tells us that

$$\mu_t \begin{cases} = 0 & \text{when } c_t = \max_{0 \leq s \leq t} \{c^*(\phi_s, s)\}, \\ \leq 0 & \text{otherwise,} \end{cases} \quad (26)$$

so  $\mu_t = 0$  whenever (12) does not bind. Hence, we have complementary slackness and a solution to the problem. Finally, note that because  $u(\cdot)$  is concave and the constraints form a convex set, the problem has a unique solution. The contract defined by Equation (13) is thus the unique solution to the original program, Equations (9)–(12).

## C Proof of Proposition 2

By Ito's Lemma, when  $\phi_t < \bar{\phi}_t$ ,

$$dV = V_\phi d\phi + \frac{1}{2}V_{\phi\phi}\sigma^2 dt. \quad (27)$$

In equilibrium, shareholders must earn a fair rate of return on their investment, implying that

$$E(dV) = (rV - \delta_t) dt,$$

where  $\delta_t$  is the dividend payment, Combining these, we obtain a p.d.e. for  $V(\phi, \bar{\phi})$ :

$$\frac{1}{2}\sigma^2 V_{\phi\phi} - rV + \delta_t = 0. \quad (28)$$

From Equation (1), the dividend is given by

$$\delta_t = \begin{cases} Kr - Dr(1 - \tau) + (\phi_t - c^*(\bar{\phi}))(1 - \tau) & \text{if } \phi \geq \phi^*, \\ 0 & \text{otherwise.} \end{cases} \quad (29)$$

Equation (28) thus takes two different forms, depending on whether or not the firm is currently in financial distress:

$$\frac{1}{2}\sigma^2 V_{\phi\phi} - rV + Kr - Dr(1 - \tau) + (\phi - c^*(\bar{\phi}))(1 - \tau) = 0 \quad \text{if } \phi \geq \phi^*, \quad (30)$$

$$\frac{1}{2}\sigma^2 V_{\phi\phi}^f - rV^f = 0 \quad \text{otherwise.} \quad (31)$$

The notation  $V^f$  here is used to indicate the equity value when the firm is in financial distress. The general solutions to equations (30) and (31) are

$$V(\phi, \bar{\phi}) = H(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + M(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} + \frac{(\phi - c^*(\bar{\phi}))(1 - \tau)}{r} + K - D(1 - \tau), \quad (32)$$

$$V^f(\phi, \bar{\phi}) = Q(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + G(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma}. \quad (33)$$

To pin down the four unknown functions  $H$ ,  $M$ ,  $Q$  and  $G$ , we need four boundary conditions. The first, applying at the upper boundary  $\phi = \bar{\phi}$ , is<sup>12</sup>

$$\left. \frac{\partial}{\partial \phi} \right|_{\phi=\bar{\phi}} V(\phi, \bar{\phi}) = 0. \quad (34)$$

At the point the firm enters financial distress,  $\phi^*$ , the values and derivatives must be matched, providing two additional boundary conditions,

$$V(\phi^*, \bar{\phi}) = V^f(\phi^*, \bar{\phi}), \quad (35)$$

$$V_{\phi}(\phi^*, \bar{\phi}) = V_{\phi}^f(\phi^*, \bar{\phi}). \quad (36)$$

Finally, at the point of bankruptcy (when the firm cannot meet its interest obligations even if the employee gives up all his wages),  $\underline{\phi}$ , the firm fires the employee and replaces him with

---

<sup>12</sup>See Goldman, Sosin, and Gatto (1979).



an employee who puts the capital to full productive use, so

$$V^f(\underline{\phi}, \bar{\phi}) = K - D. \quad (37)$$

These four boundary conditions are sufficient to pin down  $H$ ,  $M$ ,  $Q$  and  $G$  for any given specification of the wage function. However, we also want to determine the optimal wage function,  $c^*(\bar{\phi})$ . This requires an additional condition, which is that the value of equity at the moment the manager is hired must be equal to  $K - D$ , i.e.,

$$V(\bar{\phi}, \bar{\phi}) = K - D. \quad (38)$$

As written, the five equations (34)–(38), are enough in principle to determine  $H$ ,  $M$ ,  $Q$ ,  $G$  and  $c^*$ , but applying them directly results in o.d.e.s for each function, due to the presence of the  $\bar{\phi}$  derivative in Equation (34). To eliminate this derivative, we replace Equation (34) with another (equivalent) condition. To do this, note that because Equation (38) holds for all  $\bar{\phi}$ , we can differentiate it with respect to  $\bar{\phi}$ , obtaining

$$\begin{aligned} \frac{dV(\bar{\phi}, \bar{\phi})}{d\bar{\phi}} &= \left. \frac{\partial V(\phi, \bar{\phi})}{\partial \phi} \right|_{\phi=\bar{\phi}} + \left. \frac{\partial V(\phi, \bar{\phi})}{\partial \bar{\phi}} \right|_{\phi=\bar{\phi}}, \\ &= 0. \end{aligned}$$

Combining this with Equation (34) we obtain

$$\left. \frac{\partial}{\partial \phi} \right|_{\phi=\bar{\phi}} V(\phi, \bar{\phi}) = 0. \quad (39)$$

Using (38),(39),(35),(36) and (37) to solve for the coefficients and the optimal wage gives:

$$\begin{aligned}
H(\bar{\phi}) &= \frac{\left(4\left(\frac{D-K}{1-\tau}\right)r^{3/2} + \sqrt{2}e^{-\frac{\sqrt{2r}c}{\sigma}}\sigma - \sqrt{2}e^{\frac{\sqrt{2r}c}{\sigma}}\sigma\right)e^{\frac{\sqrt{2r}\bar{\phi}}{\sigma}} + 4\sqrt{r}\left(c - \frac{Dr\tau}{1-\tau} - \bar{\phi}\right)e^{\frac{\sqrt{2r}\bar{\phi}}{\sigma}}}{\frac{4r^{3/2}}{1-\tau}\left(e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} - e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}}\right)}, \\
M(\bar{\phi}) &= \frac{\left(4\left(\frac{K-D}{1-\tau}\right)r^{3/2} - \sqrt{2}e^{-\frac{\sqrt{2r}c}{\sigma}}\sigma + \sqrt{2}e^{\frac{\sqrt{2r}c}{\sigma}}\sigma\right)e^{\frac{\sqrt{2r}(2\bar{\phi}+\phi)}{\sigma}} - 4\sqrt{r}\left(c - \frac{Dr\tau}{1-\tau} - \bar{\phi}\right)e^{\frac{\sqrt{2r}(\bar{\phi}+2\phi)}{\sigma}}}{\frac{4r^{3/2}}{1-\tau}\left(e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} - e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}}\right)}, \\
Q(\bar{\phi}) &= \frac{4\left(\frac{D-K}{1-\tau}\right)r^{3/2}e^{\frac{\sqrt{2r}\bar{\phi}}{\sigma}} + \sqrt{2}\sigma\left(e^{-\frac{\sqrt{2r}(c+\phi-2\bar{\phi})}{\sigma}} - e^{\frac{\sqrt{2r}(c+\phi)}{\sigma}}\right) + 4\sqrt{r}\left(c - \bar{\phi} - \frac{Dr\tau}{1-\tau}\right)e^{\frac{\sqrt{2r}\bar{\phi}}{\sigma}}}{\frac{4r^{3/2}}{1-\tau}\left(e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} - e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}}\right)}, \\
G(\bar{\phi}) &= \frac{\left(4\left(\frac{K-D}{1-\tau}\right)r^{3/2} - \sqrt{2}e^{-\frac{\sqrt{2r}c}{\sigma}}\sigma\right)e^{\frac{\sqrt{2r}(2\bar{\phi}+\phi)}{\sigma}} - 4\sqrt{r}\left(c - \frac{Dr\tau}{1-\tau} - \bar{\phi}\right)e^{\frac{\sqrt{2r}(\bar{\phi}+2\phi)}{\sigma}} + \sqrt{2}e^{\frac{\sqrt{2r}(c+3\phi)}{\sigma}}\sigma}{\frac{4r^{3/2}}{1-\tau}\left(e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} - e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}}\right)},
\end{aligned}$$

and the wage is

$$c = c^*(\bar{\phi}),$$

where

$$c^*(\phi) \equiv \left\{c \mid \Delta(\phi, D, c) = 0, \bar{\phi} + \frac{Dr\tau}{1-\tau} - \frac{\sigma}{\sqrt{2r}} \leq c < \bar{\phi} + \frac{Dr\tau}{1-\tau}\right\}$$

and

$$\begin{aligned}
\Delta(\phi, D, c) &\equiv \left(2\sqrt{2}\left(\frac{D-K}{1-\tau}\right)r^{3/2} + \left(e^{-\frac{\sqrt{2r}c}{\sigma}} - e^{\frac{\sqrt{2r}c}{\sigma}}\right)\sigma\right)e^{\frac{\sqrt{2r}\left(\left(\frac{K}{1-\tau}-D\right)r+\phi\right)}{\sigma}} - \sigma - \quad (40) \\
&\quad \sqrt{2r}\left(\phi - c + \frac{Dr\tau}{1-\tau}\right) + e^{\frac{2\sqrt{2r}\left(\left(\frac{K}{1-\tau}-D\right)r+\phi\right)}{\sigma}}\left(\sigma - \sqrt{2r}\left(\phi - c + \frac{Dr\tau}{1-\tau}\right)\right).
\end{aligned}$$

It is straightforward to show that  $\Delta(\phi, D, c)$  always has a unique root between  $\bar{\phi} + \frac{Dr\tau}{1-\tau} - \frac{\sigma}{\sqrt{2r}}$  and  $\bar{\phi} + \frac{Dr\tau}{1-\tau}$ .<sup>13</sup>

## D Proof of Proposition 3

For any  $\phi \leq \bar{\phi}$ , the Bellman equation for the manager's value function,  $J$ , takes the form

$$\frac{1}{2}\sigma^2 J_{\phi\phi} - rJ + u(c) = 0. \quad (41)$$

<sup>13</sup>Proof available on request from the authors.

The manager's pay,  $c$ , is given by

$$c = \begin{cases} c^*(\bar{\phi}) & \text{if } \phi \geq \phi^*, \\ \phi + r \left( \frac{K}{1-\tau} - D \right) = \phi - \underline{\phi} & \text{otherwise.} \end{cases} \quad (42)$$

Equation (41) thus takes two different forms, depending on whether or not the firm is currently in financial distress:

$$\frac{1}{2}\sigma^2 J_{\phi\phi} - rJ - e^{-\gamma c^*(\bar{\phi})} = 0 \quad \text{if } \phi \geq \phi^*, \quad (43)$$

$$\frac{1}{2}\sigma^2 J_{\phi\phi}^f - rJ^f - e^{-\gamma(\phi - \underline{\phi})} = 0 \quad \text{otherwise.} \quad (44)$$

The notation  $J^f$  is used here to emphasize that  $J$  is being calculated when the firm is in financial distress. The general solutions to these p.d.e.s are

$$J(\phi, \bar{\phi}) = A(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + B(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} - \frac{e^{-\gamma c^*(\bar{\phi})}}{r}, \quad (45)$$

$$J^f(\phi, \bar{\phi}) = C(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + F(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} - \frac{e^{-\gamma(\phi - \underline{\phi})}}{r - \frac{\gamma^2\sigma^2}{2}}. \quad (46)$$

To determine the functions  $A$ ,  $B$ ,  $C$  and  $F$ , we need the following boundary conditions. The first boundary condition is

$$J^f(\underline{\phi}, \bar{\phi}) = \int_0^\infty e^{-rt} u(0) dt = -1/r. \quad (47)$$

At the point of financial distress,  $\phi^*$ , the values and slopes must match, yielding two additional boundary conditions:

$$J(\phi^*, \bar{\phi}) = J^f(\phi^*, \bar{\phi}), \quad (48)$$

$$J_\phi(\phi^*, \bar{\phi}) = J_\phi^f(\phi^*, \bar{\phi}). \quad (49)$$

The final boundary conditions are

$$\left. \frac{\partial}{\partial \bar{\phi}} J(\phi, \bar{\phi}) \right|_{\phi=\bar{\phi}} = 0, \quad (50)$$

$$\lim_{\phi \rightarrow \infty} J(\phi, \bar{\phi}) = 0. \quad (51)$$

The first of these is analogous to Equation (34), and the second follows from the fact that, when  $\phi$  is very large, so is the manager's compensation, and

$$\lim_{c \rightarrow \infty} u(c) = 0.$$

These boundary conditions allow us to solve for the functions  $A(\bar{\phi})$ ,  $B(\bar{\phi})$ ,  $C(\bar{\phi})$  and  $F(\bar{\phi})$ :

$$A(\bar{\phi}) = \int_{\bar{\phi}}^{\infty} \frac{\gamma \left( 2e^{\frac{\sqrt{2r}u}{\sigma}} - e^{\frac{\sqrt{2r}(\phi - c^*(u))}{\sigma}} - e^{\frac{\sqrt{2r}(\phi + c^*(u))}{\sigma}} \right) \frac{\partial c^*(u)}{\partial u}}{2e^{c^*(u)} \gamma \left( e^{\frac{2\sqrt{2r}u}{\sigma}} - e^{\frac{2\sqrt{2r}\phi}{\sigma}} \right) r} du, \quad (52)$$

$$B(\bar{\phi}) = \frac{1 - \frac{\sqrt{2r}}{\gamma\sigma} - 2e^{c^*(\bar{\phi})} \left( \gamma + \frac{\sqrt{2r}}{\sigma} \right) + e^{\frac{2\sqrt{2r}c^*(\bar{\phi})}{\sigma}} \left( 1 + \frac{\sqrt{2r}}{\gamma\sigma} \right)}{2e^{c^*(\bar{\phi})} \gamma - \frac{\sqrt{2r}(\phi - c^*(\bar{\phi}))}{\sigma} r \left( 1 - \frac{2r}{\gamma^2\sigma^2} \right)} - e^{\frac{2\sqrt{2r}\phi}{\sigma}} A(\bar{\phi}), \quad (53)$$

$$F(\bar{\phi}) = \frac{\gamma\sigma \left( 2\sqrt{2}e^{\frac{\sqrt{2r}\phi}{\sigma}} \gamma\sigma + e^{\frac{\sqrt{2r}(\phi - c^*(\bar{\phi}))}{\sigma}} - c^*(\bar{\phi})\gamma \left( 2\sqrt{r} - \sqrt{2}\gamma\sigma \right) \right)}{2\sqrt{2}r \left( 2r - \gamma^2\sigma^2 \right)} - e^{\frac{2\sqrt{2r}\phi}{\sigma}} A(\bar{\phi}), \quad (54)$$

$$C(\bar{\phi}) = -\frac{e^{-\frac{\sqrt{2r}(c^*(\bar{\phi}) + \phi)}{\sigma}} \gamma\sigma}{2e^{c^*(\bar{\phi})} \gamma r \left( \sqrt{2r} + \gamma\sigma \right)} + A(\bar{\phi}). \quad (55)$$

The final boundary condition, (51), is required to pin down the constant of integration in the expression for  $A(\bar{\phi})$ . When  $\phi$  goes to infinity, so does  $\bar{\phi}$ , implying that  $\lim_{\bar{\phi} \rightarrow \infty} A(\bar{\phi}) = 0$ . A sufficient condition for the convergence of the integral in (52) is  $\sqrt{2r}/\sigma < \gamma$ .

Although we do not have an analytic expression for  $c^*(u)$ , an analytic expression for  $\frac{\partial c^*(u)}{\partial u}$  can be derived by first noting that  $\Delta(u, D, c^*(u)) = 0$  for any value of  $u$ , and then (totally) differentiating this expression with respect to  $u$ , and solving for  $\frac{\partial c^*(u)}{\partial u}$ .

## References

- Andrade, Gregor, and Steven N. Kaplan, 1998, How costly is financial (not economic) distress? Evidence from highly levered transactions that became distressed, *Journal of Finance* 53, 1443–1493.
- Baldwin, Carliss Y., 1983, Productivity and labor unions: An application of the theory of self-enforcing contracts, *Journal of Business* 56, 155–185.
- Bebchuk, Lucian A., and Alma Cohen, 2005, The costs of entrenched boards, *Journal of Financial Economics* 78, 409–433.
- Berens, James L., and Charles J. Cuny, 1995, The capital structure puzzle revisited, *Review of Financial Studies* 8, 1185–1208.
- Berger, Philip G., Eli Ofek, and David L. Yermack, 1997, Managerial entrenchment and capital structure decisions, *Journal of Finance* 52, 1411–1438.
- Berkovitch, Elazar, Ronen Israel, and Yossef Spiegel, 2000, Managerial compensation and capital structure, *Journal of Economics and Management Strategy* 9, 549–584.
- Bester, Helmut, 1983, Long-term wage contracts and dual labour markets, Working paper, University of Bonn.
- Brown, Charles, and James Medoff, 1989, The employer size-wage effect, *Journal of Political Economy* 97, 1027–59.
- Cadenillas, Abel, Jakša Cvitanić, and Fernando Zapatero, 2004, Leverage decision and manager compensation with choice of effort and volatility, *Journal of Financial Economics* 73, 71–92.
- Chang, Chun, 1992, Capital structure as an optimal contract between employees and investors, *Journal of Finance* 47, 1141–1158.
- Chang, Chun, 1993, Payout policy, capital structure, and compensation contracts when managers value control, *Review of Financial Studies* 6, 911–933.
- DeMarzo, Peter M., and Michael J. Fishman, 2006, Optimal long-term financial contracting, Working paper, Stanford University.
- Fama, Eugene F., and Kenneth R. French, 2002, Testing trade-off and pecking order predictions about dividends and debt, *Review of Financial Studies* 15, 1–33.
- Gale, Douglas, and Martin Hellwig, 1985, Incentive-compatible debt contracts: The one-period problem, *Review of Economic Studies* 52, 647–663.
- Gamber, Edward N., 1988, Long-term risk-sharing wage contracts in an economy subject to permanent and temporary shocks, *Journal of Labor Economics* 6, 83–99.
- Gilson, Stuart C., and Michael R. Vetsuypens, 1993, CEO compensation in financially distressed firms: An empirical analysis, *Journal of Finance* 48, 425–458.

- Goldman, M. Barry, Howard B. Sosin, and Mary Ann Gatto, 1979, Path dependent options: “Buy at the low, sell at the high”, *Journal of Finance* 34, 1111–1127.
- Graham, John R., and Campbell R. Harvey, 2001, The theory and practice of corporate finance: Evidence from the field, *Journal of Financial Economics* 60, 187–243.
- Graham, John R., 2000, How big are the tax benefits of debt?, *Journal of Finance* 55, 1901–1941.
- Guiso, Luigi, Luigi Pistaferri, and Fabiano Schivardi, 2005, Insurance within the firm, *Journal of Political Economy* 113, 1054–87.
- Harris, Milton, and Bengt Holmström, 1982, A theory of wage dynamics, *Review of Economic Studies* 49, 315–333.
- Hart, Oliver, and John Moore, 1994, A theory of debt based on the inalienability of human capital, *Quarterly Journal of Economics* 109, 841–879.
- Haugen, Robert A., and Lemma W. Senbet, 1978, The insignificance of bankruptcy costs to the theory of optimal capital structure, *Journal of Finance* 33, 383–393.
- Hennessy, Christopher A., 2005, Debt overhang and credibility in the firm-supplier relationship, Working paper, University of California, Berkeley.
- Holmström, Bengt, 1983, Equilibrium long-term labor contracts, *Quarterly Journal of Economics* 98, 23–54.
- Kalay, Avner, Rajeev Singhal, and Elizabeth Tashjian, 2007, Is Chapter 11 really costly?, Working paper, University of Utah, forthcoming, *Journal of Financial Economics*.
- Kayhan, Ayla, 2003, Managerial entrenchment and the debt-equity choice, Working paper, University of Texas at Austin.
- Kisgen, Darren J., 2006, Bond ratings and capital structure, *Journal of Finance* 61, 1035–1072.
- Kraus, Alan, and Robert Litztenberger, 1973, A state preference model of optimal financial leverage, *Journal of Finance* 28, 911–922.
- Krueger, Alan B., 1999, Measuring labor’s share, *American Economic Review* 89, 45–51.
- Lemmon, Michael L., Michael R. Roberts, and Jaime F. Zender, 2006, Back to the beginning: Persistence and the cross-section of corporate capital structure, Working paper, University of Utah.
- Miller, Merton H., 1988, The Modigliani-Miller propositions after thirty years, *Journal of Economic Perspectives* 2, 99–120.
- Modigliani, Franco, and Merton H. Miller, 1958, The cost of capital, corporation finance and the theory of investment, *American Economic Review* 48, 261–197.
- Morellec, Erwan, 2004, Can managerial discretion explain observed leverage ratios?, *Review of Financial Studies* 17, 257–294.

- Neal, Derek, 1995, Industry-specific human capital: Evidence from displaced workers, *Journal of Labor Economics* 13, 653–77.
- Novaes, Walter, and Luigi Zingales, 1995, Capital structure choice when managers are in control: Entrenchment versus efficiency, Working Paper 5384, NBER.
- Perotti, Enrico C., and Kathryn E. Spier, 1993, Capital structure as a bargaining tool: The role of leverage in contract renegotiation, *American Economic Review* 83, 1131–1141.
- Pontiff, Jeffrey, Andrei Shleifer, and Michael S. Weisbach, 1990, Reversions of excess pension assets after takeovers, *RAND Journal of Economics* 21, 600–613.
- Rajan, Raghuram G., and Luigi Zingales, 1995, What do we know about capital structure? Some evidence from international data, *Journal of Finance* 50, 1421–1460.
- Strömberg, Per, 2000, Conflicts of interest and market illiquidity in bankruptcy auctions: Theory and tests, *Journal of Finance* 55, 2641–2692.
- Stulz, René M., 1990, Managerial discretion and optimal financing policies, *Journal of Financial Economics* 26, 3–27.
- Subramanian, Ajay, 2002, Managerial flexibility, agency costs, and optimal capital structure, Working paper, Georgia Institute of Technology.
- Thomas, Jonathan, and Tim Worrall, 1988, Self-enforcing wage contracts, *Review of Economic Studies* 55, 541–553.
- Titman, Sheridan, and Roberto Wessels, 1988, The determinants of capital structure choice, *Journal of Finance* 43, 1–19.
- Titman, Sheridan, 1984, The effect of capital structure on a firm’s liquidation decision, *Journal of Financial Economics* 13, 1–19.
- Townsend, Robert M., 1979, Optimal contracts and competitive markets with costly state verification, *Journal of Economic Theory* 21, 265–293.
- Tserlukevich, Yuri, 2005, Can real options explain financing behavior?, Working paper, U.C. Berkeley.
- Zwiebel, Jeffrey, 1996, Dynamic capital structure under managerial entrenchment, *American Economic Review* 86, 1197–1215.