

Human Capital, Bankruptcy and Capital Structure*

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ABSTRACT

This paper identifies a previously overlooked friction, human capital risk, which can explain an important puzzle in corporate finance — why firms maintain such low levels of debt, given the apparently modest costs of bankruptcy. We derive the optimal compensation contract when employees are averse to their own human capital risk, but equity holders are not averse to this risk, and show that, in the absence of other frictions, all firms will be unlevered. In the presence of corporate taxes, optimal debt levels are consistent with the levels observed, implying that human capital risk is of the same order of importance as taxes in the capital structure decision. Because these costs are impossible to measure directly, existing empirical studies that attempt to measure the costs of bankruptcy grossly underestimate them.

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1 Introduction

Ever since Modigliani and Miller (1958) first proved that capital structure is irrelevant in a frictionless economy, financial economists have puzzled over what the frictions are that make the capital structure decision so important in reality. The most important friction yet identified was noted by Modigliani and Miller themselves: corporate taxes. Because dividends are subject to corporate taxation while interest payments are not, 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 resulted 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 managers changing behavior and moving 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 firms appear to have too little debt?

Clearly, an opposing friction must exist. However, economists have struggled to identify it. One candidate is bankruptcy costs: High levels of debt increase the probability of bankruptcy, so if there are deadweight costs associated with bankruptcy, these costs will be a disincentive to issue debt. However, in an important paper on bankruptcy costs, Haugen and Senbet (1978) argue that the importance of these costs cannot exceed the cost of negotiating around them — debt holders bear the costs of bankruptcy, so they have incentives to recapitalize the firm outside of bankruptcy, and thus avoid these costs. Hence, deadweight bankruptcy costs cannot exceed the cost of renegotiating, which significantly limits their potential role as an effective counterweight to the large benefit of the tax shield.

A simple “back of the envelope” calculation shows the significance of this point: Suppose costs of 30% are incurred in the event of bankruptcy (a very high number, in light of Haugen and Senbet (1978)), and there is a 5% chance of bankruptcy occurring. Then the expected cost of bankruptcy at the time of the capital structure decision is 1.5% of the *financial distress* value, and hence substantially *less* than 1.5% of the value of the firm at the time of the decision. Graham (2000) estimates the tax benefit of debt to be in the range of 10% of

value at the time of the capital structure decision, so taxes are at least an order of magnitude more important than bankruptcy costs.

Although financial economists have not identified the precise nature of the costs associated with high debt levels, substantial costs must exist to explain the debt levels observed in the economy. Hence it has become standard amongst corporate finance researchers simply to assume that some cost of debt exists, and move on to formulate theories of optimal capital structure. This has led to a number of theoretical predictions of optimal capital structure that have proved difficult to verify empirically. Indeed, in response to the apparent lack of empirical support for the theoretical predictions, Welch (2004) (p. 106) concludes that capital structure decisions “remain largely a mystery.” Clearly, the source of this mystery lies in the fact that we cannot identify the first order friction that acts as a counterbalance to corporate taxes and thus limiting the benefits of debt.

An interesting characteristic of the literature on bankruptcy costs is the apparent disconnect between the costs that researchers study and the ones identified in the popular press. During a corporate bankruptcy a major focus of the popular press is the *human* cost of bankruptcy, yet these costs have received minimal attention in the research literature. It is not difficult to understand why. In an efficient labor market there should be no human costs associated with bankruptcy. If employees are being paid their competitive wage, it should be relatively costless 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? It would appear to be relatively costless to lower wages to their competitive levels, especially at times when the firm is facing the prospect of bankruptcy.¹

In this paper we argue that this intuition is wrong. In an economy with perfectly competitive capital and labor markets, one should *expect* large human costs of bankruptcy, and it is precisely these costs that limit the use of corporate debt. We begin with Harris and Holmström (1982) insight on the form of optimal employment contracts in perfect capital and labor markets. In a setting without bankruptcy, they show that the optimal employment contract guarantees job security (employees are never fired), and pays employees a

¹One possible explanation is the existence of firm specific human capital (see Neal (1995)). Yet in an efficient labor market it is not clear that employees are necessarily paid for their investments in human capital. Furthermore, 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.

fixed wage that never goes down, but rises in response to good news about employee ability. The intuition behind their 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 by investing in many firms. Optimal risk sharing then implies that the shareholders will bear all of this risk by offering employees a fixed wage contract. The problem with this contract is that employees cannot be forced to work under it: Employees who turn out to be better than expected will threaten to quit unless they get a pay raise. This imperfection leads to the optimal employment contract Harris and Holmström (1982) identified.²

In Harris and Holmström (1982), firms carry no debt, and equity holders do not have limited liability. To credibly commit to the terms of the contract, equity holders guarantee the fixed wage by implicitly promising to make the wage payments even when the firm could not — that is, the equity holders have unlimited personal liability. 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 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, imposing the restriction that equity has limited liability is important.

Our first objective in this paper is to derive the optimal compensation contract in a setting that includes both limited liability equity and debt. We show that the optimal employment contract in this setting is similar to that in Harris and Holmström (1982): As in Harris and Holmström (1982), unless the firm is in financial distress, wages never fall, and rise whenever employees turn out to be better than expected. However, at the point where the firm cannot make interest payments, the employee takes a *temporary* pay cut. 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 the temporary wage concessions, it is forced into bankruptcy. In bankruptcy the firm can abrogate its contracts — employees can be terminated and new, more productive, employees can be hired to replace them. As a result, entrenched employees 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 optimal capital structure. Note that most employees are likely to become entrenched — because their pay can only be increased, eventually it will be increased too much. Because such employees are destroying value (the value of the firm would go up were they replaced), investors in the firm actually benefit from a bankruptcy filing because they can effectively fire such employees

²Several 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).

or lower their wages to competitive levels. Thus, *ex post* the effect of the optimal contract is to create a *benefit* to investors of filing for bankruptcy. The Haugen and Senbet critique therefore does not apply in this case — neither debt holders nor equity holders have an incentive to avoid bankruptcy.

The implications of the optimal labor contract on the level of debt occur *ex ante*. The amount of risk sharing between investors and employees depends on the level of debt — under the optimal labor contract, higher debt levels imply less risk sharing. Thus, in the absence of taxes, the optimal level of debt is zero — with no frictions other than an incomplete market in human capital, all firms will be unlevered. Adding debt reduces profits because employees demand a higher wage *ex ante* to compensate them for the risk of bankruptcy. When corporate taxes are introduced into the model, a theory of optimal capital structure emerges that can resolve the apparent paradox present in the data: Firms maintain only modest levels of debt relative to the measured levels of the costs of bankruptcy.

Our model can successfully explain existing debt levels because the underlying assumptions are consistent with the evidence — the firm itself faces no cost of bankruptcy. Instead, the costs of bankruptcy are borne by the firm’s employees, not by the firm’s equity holders. In a world with competitive labor and capital markets in which all firms optimally choose their capital structures, employees trade off the benefits of higher wages resulting from leverage increases against the costs of less human capital insurance. Because these costs are highly dependent on preferences, they are particularly difficult to measure so it is not surprising that the literature has not found direct evidence of them.

Although the direct costs of bankruptcy are difficult to measure, one might be able to find evidence of them indirectly. Clearly, industries that are more labor intensive will have higher costs of bankruptcy. Hence our model predicts that labor intensive firms will have lower levels of debt than capital intensive firms. Capital intensive firms tend to be larger (especially if accounting numbers are used as a measure of firm size), so a cross-sectional relation between debt levels and firm value will exist — large firms will be more highly levered. These predictions are 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.

The model delivers a number of other cross-sectional implications. Firms with lower cash flow variation have higher levels of debt, as do older firms. Capital intensive industries have higher leverage and, as a consequence, should have higher wages, implying a positive relation between firm size and wages. This relation has been documented empirically, and it regarded as a puzzle by labor economists (see Brown and Medoff (1989)). Perhaps most importantly, we show that, for reasonable parameter values, the tradeoff between corporate

taxes and optimal risk sharing alone predicts debt levels consistent with those observed.

A surprising result in our setting is that, even in the presence of the frictions we study, at the time the capital structure decision is made the Modigliani-Miller proposition *holds* — that is, the value of the firm does not depend on the debt-to-equity ratio. The reason is that the costs of a sub-optimal debt-to-equity ratio are borne by the firm’s employees, not the firm’s investors. Of course, in equilibrium, a firm that chooses a sub-optimal debt-to-equity ratio will not be able to find employees willing to work for it.

The rest of the paper is organized as follows . . .

2 Review of the Literature

Several papers have analyzed the interaction between capital structure choice and the firm’s employees’ compensation and their 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. In his model, employees are risk averse and thus should be given a constant wage. However, in some states of the world, value-enhancing restructurings should be undertaken, which are costly for the employees. It is assumed that the employees’ contract cannot be made contingent on such restructuring events and, as a consequence, employees always try to avoid restructuring. Investors therefore finance the firm with both equity and debt. If the firm defaults on the debt, then investors are in charge and can force a restructuring. In a related paper, Chang (1993) focuses on the interaction between payout policy, capital structure and compensation contracts. Managers value control, so they must be motivated to pay out capital to the investors. The employee’s compensation is therefore linked to the payout to equityholders. However, the optimal payout level may change over time. Such a change is only feasible if control is transferred from the management to investors. This transfer is achieved by issuing the right amount of debt ex ante so that bankruptcy occurs in those states when new information about the optimal payout level is likely to be available. Thus, our paper relies on a key insight in both Chang (1992) and Chang (1993), namely, the triggering of bankruptcy allows value enhancing recontracting.

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.

In an early contribution, Baldwin (1983) models a firm that undertakes a capital investment. Ex post, employees can appropriate the return to capital, because capital costs have been sunk. Issuing a sufficient amount of debt may mitigate this hold-up problem. If higher wages are demanded from a highly levered firm bankruptcy occurs which 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 and thereby create an underinvestment incentive. This can then be used to obtain wage concessions from employees to restore incentives to invest. Our focus is very different. We assume that both labor markets and capital markets are competitive, so that *ex ante* the employee captures all the economic rents and makes the capital structure choice that maximizes his utility. Rather than modeling another possible benefit of debt, as the above two papers do, our model identifies a first-order friction that makes debt costly.

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.

The papers discussed so far provide new insights for optimal capital structure choices by accounting for the effect on the actions and on the compensation of management and employees. However, all of these papers assume that capital structure is chosen by the equity holders. In practice, however, capital structure choice is one of *management's* most important responsibilities.

Zwiebel (1996) provides the first formal model of an employee's capital structure choice when ownership is separated from control. In this paper, an entrenched employee determines the firm's capital structure, recognizing that he can only be replaced 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 fired. This can be done by issuing debt. By doing that, the employee commits not to undertake negative NPV projects, and thereby makes a hostile takeover unprofitable. In equilibrium, managers with low abilities issue debt, and therefore do not take on negative NPV projects. This allows them to avoid both hostile takeovers and bankruptcy.

Morellec (2004) extends the model by Zwiebel (1996), and derives a continuous-time model of an entrenched employee who may 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.

Our analysis differs in several important ways from the previous literature on managerial capital structure choice discussed above. First, the existing literature relies on exogenous contracting restrictions. Existing papers have in common an exogenously specified managerial characteristic, such as empire building preferences or effort aversion, that destroys shareholder value, and cannot be eliminated by appropriate compensation contracts. We analyze the role of capital structure without relying on moral hazard or asymmetric information and solve for the optimal employees' compensation under fairly mild contracting restrictions. Furthermore, existing models on managerial choice of capital structure imply that bankruptcy is always inefficient *ex post*, whenever costs are associated with it. In our model, it is *ex post* efficient to incur bankruptcy costs, since bankruptcy is the institution that cancels the firm's existing wage contracts and allows recontracting with employees.

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 a growing firms with relatively low current cash flows, there is little to shield, so the usefulness of debt is limited. Their point is significant 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 riskless firm is 40%.

Tserlukevich (2005) expands the analysis of Berens and Cuny (1995) by explicitly modeling corporate growth options when real investment is irreversible. This model can explain many of the empirical stylized facts on capital structure (e.g. low and mean reverting leverage ratios, a negative relation between past profits and current leverage, as well as between past stock returns and current leverage). Although it is likely that Berens and Cuny (1995) insight explains part of the reason firms 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.

Like us, Titman (1984) analyzes the effect that bankruptcy can have on a firm's stakeholders. In this model, highly levered firms liquidate too late since they do not take into

account the costs they are imposing on customers and debtholders. This assumes that equityholders' liquidation decisions cannot be contracted on, and that renegotiations between equityholders, debtholders and customers (as in Haugen and Senbet (1978)) are not possible. In such a setting, capital structure can play a role as a commitment to a first-best liquidation policy. Our paper derives a capital structure theory without relying on ex-post inefficiencies.

In a recent paper, Hennessy (2005) develops a model where 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 results are largely consistent with existing empirical evidence on capital structure. Using data from several countries, Rajan and Zingales (1995) find that leverage increases with the relative size of fixed assets, tangible assets, non-debt tax shields such as depreciation, and firm size. Furthermore, leverage is found to decrease with a firm's volatility, its probability of bankruptcy, its profitability and the uniqueness of the firm's product. All these findings are consistent with the implications from our model of employee entrenchment.

Several other empirical papers also find that firms' capital structure choice is consistent with managerial entrenchment. Berger, Ofek, and Yermack (1997) test three alternative hypotheses for managerial capital structure choice. Managers may choose to underlever due to risk aversion; they may choose to overlever to inflate the voting power of their equity stakes and reduce takeover dangers; or they could overlever to signal restructurings in order to reduce the profitability of hostile takeovers. They find strong support for the first hypothesis. Managers who appear to be more entrenched (long tenure, compensation has low sensitivity to performance, few outside directors, no large shareholder) have low leverage.³

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. Although they leave as a puzzle why shareholders would voluntarily engage in what they identify as suboptimal behavior, the contribution of our model is the insight that it is not necessarily suboptimal to let managers become entrenched, even if, *ex post* this entrenchment leads to lower Q-ratios.

Our paper is also related to the literature on conglomerate discounts. Campa and Kedia (2002) provide an analysis of the conglomerate discount, taking into account that firms' decisions to diversify are endogenous. They find that the same firm characteristics that lead

³Berkovitch, Israel, and Spiegel (2000), Kayhan (2003), and Novaes and Zingales (1995) document additional evidence that management compensation and managerial entrenchment are significantly related to firms' capital structure choices and Jung et al. (96) also present support for the agency model of capital structure choice.

firms to diversify also imply larger discounts. Taking this endogeneity into account, diversification no longer appears to destroy value. They also show that single segment firms have lower leverage, have higher R&D expenses and are smaller. Again, this evidence is consistent with our analysis. Because conglomeration diversifies employee specific risk, it allows for better risk sharing and therefore higher leverage. Conglomeration is therefore optimal *ex ante*, but *ex post* larger discounts will be associated with firms that are more diversified because, *ceteris paribus*, their management is more entrenched. Our model also produces results consistent with the observation in Campa and Kedia (2002) that conglomerate firms enter Compustat with a premium, but always have negative excess value in the last year of data.

A key insight that emerges from our analysis is that bankruptcy limits the potential to write explicit or implicit contracts with managers and other employees. Because the firm ceases to exist as a legal entity, all existing contracts with this firm are no longer enforceable. Although bankruptcy is likely the most important mechanism that allows firms to abrogate existing contracts, other mechanisms exist. For example, another event which will have similar consequences is a takeover. If a firm is merged into another company, then we would also expect that existing – possibly implicit – contracts with the target firm can be fully or partially abrogated, or are at least harder to enforce. Thus, while hostile takeovers may create value gains *ex post*, they also limit the risk sharing possibilities *ex ante*, which likely explains why the majority of firms have adopted anti-takeover provisions.

Evidence of the effect of takeovers on existing contracts has been documented in Pontiff, Shleifer, and Weisbach (1990). They find that firms do not terminate defined benefit plans whenever they can and that they provide cost-of-living adjustments to their retired workers even when they are not forced to. However, hostile takeovers are followed by an abnormally high incidence of pension asset reversions. These pension asset reversions account for approximately 11% of takeover gains. Thus, hostile takeovers seem to be frequently followed by a breach of implicit contracts. This empirical regularity is formalized in our model, where it is optimal to write a contract with management and/or workers not to lower wages or to fire employees. However, this contract is only enforceable as long as the firm remains solvent.

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 an important factor for capital structure choice. Clearly, firms with good credit rating and financial flexibility can offer more valuable human capital risk sharing to employees than firms with poor ratings and little financial flexibility.

3 Optimal Labor Contract

In this section, we derive the optimal contract for a risk-averse employee working for a risk-neutral firm. We extend the results of Harris and Holmström (1982) by both allowing for debt, and imposing personal bankruptcy if the manager's wage drops below zero. We also derive our results in continuous, rather than discrete, time.

The economy consists of a large number of identical firms all of which begin life at time 0 and last forever. Each firm requires two inputs to operate, capital in the amount K and an employee who is paid a wage c_t and adds in period t , (uncertain) value, $K R + \phi_t$. At time 0, each firm raises the capital required by issuing debt, D , and equity $K - D$. 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 coupon of r , the risk free rate of interest. The firm must pay corporate taxes at rate τ on earnings after interest expense, so the interest tax shield is $Dr\tau$, where D is the amount of debt outstanding. For simplicity, we assume that the after tax return on capital is given by $R \equiv \frac{r}{1-\tau}$. Thus, the firm produces after tax cash flows of $(\frac{K}{1-\tau} - Dr + \phi_t - c_t)(1 - \tau) + Dr$ at time t , Dr of which is paid out as interest on debt, and the rest, $(K - D)r + (\phi_t - c_t)(1 - \tau) + Dr\tau$ is paid out as dividends. Because the firm will always be able to meet its interest obligations, the level of debt remains fixed forever. Let $\beta \equiv e^{-r}$.

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

Bankruptcy occurs at the stopping time T when the firm cannot meet its interest obligations. At that point in time we assume all contracts can be unilaterally abrogated, so that the firm is no longer bound by the employee's labor contract. Hence at time T firm hires a new employee who 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 risk less (and perpetual).

A bankruptcy filing therefore creates value in our model. For simplicity we assume that the 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.⁴, but most of the results in this paper remain valid even

⁴Equity holders often maintain control even in countries without Chapter 11 protection, see Strömberg

when debt holders capture some or all of this value.

The firm can only make wage payments during the employee's active tenure within the firm. Thus, we assume that the firm cannot commit to severance payments, or to a corporate pension after the manager has been fired. The first assumption reflects reality — bankrupt firms rarely make severance payments; the second assumption is consistent with the growth of defined contribution pension plans. Although allowing such payments in our simple model would be Pareto improving, they are suboptimal in a world where the employee can lower his profitability, thereby triggering the firing event and thus initiating the retirement and/or severance payments. The manager could thereby obtain severance and pension payments and immediately start working for another firm which would again fully compensate him for his productivity.

To derive the optimal labor contract, we solve for the contract that maximizes the employee's utility subject to the constraints that the firm operates in a competitive capital and labor market. We begin by assuming that the (stochastic) point at which the firm declares bankruptcy is independent of the labor contract. We then derive the optimal contract and show that under the optimal contract, this assumption is satisfied.

Because capital markets are competitively, the market value of equity at time t , v_t , is the present value of all future cash flows,

$$\begin{aligned} v_t &= E_t \left[\int_t^T \beta^{s-t} ((K - D)r + (\phi_s - c_s)(1 - \tau) + Dr\tau) ds + \beta^{T-t} v_T \right], \\ &= E_t \left[(K - D) (1 - \beta^{T-t}) + \beta^{T-t} v_0 + \int_t^T \beta^{s-t} ((\phi_s - c_s)(1 - \tau) + Dr\tau) ds \right] \end{aligned} \quad (1)$$

where we use the fact that at the point of bankruptcy, T , the firm is restored to its initial state and hence, $v_T = v_0$. The initial value of equity must equal the value of the capital supplied, $v_0 = K - D$, so

$$v_t = K - D + E_t \left[\int_t^T \beta^{s-t} ((\phi_s - c_s)(1 - \tau) + Dr\tau) ds \right], \quad (2)$$

and so at time 0 we have

$$E_0 \left[\int_0^T \beta^t ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] = 0. \quad (3)$$

Firms compete to hire finitely many managers of a given ability in a competitive labor

(2000)

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). At time 0 the manager makes his market wage, so the value of equity cannot exceed the time 0 value, $v_t \leq v_0, \forall t$ (because if it did, the manager would have to make less than his market wage). Hence,

$$E_\tau \left[\int_\tau^T \beta^{t-\tau} ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] \leq 0, \quad \forall \tau \in [0, T]. \quad (4)$$

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

$$c_t \leq \phi_t + r \left[\frac{K}{1 - \tau} - D \right]. \quad (5)$$

The optimal contract maximizes the employee's utility subject to the above three constraints, i.e., (3)-(5):

$$\max_c E_0 \left[\int_0^T \beta^t u(c_t) dt \right] \quad (6)$$

$$\text{s.t.} \quad E_0 \left[\int_0^T \beta^t ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] = 0, \quad (7)$$

$$E_\tau \left[\int_\tau^T \beta^{t-\tau} ((\phi_t - c_t)(1 - \tau) + Dr\tau) dt \right] \leq 0, \quad \forall \tau \in [0, T], \quad (8)$$

$$(\phi_t - c_t)(1 - \tau) - r [K - D(1 - \tau)] \leq 0, \quad \forall t \in [0, T]. \quad (9)$$

The first two constraints are identical to Harris and Holmström (1982). The last is new, and reflects the limited liability of equity assumption and the presence of debt. The following proposition derives the optimal labor contract under the assumption that the future distribution of ϕ_t depends only on its current value and time:

Proposition 1 *The optimal contract is given at all dates prior to bankruptcy by*

$$c_t(\phi^t) = \min \left\{ \phi_t + r \left[\frac{K}{1 - \tau} - D \right], \max_{0 \leq s \leq t} \{c^*(\phi_s, s)\} \right\}, \quad (10)$$

where

$$\phi^t \equiv \{\phi_s; 0 \leq s \leq t\},$$

and $c^*(\phi, t)$ is the (unique) increasing function of ϕ that sets the equity value of a new firm at

time t equal to $K - D$ when $\phi_t = \phi$, (so constraint (8) holds with equality when $c_t = c^*(\phi_t, t)$).

The proof of the proposition can be found in the appendix. Note that the form of the optimal contract is similar to that in Harris and Holmström (1982). If the firm is not in *financial distress*, that is, it can meet its interest obligations, wages never fall and rise in response to positive shocks in employee ability. The main difference occurs when the firm cannot meet its interest obligations and is in financial distress. In these states the employee takes a temporary pay cut so that the firm can avoid bankruptcy and keep operating. If the employee gives up all his wages and the firm still cannot make interest payments, it is forced into bankruptcy. At that point the firm's cash flow is $Kr/(1 - \tau) + \phi$. which is less than the interest owed, Dr , that is,

$$Kr + \phi(1 - \tau) + Dr\tau < Dr.$$

So bankruptcy occurs when ϕ is less than, $\underline{\phi}$, where

$$\underline{\phi} \equiv - \left[\frac{K}{1 - \tau} - D \right] r$$

which is independent of the labor contract offered to the employee, so the optimal contract satisfies our initial assumption.

We are now ready to derive the first implication of this labor contract for the capital structure choice of the firm.

Proposition 2 *In the absence of corporate taxes, the optimal level of debt is zero.*

Proof: Consider two debt levels satisfying $0 \leq D_1 < D_2$. First note that when $\tau = 0$, the firm's cash flow is independent of the level of debt. Let T_1 and T_2 be the point of bankruptcy with debt levels D_1 and D_2 respectively. Note that $T_1 > T_2$. Because the firm's cash flow is independent of the level of debt, the wage policy that pays the optimal wage when $D = D_2$ until T_2 and nothing thereafter is feasible when the debt level is D_1 . However it is not optimal because the identical contract that pays strictly positive wages between T_2 and T_1 dominates it. Thus the employee is strictly better off with debt level D_1 than with debt level D_2 . This is true for any $0 \leq D_1 < D_2$, so the optimal debt level is zero.

Our next result shows that the Modigliani-Miller Proposition holds at time 0 when the debt level is determined.

Proposition 3 *The value of the firm, as well as the per share value of equity does not depend on the debt-to-equity ratio at time 0.*

Proof: Debt is riskless and so always trades for its face value, D . At time 0 the value of equity is $K - D$, so the value of the firm is $D + (K - D) = K$ which is independent of the level of debt.

The reason why the value of the firm is independent of the level of debt is that the benefits of debt (the tax shield) accrue to the employee, not the firm in our model. Hence, the employee bears the consequences of a suboptimal capital structure. This result is a consequence of competition in the capital markets — if the benefit of the tax shield accrued to investors they would earn a return in excess of the risk free rate, which is not sustainable in a competitive capital market.

For notational convenience, from now on we shall assume that the future distribution of ϕ_t does not depend on time. Under this assumption the optimal labor contract can be written in the more compact form:

$$c_t(\phi^t) = \min \left\{ \phi_t + r \left[\frac{K}{1 - \tau} - D \right], c^*(\bar{\phi}_t) \right\}, \quad \text{where} \quad (11)$$

$$\bar{\phi}_t \equiv \max_{0 \leq s \leq t} \phi_s. \quad (12)$$

4 Implementing the Optimal Contract

So far, we have demonstrated that in the absence of taxes the inability of employees to fully insure their own human capital risk implies that firms will have preference for equity. Of course, in reality, the tax deductibility of interest creates a strong incentive to issue debt. In this section we demonstrate that these two frictions are of the same order of magnitude.

To model human capital risk we necessarily have to make a number of restrictive assumptions, for example, we need an explicit assumption on preferences. These assumptions effectively rule out the possibility of the model quantitatively matching the data. That is not our objective. Instead by making a number of restrictive assumptions and choosing a set of realistic parameter values we are able to demonstrate that human capital risk alone can effectively counterbalance taxes to produce realistic debt-to-equity ratios.

Our strategy is as follows. We first solve explicitly for the optimal contract offered by the firm to the employee. Given this contract we derive an expression for the employee's indirect utility function as a function of the level of debt and then optimize this function to find the optimal debt level.

4.1 Optimal Wage

Define

$$\delta_t \equiv (\phi_t - c_t)(1 - \tau) + Dr\tau, \quad (13)$$

so the expected discounted value of the excess cash flows added by the employee is

$$V(\phi, \bar{\phi}, t) \equiv E_t \left[\int_t^T e^{-r(\tau-t)} \delta_\tau d\tau \mid \phi_t = \phi, \bar{\phi}_t = \bar{\phi} \right]. \quad (14)$$

and the value of equity is $K - D + V(\phi, \bar{\phi}, t)$. Whenever the employee is paid his competitive wage,

$$V(\phi, \phi, t) = 0. \quad (15)$$

At other times $V(\phi, \bar{\phi}, t) < 0$, that is, the value of equity is either equal to value when the employee is hired, or it is less. Note that this means the value of the firm is can never exceed the value if the human capital is replaced which is opposite to what q theory predicts about physical capital. There the value of the firm is never lower than the replacement value of physical capital.

Our object is to derive the cross-sectional implications of our model. To do that we will derive a closed form expression for firm value and employee utility. In this setting this requires making restrictive assumptions. The first one is that we will assume that ϕ_t follows a random walk,

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

This assumption greatly simplifies the analysis because the variance remains constant, so there is no time dependency in the problem, and V does not depend explicitly on t . By Ito's Lemma, when $\phi_t < \bar{\phi}_t$,

$$dV = V_\phi d\phi + \frac{1}{2} V_{\phi\phi} \sigma^2 dt. \quad (17)$$

First consider the state when the firm can make interest payments. In equilibrium, shareholders must earn a fair rate of return on their investment, i.e.

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

Combining these, we obtain a p.d.e. for $V(\phi, \bar{\phi})$:

$$\frac{1}{2} \sigma^2 V_{\phi\phi} - rV + \delta_t = 0 \quad (18)$$

The general solution to this equation is

$$V(\phi, \bar{\phi}) = A(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + B(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} + \frac{(\phi - c^*(\bar{\phi}, D))(1 - \tau)}{r} + D\tau. \quad (19)$$

When $\phi = \bar{\phi}$, V equals zero (by (15)). In addition, as ϕ approaches $\bar{\phi}$, we have the additional boundary condition⁵

$$V_{\bar{\phi}}(\bar{\phi}, \bar{\phi}) = 0. \quad (20)$$

When the firm cannot meet its interest obligations so the firm is in *financial distress*, the employee takes a temporary pay cut to just make sure that the interest obligations are met. Financial distress occurs at the point when all the revenues of the firm equal the interest owed:

$$\frac{Kr}{1 - \tau} + \phi_t - c_t = Dr$$

or when

$$\phi = \phi^* \equiv c - \left[\frac{K}{1 - \tau} - D \right] r. \quad (21)$$

and

$$\delta = -(K - D)r. \quad (22)$$

δ remains constant at this level while the firm is in financial distress — said another way, the firm pays zero dividends when it is in distress. Shareholders must still earn a fair rate of return on their investment while in financial distress, i.e.

$$E(dV^f) = (rV^f + (K - D)r) dt.$$

so the o.d.e. in this region is

$$\frac{1}{2}\sigma^2 V_{\phi\phi}^f - rV^f - (K - D)r = 0. \quad (23)$$

The general solution to this equation is

$$V^f(\phi, \bar{\phi}) = F(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + G(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} - (K - D). \quad (24)$$

At the point the firm enters financial distress, ϕ^* , the values and derivatives must be

⁵See Goldman, Sosin, and Gatto (1979).

matched:

$$V(\phi^*, \bar{\phi}) = V^f(\phi^*, \bar{\phi}) \quad (25)$$

$$V_\phi(\phi^*, \bar{\phi}) = V_\phi^f(\phi^*, \bar{\phi}) \quad (26)$$

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 an employee who puts the capital to full productive use so

$$V^f(\underline{\phi}, \bar{\phi}) = 0. \quad (27)$$

Using these boundary conditions to solve for the coefficients and the optimal wage gives:

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

and the wage is

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

where

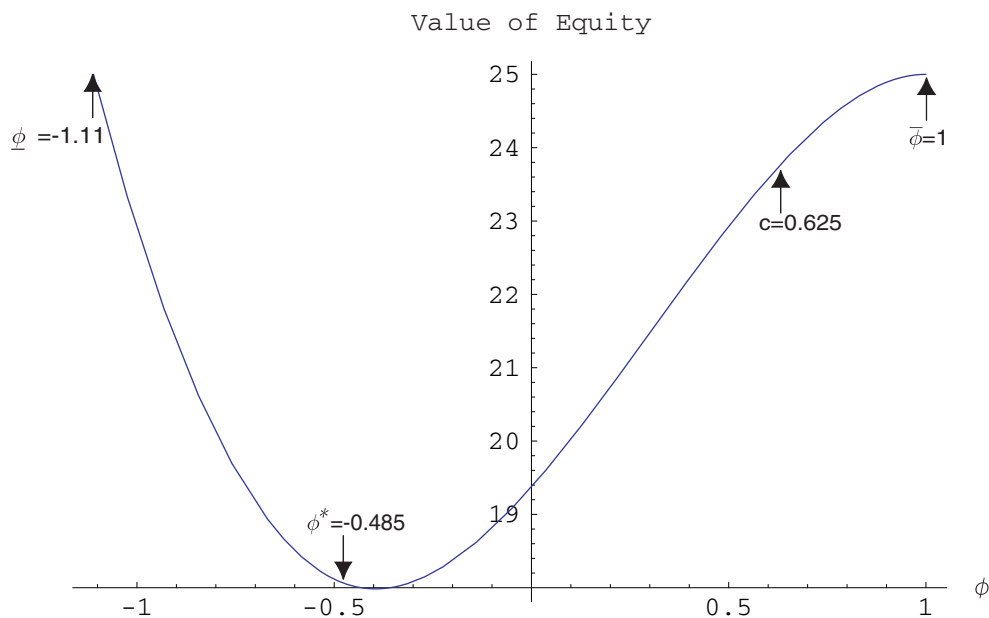
$$c^*(\phi, D) \equiv \{c | \Delta(\phi, D, c) = 0, 0 \leq c < \bar{\phi} + Dr\tau\}$$

and

$$\begin{aligned} \Delta(\phi, D, c) &\equiv \left(2\sqrt{2} \left(\frac{D-K}{1-\tau}\right) r^{3/2} + \left(e^{-\frac{\sqrt{2rc}}{\sigma}} - e^{\frac{\sqrt{2rc}}{\sigma}}\right) \sigma\right) e^{\frac{\sqrt{2r}\left(\left(\frac{K}{1-\tau}-D\right)r+\phi\right)}{\sigma}} - \sigma - \quad (28) \\ &\sqrt{2r} \left(\phi - c + \frac{Dr\tau}{1-\tau}\right) + e^{\frac{2\sqrt{2r}\left(\left(\frac{K}{1-\tau}-D\right)r+\phi\right)}{\sigma}} \left(\sigma - \sqrt{2r} \left(\phi - c + \frac{Dr\tau}{1-\tau}\right)\right). \end{aligned}$$

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 (we will show presently that the assumed level of debt is optimal). The value of equity equals the initial equity investment at inception and at bankruptcy, that is, at any point a new employee is hired and paid their market wage. At all other points the value of equity is below the amount of the initial equity investment. Equity holders still get a fair market return because when the employee is hired, she is hired a wage below her ability — $c = 0.7$ 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 (ϕ) between $\underline{\phi} = -0.96$ and $\bar{\phi} = 1$. The parameters values are listed in Table 1 with an initial debt-to-equity ratio (when $\phi = \bar{\phi}$) of 1.06, which is optimal.



4.2 Employee’s Utility

Given the wage schedule derived in the previous section, we can calculate the employee’s expected utility. Write

$$J(\phi, \bar{\phi}) \equiv E \left[\int_0^\infty e^{-rt} u(c_t) dt \mid \phi_0 = \phi, c_0 = c^*(\bar{\phi}, D) \right].$$

To solve for J explicitly we must make an assumption on preferences. Again we make a restrictive assumption that allows us to derive a closed form expression for J , we assume that

$$u(c) = -e^{-\gamma c} \quad (29)$$

When the firm is not in financial distress and ϕ is below $\bar{\phi}$, wages are constant so the Bellman equation for J is

$$\frac{1}{2}\sigma^2 J_{\phi\phi} - rJ + u(c) = 0. \quad (30)$$

The general solution to this o.d.e. is

$$J(\phi, \bar{\phi}) = A(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + B(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} - \frac{e^{-\gamma c}}{r}. \quad (31)$$

where $c = c^*(\bar{\phi}, D)$. When the firm is in financial distress, the employee makes up the interest payment out of his pocket. Using (22), the firm goes into distress when ϕ drops to ϕ^* . While in distress the managers compensation is $c - (\phi^* - \phi) = \phi + r(K - D(1 - \tau)) = \phi - \underline{\phi}$. So the Bellman equation in this region is

$$\frac{1}{2}\sigma^2 J_{\phi\phi}^f - rJ^f + u(\phi - \underline{\phi}) = 0. \quad (32)$$

The general solution to this o.d.e. is

$$J^f(\phi, c) = C(\bar{\phi})e^{\sqrt{2r}\phi/\sigma} + F(\bar{\phi})e^{-\sqrt{2r}\phi/\sigma} - \frac{e^{-\gamma(\phi - \underline{\phi})}}{r - \frac{\gamma^2\sigma^2}{2}}. \quad (33)$$

Anytime $\phi \leq \underline{\phi}$ the employee loses his job, and cannot find another job at a positive wage so he chooses not to work and gets zero forever (his reservation wage in this model):⁶

$$J(0, 0) = \int_0^\infty e^{-rt} U(0) dt = -1/r$$

The first boundary condition is therefore

$$J^f(\underline{\phi}, \bar{\phi}) = -1/r \quad (34)$$

⁶This follows because at the point of bankruptcy, $\phi < 0$ and $c^*(\phi, D) \leq \phi$ for any D .

At the point of financial distress, ϕ^* , the values and slopes must match:

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

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

The final boundary conditions are

$$J_{\bar{\phi}}(\bar{\phi}, \bar{\phi}) = 0, \quad (37)$$

$$\lim_{\phi, \bar{\phi} \rightarrow \infty} J(\phi, \bar{\phi}) = 0. \quad (38)$$

The first of these is analogous to Equation (20), and the second follows from the fact that, when $\bar{\phi}$ 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 $F(\bar{\phi})$:

$$A(\bar{\phi}) = \int_{\bar{\phi}}^{\infty} \frac{\gamma \left(2e^{\frac{\sqrt{2r}\bar{\phi}}{\sigma}} - e^{\frac{\sqrt{2r}(\bar{\phi}-c^*(\bar{\phi}, D))}{\sigma}} - e^{\frac{\sqrt{2r}(\bar{\phi}+c^*(\bar{\phi}, D))}{\sigma}} \right) \frac{\partial c^*(\bar{\phi}, D)}{\partial \bar{\phi}}}{2e^{c^*(u, D)\gamma} \left(e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} - e^{\frac{2\sqrt{2r}\phi}{\sigma}} \right) r} du \quad (39)$$

$$B(\bar{\phi}) = \frac{1 - \frac{\sqrt{2r}}{\gamma\sigma} - 2e^{c(\gamma + \frac{\sqrt{2r}}{\sigma})} + e^{\frac{2\sqrt{2r}c}{\sigma}} \left(1 + \frac{\sqrt{2r}}{\gamma\sigma} \right) - e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} A(\bar{\phi})}{2e^{c\gamma - \frac{\sqrt{2r}(\bar{\phi}-c)}{\sigma}} r \left(1 - \frac{2r}{\gamma^2\sigma^2} \right)} \quad (40)$$

$$F(\bar{\phi}) = \frac{\gamma\sigma \left(2\sqrt{2}e^{\frac{\sqrt{2r}\bar{\phi}}{\sigma}}\gamma\sigma + e^{\frac{\sqrt{2r}(\bar{\phi}-c)}{\sigma} - c\gamma} (2\sqrt{r} - \sqrt{2}\gamma\sigma) \right)}{2\sqrt{2}r (2r - \gamma^2\sigma^2)} - e^{\frac{2\sqrt{2r}\bar{\phi}}{\sigma}} A(\bar{\phi}) \quad (41)$$

$$C(\bar{\phi}) = -\frac{e^{-\frac{\sqrt{2r}(c+\bar{\phi})}{\sigma}}\gamma\sigma}{2e^{c\gamma}r (\sqrt{2r} + \gamma\sigma)} + A(\bar{\phi}) \quad (42)$$

To plot the employee's utility, we use the parameters listed in Table 1. Our intention here is not to calibrate the model — it is far too simple to capture all the complexities of actual capital structure decisions. However, to evaluate whether the effects we study are economically important, we attempt to pick parameters that are economically realistic. We use a risk aversion coefficient of 2, consistent with values derived from experiments and a tax rate of 30%, close to the U.S. corporate tax rate. Another important parameter is the fraction of revenue attributable to labor versus capital. We pick an initial $\phi_0 = \bar{\phi} = 1$ and

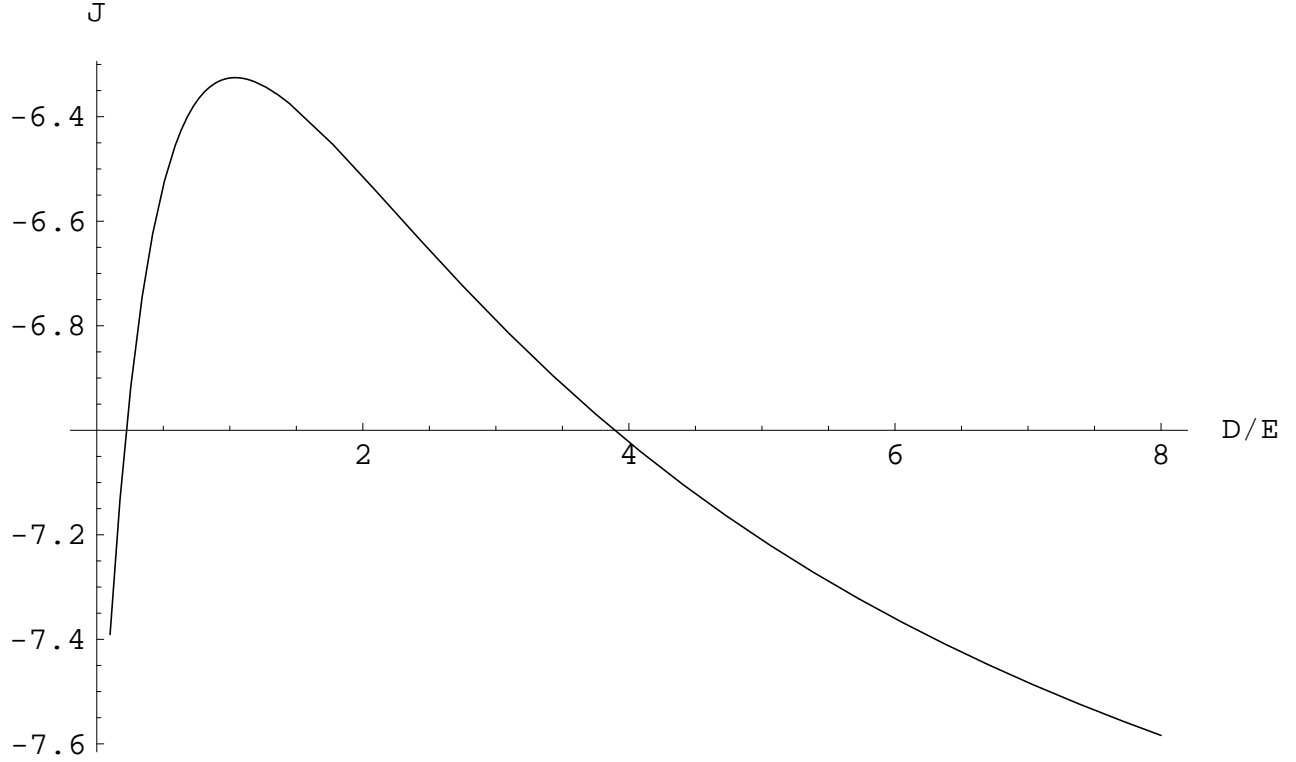
$K = 50$. With $r = 3\%$, this implies that the revenue attributable to capital is $Kr = 1.5$. So at these parameter values, the revenue attributable to labor is two thirds the revenue attributable to capital.

Variable	Symbol	Value
Capital	K	50
Initial ϕ	$\bar{\phi}$	1
Risk Aversion	γ	2
Interest Rate	r	3%
Tax Rate	τ	20%
Standard Deviation	σ	20%

Table 1: **Parameter Values**

Figure 2 plots 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 1.06, the ratio we used to generate Figure 1. What is important about this result is that it implies that the importance of human capital risk is of the same order as taxes, and that with this friction alone can act as a counterbalance to taxes and deliver realistic debt-to-equity ratios. In the next section we will explicitly derive the optimal level of debt by maximizing J .

Figure 2: **Employee's Derived Utility:** The figure shows the employee's utility, J , as a function of the debt-to-equity ratio for the parameters in Table 1.



4.3 The Optimal Level of Debt

To get the optimal level of debt, we maximize the employee's derived utility function. The main complication is that $c^*(\bar{\phi}, D)$ is only defined implicitly by (28). First, write J as an explicit function of D , $J(\phi, \bar{\phi}, D)$. At the point of inception, when $\phi = \bar{\phi}$, compute the gradient of J , that is the full derivative of J with respect to D :

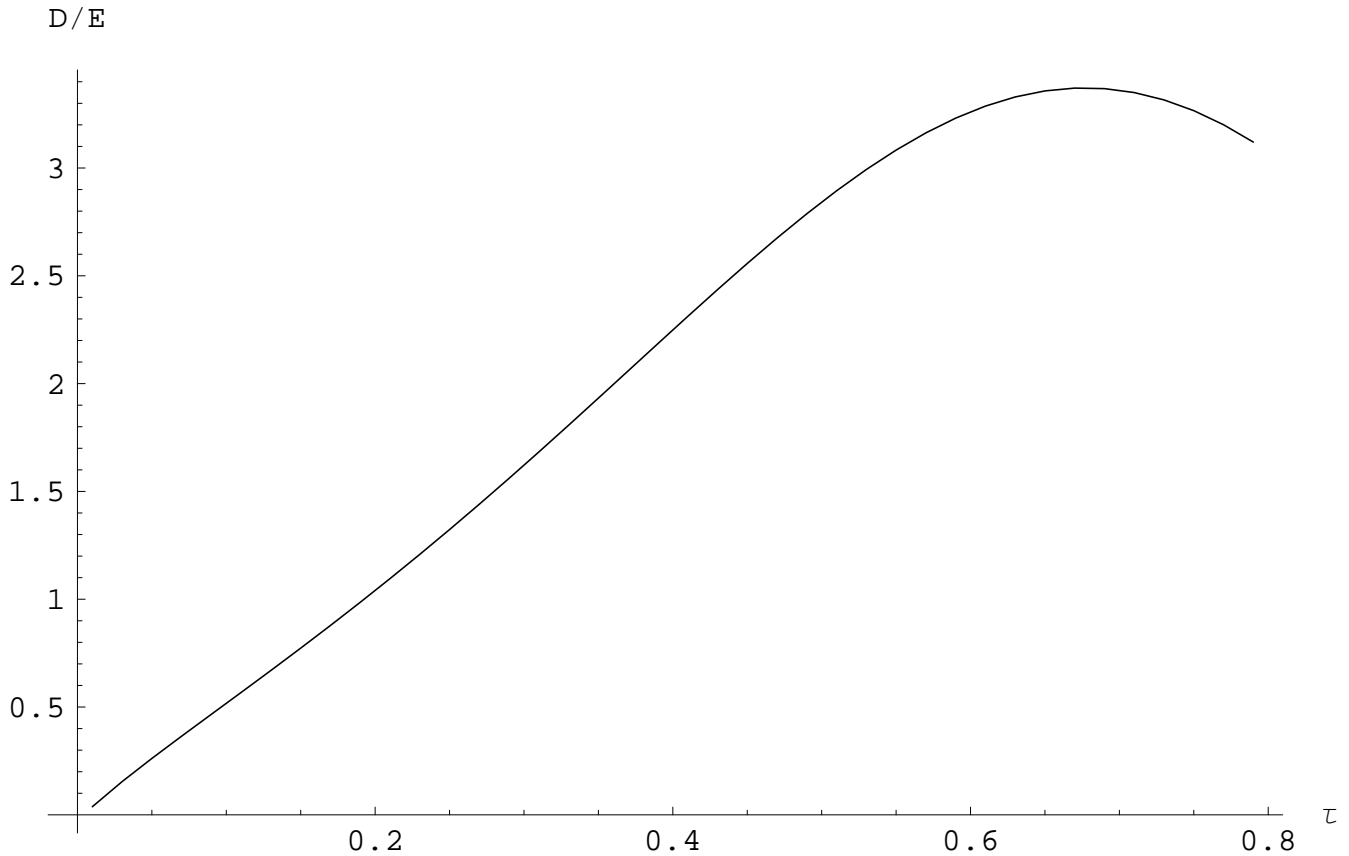
$$\begin{aligned} \frac{d}{dD} J(\bar{\phi}, \bar{\phi}, D) &= \frac{\partial}{\partial D} J(\bar{\phi}, \bar{\phi}, D) + \frac{\partial}{\partial \bar{\phi}} J(\bar{\phi}, \bar{\phi}, D) \frac{\partial \bar{\phi}}{\partial D} \\ &= \frac{\partial}{\partial D} J(\bar{\phi}, \bar{\phi}, D). \end{aligned}$$

where the second line follows from the upper boundary condition (37) on the derived utility function. So the optimal level of debt solves

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

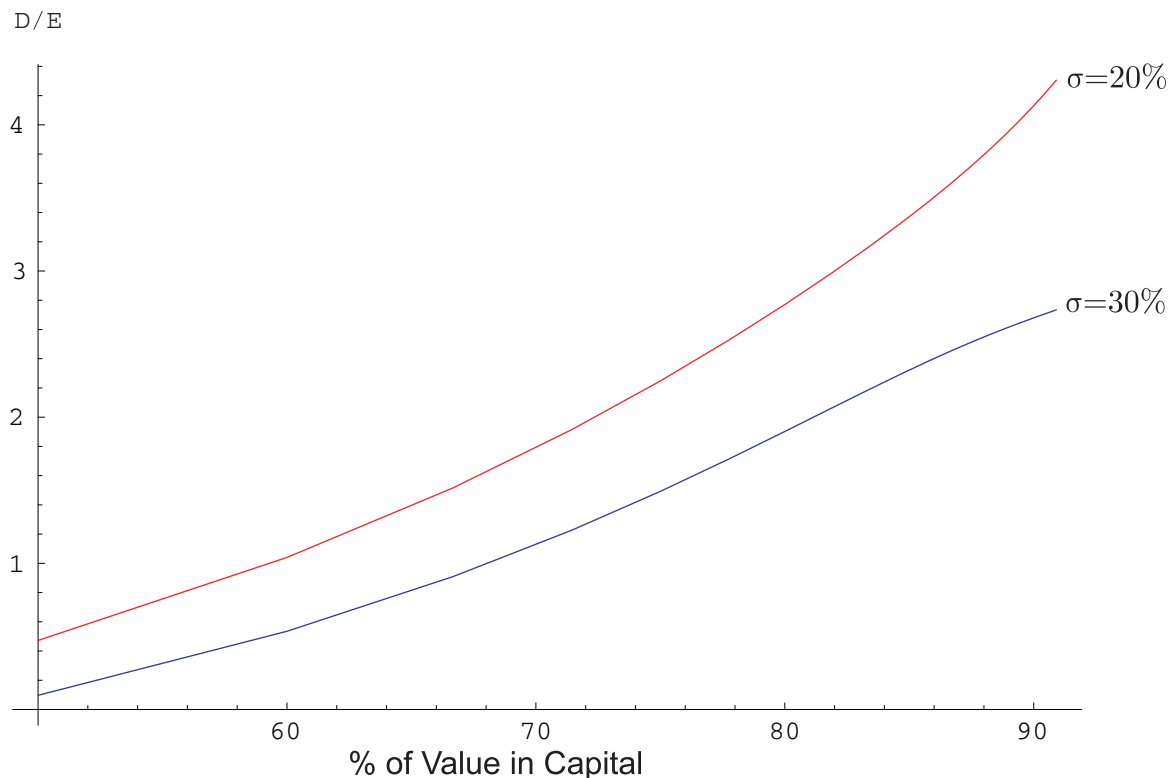
Figure 3 plots the optimal debt-to-equity ratio at inception as a function of the tax rate. Note that the book level of debt is constant in the model, but because the level of debt is determined when $\phi = \bar{\phi}$ the market level of debt varies. Since $V \leq 0$, market leverage is always equal to or less than book leverage. As the plot shows, the presence of human capital risk alone is enough to generate realistic leverage ratios even in the presence of significant tax rates.

Figure 3: Optimal D/E



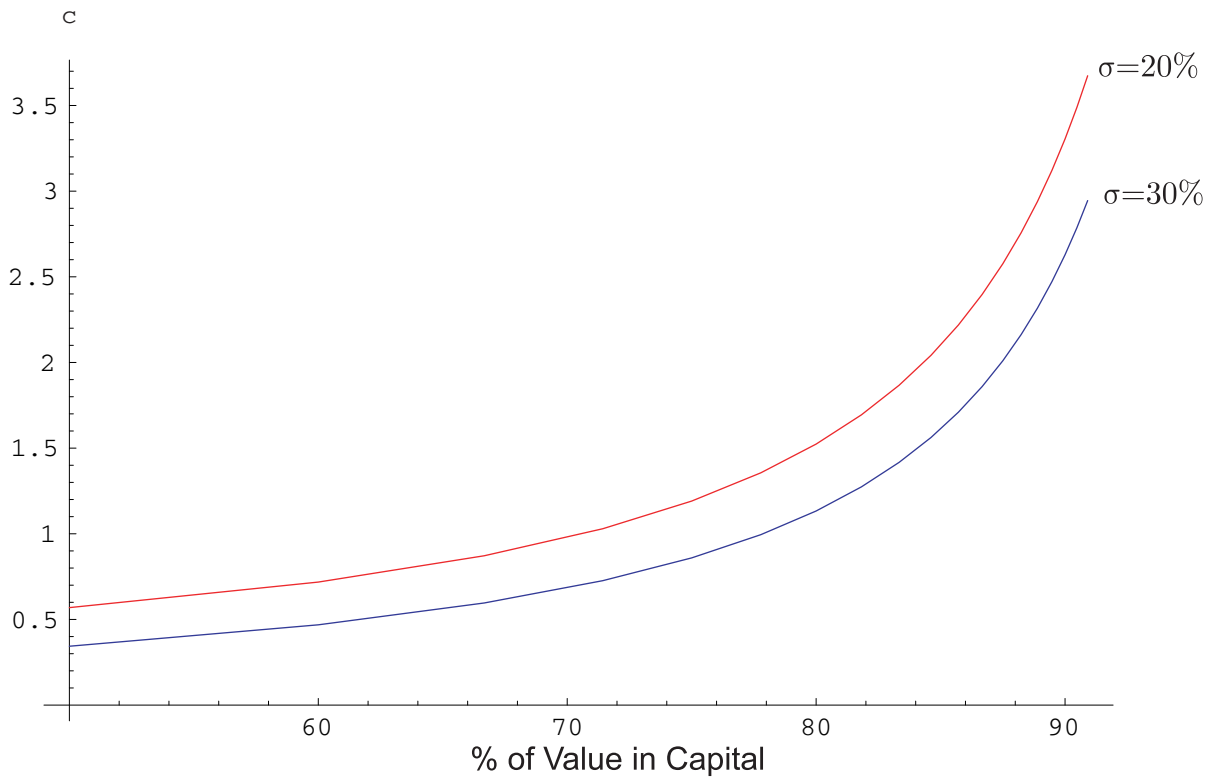
One thing to note is that the optimal level of leverage is a function of the amount of physical capital K . *Ceteris paribus*, more physical capital implies a lower probability of bankruptcy and thus a higher optimal level of debt. Figure 4 plots the optimal debt-to-equity ratio as a function of the fraction of revenues attributable to physical capital. The clear inference is that labor intensive firms should have lower levels of debt, something that is, at least anecdotally, characteristic of the economy. Furthermore, since physical capital intensive firms tend to be large (especially if accounting numbers are used as a measure of firm size), this also delivers the empirical implication that larger firms have higher leverage, which is consistent with the empirical evidence.

Figure 4: **Firm Size and Debt Levels:** The plot shows the optimal debt-to-equity ratio as a function of the percentage of firm value attributable to physical capital, K . Each line corresponds to an economy with different levels of cash flow uncertainty, σ .



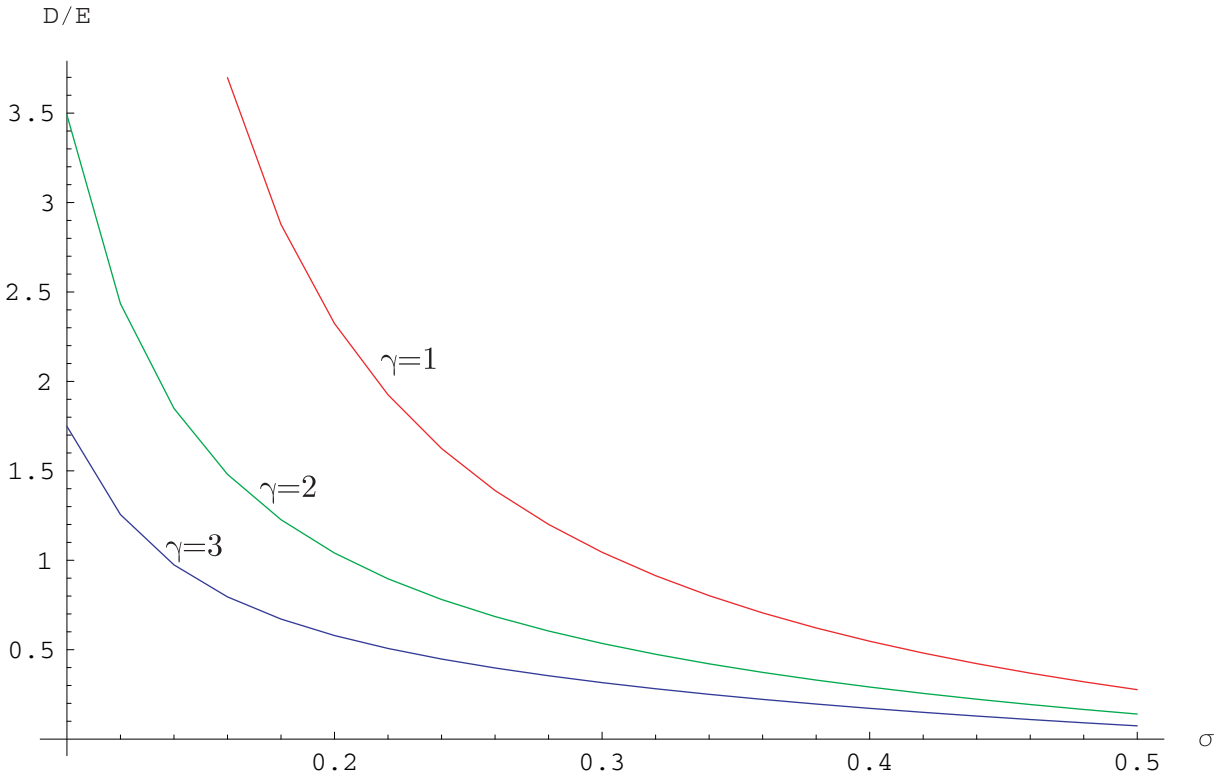
An interesting question is what the cross-sectional variation in the capital versus labor intensity of firms implies about wages. *Ceteris paribus*, labor intensive industries have a higher probability of bankruptcy so there is less scope for risk sharing and one would expect higher wages in these industries. On the other hand, firms in these industries endogenously respond by holding less debt, thus increasing the probability of bankruptcy. Figure 5 shows that the endogenous response is enough to reverse the initial effect — physical capital intensive firms and hence larger firms pay *higher* wages. This is a robust characteristic of the data and is regarded as a puzzle by labor economists (see Brown and Medoff (1989)).

Figure 5: **Physical Capital Intensive Firms Pay Higher Wages:** The plot shows the cross sectional distribution of wages, c , (at optimal debt levels) for different levels of physical capital. Each line corresponds to an economy with differing levels of cash flow uncertainty, σ .



We next turn to the effect of uncertainty on the debt-to-equity ratio. Intuitively, the effect is clear. More uncertainty implies more risk, so the endogenous response is to reduce debt levels, as Figure 6 demonstrates.

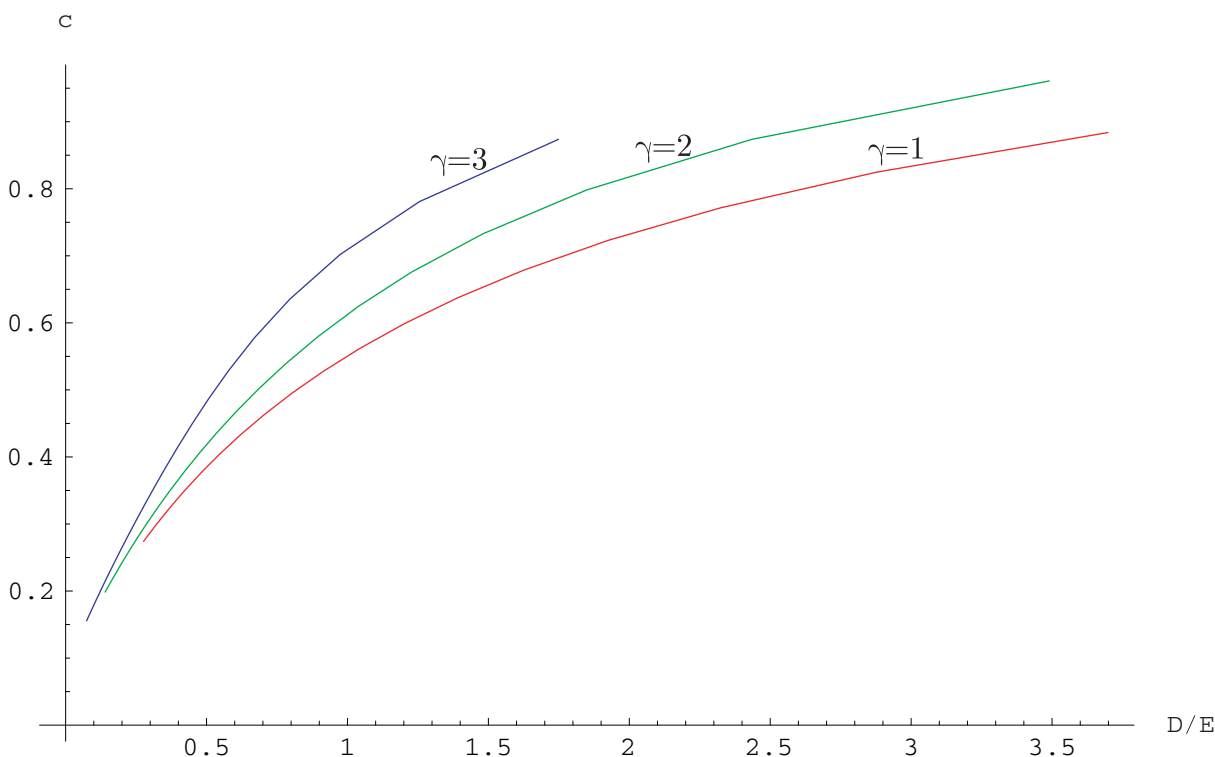
Figure 6: **Optimal D/E as a Function of Cash Flow Uncertainty:** The plot shows the optimal debt-to-equity ratio as a function of the level of cash flow uncertainty, σ at three different levels of risk aversion, γ .



An important driver of underlying cash flow uncertainty is firm age — younger firms face higher levels of uncertainty. Therefore an immediate implication of this result is that younger firms should maintain lower leverage levels, another robust characteristic of the data. Growth firms also have higher uncertainty, which again reproduces the empirical finding that growth firms have less leverage.

The level of uncertainty varies across industries, so this is another driver of cross-sectional variation in wages. Figure 7 plots the optimal wages of firms as a function of the debt-to-equity ratio. It shows that at these parameter values, firms with higher leverage pay higher wages.

Figure 7: **Firms with Higher Leverage Pay Higher Wages:** The plot shows the cross sectional distribution of wages, c , and debt levels for firms with different levels of cash flow uncertainty. Each line corresponds to an economy with agents of differing levels of risk aversion, γ .



5 Conclusion

According to the dominant corporate finance paradigm capital structure choice is a tradeoff decision. Benefits associated with the level of debt are traded off against the costs of debt. There is broad agreement amongst academics and practitioners on what the benefits of debt are. Most countries' tax codes provide a motive for issuing debt since equity income is taxed twice whereas interest income is taxed only once. In addition to the tax motive, there are other plausible reasons why debt may be beneficial, for example due to its strategic effects in an oligopolistic product market or in a bargaining situation with labor unions.

However, identifying the main costs of debt remains one of the biggest puzzles in corporate finance. Most existing papers on capital structure require sizeable bankruptcy costs to act as counterweight to the tax advantage of debt. However, empirical evidence does not support the notion that the firm (or its investors) bear substantial bankruptcy costs.

In contrast to the limited importance of bankruptcy costs borne by a firm's investors, the

anecdotal evidence is that bankruptcy costs borne by employees of the firm are important. Yet, these bankruptcy costs have not received attention in the finance literature. In this paper we argue that it is not the firm’s investors’ bankruptcy costs that matter for capital structure choice, but bankruptcy costs borne by the firm’s employees. 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 benefit of debt.

Analyzing the human cost of bankruptcy generates a rich set of new empirical predictions. First, we find that for reasonable parameters values, the model produces moderate leverage ratios, implying an apparent “underutilization” of debt tax shields if these costs are ignored. Second, in our model capital intensive firms have higher optimal leverage ratios. Third, these firms also pay higher wages. Fourth, riskier firms choose lower leverage ratios. Finally, highly levered firms pay higher wages to their employees.

Our analysis highlights the role of bankruptcy as an event which forces recontracting. All explicit and implicit contracts become worthless in bankruptcy, and this has implications for optimal capital structure. There may be other important events, such as takeovers, which trigger recontracting. Like bankruptcy, a takeover frequently means that the target ceases to exist as a legal entity, which is likely to make implicit, and possibly also explicit contracts worthless, as documented by Pontiff, Shleifer, and Weisbach (1990). Extending our model to analyze human capital uncertainty in a model with takeovers may shed new light on the tradeoffs when choosing whether or not to introduce anti-takeover measures.

In deriving our results, we have made several simplifying assumptions. Relaxing these assumptions would lead to interesting extensions. 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, issue new or retire old debt and equity is likely to yield interesting new insights. After their contracts are determined, managers in our model would generally be reluctant to pay out dividends, preferring instead to pay down debt, because this decreases the chance of bankruptcy and therefore increases the human capital insurance that the labor contract provides. Yet, *ex ante*, the manager must commit to pay out some dividends, otherwise equity holders cannot realize a fair return on their investment. In addition they must maintain levels of debt that justify the tax shields implicit in the manager’s compensation. Therefore, in principal, the compensation contract, dividend policy and dynamic capital structure policy should be jointly determined. At this stage, deriving a model that would endogenize all three decisions is daunting, however, such a model is likely to yield important insights that might explain the seemingly puzzling behavior documented in Welch (2004).

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 Proof of Proposition 1

Proof: It is sufficient to verify that the contract given in the proposition maximizes the Lagrangian for program (6)–(9), and satisfies the complementary slackness conditions. The Lagrangian can be written (after first multiplying the constraints (8) and (9) by the unconditional probability of the respective ϕ^t , multiplying (9) by powers of β , and then collecting terms) as follows:

$$\max_{c_t} E_0 \int_0^T \beta^t [u(c_t) + \lambda^t((\phi_t - c_t)(1 - \tau) + Dr\tau) + \mu_t((\phi_t - c_t)(1 - \tau) - r[K - D(1 - \tau)])] dt, \quad (43)$$

where

$$\lambda^t \equiv \int_0^t \lambda_s(\phi^s) dt, \quad (44)$$

and $\lambda_s(\phi^s)$ is the Lagrange multiplier corresponding to Equation (8). The first order conditions take the form

$$u'(c_t) = \lambda^t - \mu_t. \quad (45)$$

Assume c_t is given by Equation (10), and define Lagrange multipliers

$$\lambda^t = u' \left(\max_{0 \leq s \leq t} \{c^*(\phi_s, s)\} \right), \quad (46)$$

$$\lambda_t = \frac{d\lambda^t}{dt}, \quad (47)$$

$$\mu_t = u' \left(\max_{0 \leq s \leq t} \{c^*(\phi_s, s)\} \right) - u'(c_t). \quad (48)$$

These immediately satisfy the first order condition, Equation (45). Since the maximum inside the bracket in Equation (46) is always increasing in t , Equation (47) immediately tells us that

$$\lambda_t \begin{cases} \leq 0 & \text{when } c_t = c^*(\phi_t, t), \\ = 0 & \text{otherwise.} \end{cases} \quad (49)$$

Also, since at all times

$$c_t \leq \max_{0 \leq s \leq t} \{c^*(\phi_s, s)\},$$

Equation (48) immediately tells us that

$$\mu_t \begin{cases} \leq 0 & \text{when } c_t = \max_{0 \leq s \leq t} \{c^*(\phi_s, s)\}, \\ = 0 & \text{otherwise.} \end{cases} \quad (50)$$

The contract defined by Equation (10), together with these Lagrange multipliers, thus maximizes the Lagrangian (by concavity, this is a consequence of its satisfying the first order conditions), and (together with the Lagrange multipliers) satisfies the complementary slackness conditions. By weak duality, the contract is also the solution to the original program, Equations (6)–(9).

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