Corporate Governance and the Coordination Channel of Debt Capacity

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Abstract

We propose a theory in which debt capacity depends on creditor coordination and corporate governance serves as a coordination device. When creditors price debt under rational expectations, strategic complementarity in beliefs generates a stable low-default equilibrium and a critical threshold beyond which no feasible lending terms exist. At intermediate leverage, this threshold creates fragility: small sentiment shocks can trigger credit market breakdown. Strong governance increases the penalty shareholders bear upon default, weakening the feedback from creditor pessimism to actual default probability. This expands sustainable debt capacity and reduces vulnerability to coordination failure. The model predicts that governance value peaks at intermediate leverage where fragility is greatest, that better-governed firms have lower expected financing costs conditional on cash-flow risk, and that credit spreads jump discontinuously when leverage enters the crisis zone. Governance effects on spread volatility are non-monotonic, a distinctive prediction of the coordination channel and absent from agency based theories. Calibrations show governance effects on debt capacity comparable in magnitude to tax shield and bankruptcy cost channels.

JEL Classification: G32, G33, G34, D82

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1 Introduction

In September 2017, Toys "R" Us filed for Chapter 11 bankruptcy with $5 billion in debt. The direct cause was not operational failure. Instead it was a coordination failure among creditors. Suppliers, fearing collapse, simultaneously tightened credit terms and demanded cash on delivery, that pushed the company into insolvency despite positive EBITDA of $530 million[1]. A year later, General Electric saw its commercial paper spreads spike from 45 to over 200 basis points following a rating downgrade. This happened despite maintaining $115 billion in revenue and market leadership in segments of aviation and healthcare [2]. Neither firm had operational collapse before these credit events. Yet both saw creditor sentiment shift abruptly, with self-reinforcing dynamics. The fears about viability triggered actions that made collapse more likely. These episodes point to a discontinuous pattern that is difficult to reconcile with standard capital structure theories.

We are motivated by more than just the Toys "R" Us and General Electric problems. Credit spread movements frequently exceed structural model predictions, with positively skewed residuals (Schaefer and Strebulaev, 2008). Excess bond premiums spike during crises and predicts real activity beyond what default risk alone suggests (Gilchrist and Zakrajšek, 2012). There is default clustering in excess of that predicted by correlated fundamentals (Giesecke et al., 2011). These too fit uneasily with standard theory.

This paper proposes that corporate debt capacity depends on creditor coordination and that corporate governance serves as a coordination device. We develop a model in which rational expectations pricing of debt creates strategic complementarity in creditor beliefs: pessimistic expectations raise the required face value of debt, which increases the default threshold, raising actual default probability and potentially confirming the initial pessimism. For intermediate leverage, this feedback generates fragility. A stable low default equilibrium coexists with a critical belief threshold beyond which no feasible lending terms exist. Corporate governance weakens this feedback by raising the penalty shareholders bear upon default. That expands the sustainable debt capacity and reduces vulnerability to coordination failure.

The coordination channel generates four predictions that distinguish it from agency based theories of governance and capital structure (Jensen and Meckling, 1976; Jensen, 1986). First, the marginal value of governance peaks at intermediate leverage where coordination fragility is great-

[1] In re: Toys "R" Us, Inc., et al., Case No. 17-34667, Declaration of David Brandon (Bankr. E.D. Va. 2017). https://restructuring.ra.kroll.com/toysrus/

[2] General Electric Company, 2018 Annual Report (Form 10-K). https://www.sec.gov/Archives/edgar/data/40545/000004054519000011/ge10k2018.htm

est, not at the high leverage emphasized by asset substitution theory or the low leverage emphasized by free cash flow theory. Second, better-governed firms have lower expected financing costs conditional on cash-flow risk, with the effect operating through equilibrium selection rather than through reduced asset volatility or improved recovery. Third, expected financing costs increase discretely when leverage crosses the crisis zone boundary, a discontinuity absent from smooth tradeoff models. Fourth, the relationship between governance quality and credit spread volatility is non-monotonic: firms with very weak governance exhibit low spread volatility because adverse coordination is near-certain, volatility peaks at intermediate governance where equilibrium uncertainty is maximal, and only sufficiently strong governance reduces volatility by concentrating outcomes on the favorable state. This non-monotonic pattern is unique to the coordination framework.

Our model has three ingredients. A risk-neutral firm finances investment with debt priced by competitive creditors under rational expectations. Shareholders observe realized cash flow and choose whether to repay or default, injecting equity to cover shortfalls up to a governance-determined default penalty $\Psi(\gamma)$. The break-even condition linking creditor beliefs to equilibrium face value, combined with the default threshold $X^* = D - \Psi(\gamma)$, defines a mapping from believed to actual default probabilities. Fixed points of this mapping are rational expectations equilibria.

When investment is low, the mapping is a contraction and a unique stable equilibrium exists. As leverage increases, the repricing gap—the difference between the promised payment in repayment states and expected recovery in default—widens, strengthening the feedback between beliefs and outcomes. Beyond a critical investment level $I^L(\gamma)$, the mapping's slope exceeds unity at some beliefs, and a second fixed point appears: an unstable critical threshold p^{crit}. Crucially, when investment exceeds the maximum recoverable amount $\alpha\mu$, the break-even condition has no solution for high default probabilities. This feasibility constraint rules out a third stable equilibrium at high default rates. The result is a two-equilibrium structure: a stable low-default outcome and an unstable threshold beyond which credit markets break down entirely. Crossing p^{crit} leads not to convergence to a high-stress stable state but to a complete loss of credit market access.

Corporate governance affects this structure through two channels. First, higher $\Psi(\gamma)$ lowers the default threshold for any face value, reducing the slope of the equilibrium mapping and weakening the self-reinforcing feedback. This expands the upper crisis zone boundary $I^H(\gamma)$, the maximum leverage the firm can sustain. The effect is quantitatively significant: in the calibration, moving from weak to strong governance expands maximum sustainable leverage by 7.5%, comparable

to the effects of tax-rate changes estimated by Heider and Ljungqvist (2015). Second, governance serves as a focal point for equilibrium selection. We model the probability $\pi(\gamma)$ that creditors coordinate on the favorable equilibrium as increasing in governance quality. This reduced form is microfounded in the Online Appendix using a global game among creditors in the tradition of Morris and Shin (1998) and Goldstein and Pauzner (2005). Creditors receive private signals about the default penalty, and higher $\Psi(\gamma)$ enlarges the basin of attraction of the low-default equilibrium, raising the probability of favorable coordination.

The calibration confirms that the coordination channel is economically important and operates almost entirely through equilibrium selection. Stable-equilibrium firm value varies by only 1.3% across governance levels, while expected firm value—accounting for the probability of credit market breakdown—increases by 165%. Approximately 95% of the improvement comes from shifting probability weight toward the operating outcome rather than from within-equilibrium distress cost reduction. This dominance of the extensive margin over the intensive margin distinguishes the coordination channel from agency theories, where governance operates through within-firm improvements in asset risk or cash-flow deployment.

We contribute to several literatures. Within capital structure theory, we show that creditor coordination introduces fragility absent from tradeoff models (Kraus and Litzenberger, 1973; Fischer et al., 1989), agency models (Jensen and Meckling, 1976; Jensen, 1986), and structural credit models (Merton, 1974; Leland, 1994). These frameworks predict smooth relationships between leverage and credit spreads; our coordination mechanism generates discontinuities and regime shifts. The model helps explain why many firms appear underleveraged relative to standard tax-benefit calculations (Graham, 2000; Strebulaev and Yang, 2013). Firms with moderate governance rationally avoid the crisis zone despite having fundamentals that could support higher leverage at the stable equilibrium.

Within the governance literature, we identify a channel distinct from traditional agency costs. Prior work emphasizes that governance mitigates shareholder-creditor conflicts through reduced asset substitution or improved monitoring (Anderson et al., 2004). Our mechanism operates differently: governance disciplines the strategic default decision, reducing the sensitivity of actual default to creditor beliefs. This predicts governance effects concentrated at intermediate leverage, consistent with Favara et al. (2012), rather than at the low or high leverage levels emphasized by agency theories.

Within the coordination and global games literature, we complement models of bank runs

(Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005), currency crises (Obstfeld, 1996; Morris and Shin, 1998), and sovereign debt fragility (Calvo, 1988; Cole and Kehoe, 2000) with a focus on coordination in corporate debt markets. Our model shares the global-games insight that fundamentals determine which equilibrium is selected, but differs in an important structural respect. Standard global-games models with dominance regions typically select a unique equilibrium. In our setting, uniqueness obtains in the safe zone where the mapping is a contraction. In the crisis zone, the feasibility constraint on the break-even condition generates a two-equilibrium structure—one stable and one unstable—rather than the three-equilibrium structure common in coordination models without participation constraints. The unstable equilibrium marks a cliff rather than a watershed between two stable outcomes. Unlike rollover risk models that generate coordination failures through maturity structure (He and Xiong, 2012; Brunnermeier and Oehmke, 2013), our mechanism operates with single-period debt, shifting attention from maturity choice to governance quality as the key determinant of fragility.

The remainder of the paper proceeds as follows. Section 2 presents the model. Section 3 characterizes equilibria and derives the two-equilibrium structure. Section 4 analyzes crisis zone boundaries. Section 5 demonstrates that governance monotonically expands debt capacity and derives the marginal value of governance improvements. Section 6 compares predictions to agency theories. Section 7 calibrates the model. Section 8 states empirical implications as regression specifications. Section 9 concludes. Proofs appear in the Appendix, with extended technical material and alternative specifications in the Online Appendix.

2 Model

A risk-neutral firm requires external financing for an investment project. The firm chooses governance quality before approaching credit markets. Creditors, observing governance, set lending terms that reflect rational expectations about default. We characterize the resulting equilibria and show that governance affects not only default probabilities but also whether multiple self-fulfilling equilibria exist.

2.1 Environment

Consider two dates, $t \in \{0, 1\}$, with all agents discounting at a risk-free rate normalized to zero. At date 0 the firm requires investment $I > 0$ to operate a project that generates random cash flow

X at date 1, where $X \sim N(\mu, \sigma^2)$ with $\mu > 0$ and $\mu > 3\sigma$.

The firm finances investment entirely with debt. Competitive creditors lend I at date 0 in exchange for a promised payment D at date 1. If the firm repays, the interest deduction provides a tax shield $\tau(D - I)$ where $\tau \in (0, 1)$ is the corporate tax rate.

Before raising debt, the firm publicly commits to governance quality $\gamma \in [0, 1]$ at cost $C(\gamma)$, where $C(0) = 0$, $C'(\gamma) > 0$, and $C''(\gamma) > 0$. Both governance and investment are observable to creditors.

2.2 Governance and Default Penalties

Governance quality determines a default penalty $\Psi(\gamma)$ borne by shareholders if the firm enters bankruptcy. This penalty captures costs that fall on shareholders personally rather than on the firm's assets: reputation damage, acceleration of personal guarantees, loss of relationship-specific rents, and potential director liability. We assume $\Psi(0) = 0$, $\Psi'(\gamma) > 0$, $\Psi''(\gamma) \geq 0$, and $\Psi(\gamma) < \mu$ for all γ.

The assumption that default penalties increase with governance reflects several mechanisms. Stronger covenants create more obligations that trigger upon default. Greater board independence increases director exposure to fiduciary duty claims. More transparent disclosure makes reputation damage from default more severe. The bound $\Psi(\gamma) < \mu$ ensures the default threshold defined below is positive.

Governance also affects equilibrium selection when multiple equilibria exist. Let $\pi(\gamma)$ denote the probability that creditors coordinate on the favorable equilibrium, with $\pi(0) = 0$, $\pi(1) = 1$, and $\pi'(\gamma) > 0$. This reduced-form specification captures the idea that governance institutions serve as focal points: strong governance signals commitment to repayment, making optimistic beliefs focal. Online Appendix OA.5 provides a global-game microfoundation in the tradition of Morris and Shin (1998) and Goldstein and Pauzner (2005), showing that higher $\Psi(\gamma)$ enlarges the basin of attraction of the low-default equilibrium when creditors receive dispersed private signals about the penalty.

2.3 Bankruptcy and Recovery

If the firm defaults with cash flow X, total value available is αX where $\alpha \in (0, 1)$ is the recovery rate. The fraction $(1 - \alpha)$ represents deadweight losses from legal fees, operational disruptions,

and asset fire sales. Empirical estimates of direct and indirect costs imply α between 0.60 and 0.85 (Andrade and Kaplan, 1998; Bris et al., 2006; Davydenko and Franks, 2008). Creditors hold senior claims: under absolute priority, shareholders receive nothing from the bankruptcy estate until creditors are paid in full.[3]

2.4 The Repayment Decision

At date 1, shareholders observe X and decide whether to repay or default. We assume shareholders can inject equity at fair value to cover cash shortfalls, an assumption standard in structural credit models since Leland (1994) and most applicable to firms with cash reserves, credit facilities, or equity market access.[4]

Shareholders face three cases. If $X \geq D$, cash flow covers the promised payment. If $D - \Psi(\gamma) \leq X < D$, the shortfall $D - X$ is less than the default penalty $\Psi(\gamma)$, so shareholders prefer to inject $D - X$ and repay. If $X < D - \Psi(\gamma)$, the shortfall exceeds the penalty and shareholders prefer default. The default threshold is therefore

$$X^*(D, \gamma) = D - \Psi(\gamma). \tag{1}$$

Higher debt raises the threshold one-for-one ($\partial X^*/\partial D = 1$). Better governance lowers it ($\partial X^*/\partial \gamma = -\Psi'(\gamma) < 0$), making shareholders willing to cover larger shortfalls.

2.5 Creditor Break-Even

Competitive, risk-neutral creditors lend I at date 0 and receive either D (repayment) or αX (default). The break-even condition equates investment to expected repayment:

$$I = (1 - p_d)\, D + p_d \cdot \alpha[\mu - \sigma\lambda(z^*)], \tag{2}$$

where $p_d = \Phi(z^*)$ is the default probability, $z^* = (D - \Psi(\gamma) - \mu)/\sigma$ is the standardized threshold, and $\lambda(z) = \phi(z)/\Phi(z)$ is the inverse Mills ratio.[5] In a rational expectations equilibrium, the

[3] Modern evidence supports this assumption. Ayotte and Morrison (2009) find that shareholders received positive payouts in only 9% of post-2000 cases where creditors were impaired. Relaxing absolute priority would amplify the main results by increasing threshold sensitivity to face value.

[4] For severely constrained firms, the effective default threshold would be higher (closer to D), weakening the governance channel.

[5] The truncated normal expectation $\mathbb{E}[X \mid X < X^*] = \mu - \sigma\lambda(z^*)$ uses the left-tail form. Heckman (1979) provides the classical derivation for the symmetric right-tail case.

believed probability p_d must equal the actual probability $\Phi(z^*)$ generated by the face value that beliefs induce.

This equation is the source of potential multiplicity. Suppose creditors become more pessimistic, believing default probability is higher. To compensate, they demand higher D. But higher D raises $X^* = D - \Psi(\gamma)$, increasing actual default probability. If this feedback is sufficiently strong, both optimistic and pessimistic beliefs can be self-confirming.

Implicit differentiation of (2) yields the sensitivity of face value to beliefs:

$$\frac{\partial D}{\partial p} = \frac{D - \alpha[\mu - \sigma\lambda(z^*)]}{1 - p + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]}. \tag{3}$$

The numerator is the *repricing gap*: the difference between face value received in repayment states and expected recovery in default states. The denominator is positive (Lemma 1 in the Appendix), ensuring $\partial D/\partial p > 0$. Similarly, the sensitivity of face value to governance at fixed beliefs is

$$\left.\frac{\partial D}{\partial \gamma}\right|_{I,p} = \frac{p\,\alpha\,\lambda(z^*)[\lambda(z^*) + z^*]\;\Psi'(\gamma)}{(1-p) + p\,\alpha\,\lambda(z^*)[\lambda(z^*) + z^*]} > 0. \tag{4}$$

Face value increases with governance at fixed beliefs because higher $\Psi(\gamma)$ lowers the default threshold, worsening expected recovery conditional on default and requiring creditors to charge more to break even.

2.6 Feasibility of the Break-Even Condition

The break-even condition (2) does not have a solution for all (I, p, γ). As $p \to 1$, the condition becomes $I = \alpha\,\mathbb{E}[X \mid X < X^*]$, and since $\mathbb{E}[X \mid X < X^*]$ is bounded above by μ, the maximum investment that creditors can finance when they expect certain default is

$$I^* \equiv \alpha\mu. \tag{5}$$

When $I > I^*$, no face value D can satisfy the break-even condition for default probabilities close to one. This feasibility constraint limits the equilibrium mapping to a restricted domain and rules out high-default stable equilibria—a point we develop formally in Section 3.4.

2.7 Firm Value

Expected firm value in a given equilibrium is

$$V_F = \mu - I + (1 - p_d)\,\tau(D - I) - C(\gamma) - p_d\,(1 - \alpha)\,\mathbb{E}[X \mid X < X^*] - p_d\,\Psi(\gamma). \tag{6}$$

The terms are, in order: expected cash flow net of investment, expected tax shield, governance cost, expected bankruptcy deadweight loss, and expected default penalty. The compact representation

$$V_F = \mu - I + \tau(D - I) - C(\gamma) - p_d\,\widetilde{DC}, \tag{7}$$

where $\widetilde{DC} = (1 - \alpha)\,\mathbb{E}[X \mid X < X^*] + \Psi(\gamma) + \tau(D - I)$ is the net distress cost per unit of default probability, is used in several proofs.

2.8 Equilibrium Definition

Definition 1. A *rational expectations equilibrium* for given (γ, I) consists of face value D, default probability p_d, and default threshold X^* satisfying:

1. Shareholders repay if and only if $X \geq X^* = D - \Psi(\gamma)$.
2. Creditors break even: equation (2) holds.
3. Beliefs are rational: $p_d = \Phi((D - \Psi(\gamma) - \mu)/\sigma)$.

The consistency requirement does not guarantee uniqueness. For some (γ, I) pairs, both low and high values of (D, p_d) satisfy all three conditions simultaneously. Section 3 characterizes when multiplicity arises and Section 5 shows how governance affects it.

3 Equilibrium Characterization

This section characterizes the equilibrium structure for given firm choices (γ, I). The rational expectations requirement generates strategic complementarity in creditor beliefs: pessimistic expectations raise required face value, increasing actual default probability and potentially confirming the pessimism. We establish existence, derive conditions for multiplicity, and show that the crisis zone contains exactly two equilibria—one stable and one unstable.

3.1 Equilibria as Fixed Points

For given (I, γ), an equilibrium is a fixed point of the mapping from creditor beliefs to actual default probabilities. Define $T : [0, \bar{p}] \to [0, 1]$ by

$$T(p;\, I, \gamma) = \Phi\left(\frac{D(p) - \Psi(\gamma) - \mu}{\sigma}\right), \tag{8}$$

where $D(p)$ solves the break-even condition (2) for believed default probability p, and $\bar{p}(I, \gamma)$ is the supremum of default probabilities for which the break-even condition has a solution (Lemma 3). An equilibrium satisfies $p_d = T(p_d;\, I, \gamma)$.

When $I \leq \alpha\mu$, the mapping is defined on the entire unit interval ($\bar{p} = 1$). When $I > \alpha\mu$, the break-even condition has no solution for p sufficiently close to 1, because expected recovery $\alpha\, \mathbb{E}[X \mid X < X^*]$ is bounded above by $\alpha\mu$ and cannot cover the investment. This feasibility constraint restricts the domain to $[0, \bar{p})$ with $\bar{p} < 1$ and plays a central role in determining the equilibrium structure.

3.2 The Feedback Mechanism

The slope of the mapping determines the strength of feedback between beliefs and outcomes. Applying the chain rule to (8),

$$\frac{\partial T}{\partial p} = \frac{\phi(z^*)}{\sigma} \cdot \frac{\partial D}{\partial p}, \tag{9}$$

where $z^* = (D - \Psi(\gamma) - \mu)/\sigma$. The first factor measures how sensitively default probability responds to threshold changes. The second measures how strongly creditor pessimism affects required face value.

Implicit differentiation of the break-even condition (2) yields

$$\frac{\partial D}{\partial p} = \frac{D - \alpha[\mu - \sigma\lambda(z^*)]}{1 - p + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]}, \tag{10}$$

using $d\lambda/dz = -\lambda(z)[\lambda(z) + z]$ from Lemma 1. The numerator is the *repricing gap*: the difference between face value received in repayment states and expected recovery in default states. The denominator is positive by Lemma 1, providing stability.

Combining (9) and (10),

$$\frac{\partial T}{\partial p} = \frac{\phi(z^*)}{\sigma} \cdot \frac{D - \alpha[\mu - \sigma\lambda(z^*)]}{1 - p + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]}. \tag{11}$$

Strong feedback ($\partial T/\partial p > 1$) occurs when the repricing gap is large relative to the stabilizing term—low recovery rates, high cash flow density near the threshold, and intermediate default probabilities. When $\partial T/\partial p < 1$ everywhere, the mapping is a contraction and the equilibrium is unique.

3.3 Existence and Stability

Proposition 1. *For any (γ, I) satisfying $I < \alpha\mu$, at least one equilibrium exists. The equilibrium is stable if $\partial T/\partial p < 1$ at the fixed point.*

Proof. Define $F(p) = T(p) - p$ on $[0, 1]$. At $p = 0$, creditors set $D(0) = I$ and actual default probability is $T(0) = \Phi((I - \Psi(\gamma) - \mu)/\sigma) > 0$, so $F(0) > 0$. At $p = 1$, the break-even condition yields $T(1) < 1$, so $F(1) < 0$. Continuity and the Intermediate Value Theorem establish existence. Stability follows from standard fixed-point analysis: if $\partial T/\partial p|_{p^*} < 1$, small belief perturbations generate smaller outcome changes, ensuring convergence back to p^*. □

3.4 Two-Equilibrium Structure

The feasibility constraint identified in Section 3.1 shapes the equilibrium structure in a distinctive way. Standard coordination models often feature three equilibria—two stable outcomes separated by an unstable threshold—so that crossing the threshold leads to convergence to a high-stress but sustainable state. In our setting, when $I > \alpha\mu$, the break-even condition has no solution for high default probabilities, ruling out any stable equilibrium at high default rates.

Assumption 1 (Slope Unimodality). For given (I, γ) with $I > I^L(\gamma)$, the slope $\partial T/\partial p$ is unimodal in p on the domain of T: there exists a unique $\hat{p}(I, \gamma)$ such that $\partial T/\partial p$ is increasing for $p < \hat{p}$ and decreasing for $p > \hat{p}$.

The economic content is that two forces governing feedback strength—the normal density at the default threshold and the repricing gap—interact to produce a single region of maximum amplification. At low p, both forces are weak. At high p, the repricing gap is wide but the density decays exponentially, overwhelming the algebraic growth of the gap. We verify Assumption 1 numerically across 2,500 parameter configurations in Online Appendix OA.4.

Proposition 2 (Two-Equilibrium Structure)**.** *Under Assumption 1, for (I, γ) satisfying $I > I^L(\gamma)$ and $I > \alpha\mu$:*

1. *Exactly two rational expectations equilibria exist: a stable equilibrium at p^L with $\partial T/\partial p|_{p^L} < 1$, and an unstable equilibrium at p^{crit} with $\partial T/\partial p|_{p^{crit}} > 1$.*

2. *No equilibrium exists for believed default probabilities above p^{crit}. If creditor beliefs exceed p^{crit}, the break-even condition is infeasible and credit markets break down.*

3. *The distance $p^{crit} - p^L > 0$ measures the firm's resilience to sentiment shocks. Better governance increases this distance.*

Proof sketch. Define $F(p) = T(p) - p$ on the domain $\mathcal{D} = [0, \bar{p})$. At $p = 0$, $F(0) = T(0) > 0$. As $p \to \bar{p}^-$, $D(p) \to \infty$ and $T(p) \to 1$; since $\bar{p} < 1$, $F(p) \to 1 - \bar{p} > 0$. Since $I > I^L(\gamma)$, the slope exceeds unity on an interval around $\hat{p}$, implying T grows faster than the diagonal on this interval. For the baseline calibration, $T(0) = 0.041$ and $\partial T/\partial p|_{p=0} = 0.153 < 1$, so F is initially positive but decreasing ($F'(0) < 0$). The function F crosses zero at p^L, becomes negative, and must return to positive values as $p \to \bar{p}^-$. Under unimodality, T is convex then concave, permitting exactly two zero-crossings. At the first (p^L), F crosses from positive to negative, giving $\partial T/\partial p < 1$ (stable). At the second (p^{crit}), F crosses from negative to positive, giving $\partial T/\partial p > 1$ (unstable). For $p > p^{crit}$, $F > 0$ and T is undefined as $p \to \bar{p}$, so no further fixed point exists. The complete proof is in Online Appendix OA.3. □

The unstable equilibrium p^{crit} is a rational expectations equilibrium—it satisfies all three conditions in Definition 1—but it is not a rest point. Any perturbation pushes beliefs away from p^{crit}. Downward perturbations converge to p^L; upward perturbations enter a region where no fixed point exists and the break-even condition is infeasible. The result is credit market breakdown rather than convergence to a high-stress stable state.

When the firm is in the crisis zone, expected firm value must account for equilibrium selection. Let V_F^{NL} denote firm value under credit market breakdown. If the firm has committed governance expenditure $C(\gamma)$ but cannot obtain financing, $V_F^{NL} = -C(\gamma)$ in the simplest case.[6] Expected firm value is

$$V_F(\gamma, I) = \pi(\gamma)\, V_F^L(\gamma, I) + [1 - \pi(\gamma)]\, V_F^{NL}(\gamma), \tag{12}$$

where $\pi(\gamma)$ is the probability of favorable coordination. The gap $V_F^L - V_F^{NL}$ determines the value of coordination and hence the marginal benefit of governance improvements that increase $\pi(\gamma)$.

[6] If partial asset recovery through liquidation is possible, $V_F^{NL} = \alpha\mu - I - C(\gamma) - \Psi(\gamma)$. The qualitative results require only $V_F^{NL} < V_F^L$, which holds throughout.

3.5 The Fragility Threshold

The investment level at which feedback first becomes self-reinforcing marks the boundary between safe and fragile debt structures. Define the maximum feedback strength $S(I, \gamma) = \max_p \partial T / \partial p$.

Proposition 3 (Fragility Threshold)**.** *Define $I^L(\gamma)$ as the investment level where $S(I^L, \gamma) = 1$. For $I < I^L(\gamma)$, a unique stable equilibrium exists. For $I > I^L(\gamma)$, self-reinforcing pessimism becomes possible. The threshold satisfies:*

1. *The effect of governance on $I^L(\gamma)$ is ambiguous. Higher default penalties reduce the normal density at the threshold (weakening feedback) but widen the repricing gap (strengthening feedback).*
2. *$\partial I^L / \partial \alpha > 0$: higher recovery rates delay fragility.*
3. *The effect of σ on I^L is ambiguous.*

Proof. The threshold is implicitly defined by $S(I^L, \gamma) = 1$ with $\partial S / \partial I > 0$ (higher leverage widens the repricing gap). Existence and uniqueness follow from the Intermediate Value Theorem.

Part 1. Higher $\Psi(\gamma)$ affects the slope (11) through two opposing channels. *Force 1 (stabilizing):* Lower z^* shifts the threshold into a region of lower normal density, reducing $\phi(z^*)/\sigma$. *Force 2 (destabilizing):* Higher $\Psi(\gamma)$ raises equilibrium face value at fixed beliefs (equation 4) and reduces expected recovery conditional on default, widening the repricing gap. Because the density decays exponentially in $|z^*|$ while the repricing gap grows algebraically, Force 1 dominates when the threshold is deep in the left tail and Force 2 dominates when the threshold is closer to the mean.

Part 2. Higher α reduces the repricing gap in the numerator of (11), lowering S for any I and requiring higher investment to reach $S = 1$.

Part 3. Volatility σ affects multiple terms in (11) in offsetting directions. □

3.6 Comparative Statics

The feedback mechanism depends on parameters governing bankruptcy costs, cash flow uncertainty, and tax benefits.

Lower recovery rates amplify the coordination problem. When α falls, the repricing gap expands, strengthening feedback and shifting $I^L(\gamma)$ downward. Firms become fragile at lower leverage.

Higher tax benefits extend debt capacity but do not eliminate fragility. Increasing τ raises firm value through larger tax shields, shifting the upper bound of sustainable leverage upward.

However, τ does not appear in the slope expression (11), so the lower boundary $I^L(\gamma)$ is insensitive to tax rates. The crisis zone shifts upward and widens modestly, reflecting expanded debt capacity rather than increased fragility.

Cash flow volatility has ambiguous effects, as noted in Proposition 3.

The default penalty $\Psi(\gamma)$ plays a central role. Higher penalties reduce the default threshold $X^* = D - \Psi(\gamma)$ for any face value, lowering actual default probability and weakening feedback. Within the crisis zone, higher penalties shift both the stable equilibrium and the critical threshold, improving credit market outcomes at any given investment level.

4 Crisis Zones and Debt Fragility

This section characterizes the investment regions where debt structures become fragile to belief-driven outcomes and establishes their dependence on model parameters.

4.1 Crisis Zone Boundaries

Proposition 4 (Debt Sustainability Zones)**.** *For given governance quality γ, there exist thresholds $0 < I^L(\gamma) < I^H(\gamma)$ defining three regions:*

1. ***Safe Zone*** *($I \leq I^L(\gamma)$). The feedback mechanism is weak: $S(I, \gamma) < 1$. A unique stable equilibrium exists. Small shifts in creditor sentiment generate proportionally smaller changes in actual outcomes.*

2. ***Crisis Zone*** *($I^L(\gamma) < I < I^H(\gamma)$). A stable low-default equilibrium coexists with an unstable critical threshold. If sentiment deteriorates past p^{crit}, self-fulfilling pessimism drives the firm toward credit market breakdown.*

3. ***Insolvency Zone*** *($I \geq I^H(\gamma)$). Expected firm value is negative even at the favorable equilibrium. Rational creditors decline to lend.*

Proof. The lower boundary $I^L(\gamma)$ is defined by $S(I^L, \gamma) = 1$, where $S(I, \gamma) = \max_p \partial T/\partial p$ is the maximum feedback strength. Since $S(0, \gamma) = 0$ and S is continuous and increasing in I, existence and uniqueness follow from the Intermediate Value Theorem. For $I < I^L(\gamma)$, $\partial T/\partial p < 1$ everywhere and the Contraction Mapping Theorem guarantees a unique fixed point.

The upper boundary $I^H(\gamma)$ is defined by $V_F(I^H, \gamma) = 0$, where V_F accounts for equilibrium selection as in (12). At $I = I^L(\gamma)$, $V_F > 0$. As I increases, both V_F^L and the probability-weighted

expected value decline due to higher debt service and increased distress probability. Continuity ensures existence of I^H where $V_F = 0$. Since $V_F(I^L, \gamma) > 0$ and $\partial V_F / \partial I < 0$, $I^L(\gamma) < I^H(\gamma)$. Complete details are in Online Appendix OA.3. □

The lower boundary marks where fundamentals no longer uniquely determine outcomes. Below $I^L(\gamma)$, if creditors become pessimistic, the resulting increase in face value does not raise actual default probability enough to confirm the pessimism. Above $I^L(\gamma)$, the feedback between beliefs and outcomes is strong enough that sentiment shocks can trigger persistent changes in credit conditions. The upper boundary represents the limit of sustainable debt: even the probability-weighted average of favorable and unfavorable outcomes generates zero expected value to shareholders.

4.2 Economic Interpretation

Within the crisis zone, the firm's fate depends partly on which equilibrium creditors coordinate on. Under *favorable coordination*, creditors' beliefs settle near p^L, face value remains moderate, and the firm successfully services debt in most states. Under *unfavorable coordination*, a negative shock pushes beliefs past p^{crit}. Self-reinforcing feedback takes over: pessimistic beliefs demand high face value, generating high actual default probability, confirming the pessimism. Credit markets break down entirely—no feasible lending terms exist.

Strategic complementarity among creditors drives this outcome. Each creditor's optimal terms depend on other creditors' beliefs. If creditor i expects others to be pessimistic, creditor i anticipates high face value and high default probability, and must also demand high face value to break even. Individual rationality supports multiple collective outcomes. The complementarity operates through the break-even condition: under absolute priority, $\partial X^* / \partial D = 1$, so each dollar increase in required face value raises the default threshold by exactly one dollar.

The distance $p^{crit} - p^L$ measures resilience. A stable equilibrium at $p^L = 0.04$ with $p^{crit} = 0.79$ provides a large buffer; creditor sentiment must deteriorate dramatically before self-reinforcing dynamics take hold. The same p^L with $p^{crit} = 0.08$ offers little protection. Governance affects both: higher $\Psi(\gamma)$ shifts p^L downward and p^{crit} upward.

4.3 Credit Spread Behavior

The three-zone structure generates distinctive predictions for credit spreads and expected financing costs.

4.3.1 Spread Levels and Coordination Risk

In the safe zone, a unique equilibrium exists and spreads respond smoothly to leverage changes. Consider a creditor at date 0 who assigns probability $\pi(\gamma)$ to favorable coordination and $1 - \pi(\gamma)$ to credit market breakdown. Under the favorable equilibrium, the creditor receives expected repayment $(1 - p_d^L)D + p_d^L\, \alpha\, \mathbb{E}[X \mid X < X^{*L}]$. Under breakdown, the creditor does not lend and recovers investment I. The ex ante face value D^{EA} satisfies

$$I = \pi(\gamma)\left[(1 - p_d^L)\, D^{EA} + p_d^L\, \alpha\, \mathbb{E}[X \mid X < X^{*L}]\right] + [1 - \pi(\gamma)] \cdot I. \tag{13}$$

Simplifying, the bracketed expression must equal zero, so the spread conditional on lending equals the stable-equilibrium spread r^L. Coordination risk therefore does not affect the *conditional* spread but instead affects the *probability* of credit market access.

The expected cost of debt financing, accounting for the possibility of market exclusion, is

$$\mathbb{E}[\text{financing cost}] = \pi(\gamma)\, r^L \cdot I + [1 - \pi(\gamma)]\, (V_F^L - V_F^{NL}), \tag{14}$$

where $V_F^L - V_F^{NL}$ is the value destroyed by losing market access. Better governance reduces expected financing costs through both channels: lower r^L from reduced default probability, and higher $\pi(\gamma)$ from improved coordination.

4.3.2 Spread Discontinuities at Crisis Zone Boundaries

Corollary 1 (Spread Discontinuity)**.** *Expected financing costs increase discretely at the lower crisis zone boundary $I^L(\gamma)$.*

Proof. For $I < I^L(\gamma)$, lending occurs with certainty and the cost is $r^L(I) \cdot I$, where $r^L(I) = D^L(I)/I - 1$ is continuous in I by the Implicit Function Theorem. For I slightly above $I^L(\gamma)$, the critical threshold appears and expected financing cost becomes (14). The discrete increase at

$I^L(\gamma)$ is

$$\lim_{I \to I^L(\gamma)^+} \mathbb{E}[\text{cost}] - \lim_{I \to I^L(\gamma)^-} \mathbb{E}[\text{cost}] = [1 - \pi(\gamma)] \left(V_F^L - V_F^{NL}\right)\big|_{I=I^L} > 0. \tag{15}$$

□

The magnitude depends on governance through two channels. Better governance increases $\pi(\gamma)$, reducing the probability weight on breakdown. Simultaneously, better governance reduces $V_F^L - V_F^{NL}$ at the boundary by lowering stable-equilibrium distress costs. Both channels imply that spread jumps are larger for firms with weaker governance.

This discontinuity distinguishes the coordination model from standard tradeoff theories, which predict smooth leverage-spread relationships (Merton, 1974; Leland, 1994). In the coordination framework, small changes in leverage near $I^L(\gamma)$ can produce dramatic repricing of credit risk as firms cross from unique determination by fundamentals to positive probability of coordination failure.

4.4 Determinants of Crisis Zone Properties

Proposition 5 (Comparative Statics of Crisis Zone Boundaries)**.** *The crisis zone boundaries satisfy:*

1. ***Recovery rate*** α**.** *Both $I^L(\gamma)$ and $I^H(\gamma)$ are increasing in α. Higher recovery reduces the repricing gap, weakening strategic complementarity and shifting the crisis zone toward higher leverage.*

2. ***Tax rate*** τ**.** *$I^H(\gamma)$ is increasing in τ; the effect on $I^L(\gamma)$ is small. Higher tax benefits allow firms to sustain greater leverage before expected value turns negative, but τ does not enter the slope expression (11) directly.*

3. ***Cash flow volatility*** σ**.** *Effects on both boundaries are ambiguous.*

4. ***Default penalty*** $\Psi(\gamma)$**.** *$I^H(\gamma)$ is strictly increasing in $\Psi(\gamma)$. The effect on $I^L(\gamma)$ is ambiguous, as established in Proposition 3.*

Proof. Part 1. Higher α increases expected recovery, reducing the repricing gap $D - \alpha[\mu - \sigma\lambda(z^*)]$ in the numerator of (11). This lowers the slope for any (I, p), requiring higher investment to reach $S = 1$, so $\partial I^L/\partial\alpha > 0$. Higher α also reduces expected distress costs, raising firm value and allowing higher investment before the participation constraint binds: $\partial I^H/\partial\alpha > 0$.

Part 2. The tax rate τ does not appear in the slope expression (11), so its effect on I^L operates only indirectly through equilibrium face values and is quantitatively small. The primary effect is

on I^H: higher τ increases the tax shield $(1 - p_d)\tau(D - I)$, raising firm value and allowing higher sustainable investment.

Part 3. Volatility σ affects several terms in the slope expression in offsetting ways: higher σ reduces $\phi(z^*)/\sigma$ directly but changes z^* and $\lambda(z^*)$ in parameter-dependent ways.

Part 4. Higher $\Psi(\gamma)$ lowers the default threshold for any D, reducing default probability and expected distress costs. This raises firm value, increasing I^H. The effect on I^L involves the two opposing forces from Proposition 3. □

The comparative statics clarify when coordination problems are most severe. Crisis zones are wider and occur at lower leverage when recovery rates are low, because low recovery magnifies the repricing effect: creditors who fear default demand much higher face value when they expect to recover little. Crisis zones shift to higher leverage when default penalties are high, because strong governance weakens the feedback mechanism and makes fragility survivable conditional on operating in the crisis zone.

5 Governance and Debt Capacity

The previous section shows that multiple equilibria arise at intermediate investment levels. In the crisis zone, a stable low-default equilibrium coexists with a critical belief threshold beyond which no feasible lending terms exist and credit markets break down. This section shows that governance quality systematically affects the location of crisis zone boundaries, the probability of equilibrium selection, and the marginal value of governance improvements. The main result is that better governance monotonically expands sustainable debt capacity through two distinct channels.

Proposition 6 (Governance and Debt Capacity)**.**

1. *The upper crisis zone boundary is strictly increasing in governance quality:*

$$\frac{dI^H}{d\gamma} > 0. \tag{16}$$

   Consequently, maximum sustainable debt capacity expands as governance improves.

2. *The effect of governance on the lower boundary $I^L(\gamma)$ is ambiguous, determined by the opposing*

density and repricing-gap forces identified in Proposition 3. In calibrations, $|dI^L/d\gamma|$ is quantitatively small: I^L varies by 3.1% across governance levels, compared with 7.5% variation in I^H.

3. *Governance unambiguously expands total sustainable debt capacity $I^H(\gamma) - I^L(\gamma)$ when the upper-boundary effect dominates, which holds across all calibrated specifications.*

Proof. Part 1: Effect on the upper boundary. The upper boundary $I^H(\gamma)$ is defined by the zero-value condition

$$V_F\big(I^H, \gamma\big) = \pi(\gamma)\, V_F^L\big(I^H, \gamma\big) + [1 - \pi(\gamma)]\, V_F^{NL}(\gamma) = 0. \tag{17}$$

Better governance affects expected firm value through two channels.

Channel 1: Equilibrium selection. Higher γ increases $\pi(\gamma)$, shifting probability weight toward the stable equilibrium. Since $V_F^L(I^H, \gamma) > V_F^{NL}(\gamma)$ at any point where the firm is viable under favorable coordination, this increases expected firm value:

$$\pi'(\gamma)\big[V_F^L(I^H, \gamma) - V_F^{NL}(\gamma)\big] > 0.$$

Channel 2: Direct effects within each outcome. Higher γ reduces default probability in the stable equilibrium by lowering the default threshold, reducing expected net distress costs and increasing V_F^L. The breakdown value satisfies $\partial V_F^{NL}/\partial\gamma = -C'(\gamma) < 0$, but this negative effect is outweighed by the positive selection and within-equilibrium effects. The weighted sum satisfies

$$\frac{\partial V_F}{\partial \gamma} = \pi'(\gamma)\big[V_F^L - V_F^{NL}\big] + \pi(\gamma)\,\frac{\partial V_F^L}{\partial \gamma} + [1 - \pi(\gamma)]\,\frac{\partial V_F^{NL}}{\partial \gamma} > 0,$$

where the first two terms are strictly positive and dominate the negative third term at any interior governance level.

Since $\partial V_F/\partial I < 0$ at $I = I^H(\gamma)$ (the stable equilibrium is near the edge of viability), the Implicit Function Theorem gives

$$\frac{dI^H}{d\gamma} = -\frac{\partial V_F/\partial \gamma}{\partial V_F/\partial I} = -\frac{(+)}{(-)} > 0. \tag{18}$$

Part 2: Effect on the lower boundary. The lower boundary $I^L(\gamma)$ is defined by $S(I^L, \gamma) = 1$. As established in Proposition 3, the effect of governance on the maximum slope $S(I, \gamma)$ is determined by two opposing forces: the density reduction at the threshold (stabilizing) and the widening of the repricing gap (destabilizing).

To apply the Implicit Function Theorem to $S(I^L(\gamma), \gamma) = 1$, we need the sign of $\partial S/\partial\gamma$. Since

this sign is ambiguous (Proposition 3, Part 1),

$$\frac{dI^L}{d\gamma} = -\frac{\partial S/\partial \gamma}{\partial S/\partial I} \tag{19}$$

has the same sign as $-\partial S/\partial \gamma$, which is indeterminate without further restrictions on the parameterization.

In the baseline calibration, I^L decreases from 41.8 to 40.5 as γ increases from 0.3 to 0.8, indicating that the repricing-gap force slightly dominates. The magnitude is small: the 1.3-unit change represents 3.1% of the weak-governance baseline, compared with the 5.8-unit (7.5%) expansion of I^H.

Part 3: Net expansion of sustainable debt. Sustainable debt capacity is $I^H(\gamma) - I^L(\gamma)$. Since $dI^H/d\gamma > 0$ is established in Part 1 and $|dI^L/d\gamma|$ is small relative to $dI^H/d\gamma$ in all calibrated specifications, the net effect is that governance expands total sustainable debt capacity. The crisis zone width increases from 35.7 to 42.8 as governance improves from $\gamma = 0.3$ to $\gamma = 0.8$ in the baseline calibration. □

The two boundaries respond to governance through different channels, which explains their different behavior. The lower boundary $I^L(\gamma)$ depends exclusively on the feedback mechanism: it is defined by the condition that the maximum slope of the equilibrium mapping equals unity. Governance affects I^L only by changing the shape of the slope function, where the density and repricing-gap forces partially offset. The upper boundary $I^H(\gamma)$ depends on expected firm value, which governance affects through both equilibrium selection (a first-order channel with unambiguous sign) and direct distress-cost reduction. The dominance of the equilibrium selection channel explains why I^H responds much more strongly and unambiguously to governance than I^L does.

That governance may not expand the safe zone while unambiguously expanding maximum sustainable leverage has a natural economic interpretation. Better governance does not necessarily delay the onset of fragility—the point at which self-reinforcing creditor pessimism first becomes possible. What it does unambiguously is make fragility *survivable*: conditional on being in the crisis zone, better governance increases the probability of favorable coordination and reduces the consequences of unfavorable outcomes. This distinction between the onset and the consequences of fragility sharpens the paper's core message.

5.1 Marginal Value of Governance

The marginal value of governance varies systematically with the firm's position relative to crisis zone boundaries. Governance improvements are most valuable for firms near the boundaries, where small changes can trigger discrete shifts in equilibrium outcomes.

To state results compactly, we define the *net distress cost* as the total cost per unit of default probability, inclusive of the forgone tax shield:

$$\widetilde{DC} = (1-\alpha)\,\mathbb{E}[X \mid X < X^*] + \Psi(\gamma) + \tau(D-I). \tag{20}$$

The first term is the deadweight bankruptcy loss. The second is the default penalty borne by shareholders. The third is the tax shield that would have been realized had the firm repaid. With this definition, expected firm value in any single equilibrium can be written as

$$V_F = \mu - I + \tau(D-I) - C(\gamma) - p_d\,\widetilde{DC}. \tag{21}$$

Proposition 7 (Heterogeneous Returns to Governance)**.** *The marginal value of governance, $\partial V_F/\partial\gamma$, has the following properties.*

1. *In the safe zone ($I < I^L(\gamma)$), the marginal value is*

$$\left.\frac{\partial V_F}{\partial\gamma}\right|_{\text{safe}} = -C'(\gamma) - \frac{\partial p_d}{\partial\gamma}\,\widetilde{DC} - p_d\,\frac{\partial\widetilde{DC}}{\partial\gamma} + \tau\,\frac{\partial D}{\partial\gamma}. \tag{22}$$

   The first three terms dominate. The last term is second-order in the safe zone, where default risk is low and the equilibrium face value is insensitive to governance.

2. *In the crisis zone ($I^L(\gamma) < I < I^H(\gamma)$), the marginal value includes an additional equilibrium selection term:*

$$\left.\frac{\partial V_F}{\partial\gamma}\right|_{\text{crisis}} = \pi'(\gamma)\left[V_F^L - V_F^{NL}\right] + \pi(\gamma)\,\frac{\partial V_F^L}{\partial\gamma} + [1-\pi(\gamma)]\,\frac{\partial V_F^{NL}}{\partial\gamma}, \tag{23}$$

   where V_F^L is firm value at the stable equilibrium and V_F^{NL} is firm value under credit market breakdown, as defined in Section 3.4.

3. *The equilibrium selection term $\pi'(\gamma)[V_F^L - V_F^{NL}]$ is strictly positive and largest for firms near crisis zone boundaries.*

Proof. Part 1. In the safe zone, a unique equilibrium exists, so $\pi(\gamma) = 1$ and the equilibrium selection term vanishes. Using the compact representation (21), differentiate with respect to γ:

$$\frac{\partial V_F}{\partial \gamma} = \tau \frac{\partial D}{\partial \gamma} - C'(\gamma) - \frac{\partial p_d}{\partial \gamma} \widetilde{DC} - p_d \frac{\partial \widetilde{DC}}{\partial \gamma}. \tag{24}$$

Since $\partial p_d / \partial \gamma < 0$ (better governance reduces default probability), the third term is positive: reduced default probability saves distress costs. The fourth term captures the effect of governance on distress costs per unit default probability, operating through changes in the default penalty $\Psi'(\gamma) > 0$ and in expected recovery.

The residual term $\tau \, \partial D / \partial \gamma$ reflects the effect of governance on the equilibrium face value. In the safe zone, default probability is low, face value is close to the investment level ($D \approx I$), and the sensitivity of D to governance operates only indirectly through the small change in default risk. This term is second-order relative to the other three and can be neglected without material loss of accuracy.[7]

Part 2. In the crisis zone, expected firm value accounts for equilibrium selection:

$$V_F = \pi(\gamma) \, V_F^L + [1 - \pi(\gamma)] \, V_F^{NL}. \tag{25}$$

Differentiating with respect to γ,

$$\frac{\partial V_F}{\partial \gamma} = \pi'(\gamma) \left[V_F^L - V_F^{NL} \right] + \pi(\gamma) \frac{\partial V_F^L}{\partial \gamma} + [1 - \pi(\gamma)] \frac{\partial V_F^{NL}}{\partial \gamma}.$$

The first term is the equilibrium selection effect: better governance raises the probability of the favorable outcome. The remaining terms are probability-weighted direct effects within each outcome. The within-equilibrium derivative $\partial V_F^L / \partial \gamma$ corresponds to the safe-zone expression (24) evaluated at the stable equilibrium. The derivative $\partial V_F^{NL} / \partial \gamma = -C'(\gamma)$ reflects the governance cost, which is incurred regardless of whether lending occurs.[8]

Part 3. The equilibrium selection term is positive because $\pi'(\gamma) > 0$ and $V_F^L > V_F^{NL}$. The latter inequality holds because the stable equilibrium generates positive expected value from the

[7] To see this formally, note that $\partial D / \partial \gamma$ satisfies the implicit derivative of the break-even condition with respect to γ. For p_d near zero, the dominant component of the break-even condition is $(1 - p_d)D \approx D \approx I$, making D insensitive to parameters that operate through default states.

[8] If V_F^{NL} includes partial asset recovery under forced liquidation, $\partial V_F^{NL} / \partial \gamma = -C'(\gamma) - \Psi'(\gamma)$, since the default penalty is also incurred. The qualitative conclusions are unchanged because the equilibrium selection term dominates near crisis zone boundaries.

completed project while credit market breakdown does not.

The term is largest near crisis zone boundaries for two reasons. Near the lower boundary $I^L(\gamma)$, the critical threshold has just appeared. Even though V_F^L remains substantial, the possibility of breakdown creates a large value gap $V_F^L - V_F^{NL}$. A marginal governance improvement may be sufficient to shift $I^L(\gamma)$ past the firm's investment level, eliminating the critical threshold entirely and restoring unique determination by fundamentals. This discrete change in the set of possible outcomes generates a first-order value increase beyond the continuous direct effects. Near the upper boundary $I^H(\gamma)$, the firm is on the edge of viability. The stable equilibrium generates small but positive firm value, while breakdown yields negative value. Governance improvements at this margin have outsized effects: they increase coordination probability, reduce default probability in the stable equilibrium, and may shift $I^H(\gamma)$ outward sufficiently to restore clear viability. □

The proposition implies that governance improvements generate the largest returns for firms near crisis zone boundaries. Conversely, for firms deep in the safe zone (well below $I^L(\gamma)$), governance improvements yield only modest benefits through reduced default probability. For firms deep in the insolvency zone (well above $I^H(\gamma)$), governance improvements cannot restore viability. The marginal value of governance is highest in an intermediate region where coordination concerns are most relevant.

This heterogeneity has implications for observed governance choices. Firms with leverage near crisis zone boundaries have strong incentives to invest in governance. Firms with very low or very high leverage have weaker incentives. If governance investments are costly, we should expect governance quality to be highest among firms with intermediate leverage—precisely the firms most exposed to coordination risk.

5.2 Joint Optimization of Governance and Investment

Proposition 8 (Optimal Joint Policy)**.** *At an interior optimum (γ^*, I^*) within the crisis zone, the optimal governance choice satisfies*

$$\pi'(\gamma^*)\left[V_F^L - V_F^{NL}\right] = C'(\gamma^*) + \pi(\gamma^*)\left[\frac{\partial p_d^L}{\partial \gamma}\,\widetilde{DC}^L + p_d^L\,\frac{\partial \widetilde{DC}^L}{\partial \gamma} - \tau\,\frac{\partial D^L}{\partial \gamma}\right]. \tag{26}$$

The left side is the marginal benefit from improved equilibrium selection. The right side is the net marginal cost: governance expenditure plus the probability-weighted change in within-

equilibrium distress costs, less the tax shield gained from the governance-induced change in equilibrium face value. The final term $\tau\,\partial D^L/\partial\gamma$ enters with a negative sign because higher governance raises equilibrium face value at fixed beliefs (equation 4), increasing the tax deduction $\tau(D-I)$ that accrues in repayment states. This tax-shield effect is second-order in the crisis zone: since $\partial D^L/\partial\gamma$ operates through the small adjustment in face value needed to maintain creditor break-even as the default threshold shifts, and $\tau = 0.21$, the term contributes less than 3% of the right-hand side in the baseline calibration.[9]

Proof. Part 1. At an interior optimum the first-order condition $\partial V_F/\partial\gamma = 0$ must hold. In the crisis zone, $V_F = \pi(\gamma)V_F^L + [1-\pi(\gamma)]V_F^{NL}$ with $V_F^{NL} = -C(\gamma)$. Differentiating with respect to γ:

$$0 = \pi'(\gamma)\left[V_F^L - V_F^{NL}\right] + \pi(\gamma)\,\frac{\partial V_F^L}{\partial\gamma} + [1-\pi(\gamma)]\,\frac{\partial V_F^{NL}}{\partial\gamma}. \tag{27}$$

Using the compact representation $V_F^L = \mu - I + \tau(D^L - I) - C(\gamma) - p_d^L\,\widetilde{DC}^L$, the within-equilibrium derivative is

$$\frac{\partial V_F^L}{\partial\gamma} = \tau\,\frac{\partial D^L}{\partial\gamma} - C'(\gamma) - \frac{\partial p_d^L}{\partial\gamma}\,\widetilde{DC}^L - p_d^L\,\frac{\partial\widetilde{DC}^L}{\partial\gamma}. \tag{28}$$

The first term arises because the tax shield $\tau(D^L - I)$ depends on the equilibrium face value, which responds to governance through equation (4). This term sits outside the $p_d^L\,\widetilde{DC}^L$ product: although $\widetilde{DC}^L$ itself contains $\tau(D^L - I)$, the derivative of the product $p_d^L\,\widetilde{DC}^L$ captures only the fraction p_d^L of the face-value sensitivity, leaving a residual $(1-p_d^L)\,\tau\,\partial D^L/\partial\gamma$ that must be accounted for separately.

The breakdown-value derivative is $\partial V_F^{NL}/\partial\gamma = -C'(\gamma)$. Substituting into (27), noting that the $-C'(\gamma)$ terms from $\partial V_F^L/\partial\gamma$ and $\partial V_F^{NL}/\partial\gamma$ combine to yield $-C'(\gamma)$ after weighting by π and $1-\pi$, and collecting terms yields (26). □

The complementarity result has important empirical implications. It predicts a positive correlation between governance quality and leverage in the cross-section of firms, particularly for firms with intermediate leverage near crisis zone boundaries. This prediction is consistent with empirical evidence documenting positive associations between governance measures and leverage ratios (Jensen, 1986; Berger et al., 1997).

[9] To see why the term is small, note that $\partial D^L/\partial\gamma$ at the stable equilibrium satisfies equation (4) evaluated at $p = p_d^L$. For p_d^L near zero, the numerator of that expression is proportional to p_d^L, making $\tau\,\partial D^L/\partial\gamma$ of order $\tau\,p_d^L\,\alpha\,\Psi'(\gamma)$. In the baseline at $\gamma = 0.5$ and $I = 69$, $p_d^L = 0.050$ and the term equals $0.21 \times 0.36 = 0.08$, compared with the equilibrium selection benefit $\pi'(\gamma)(V_F^L - V_F^{NL}) \approx 30$.

The model also predicts that this correlation should be strongest for firms in the crisis zone and weakest for firms with very low leverage (deep in the safe zone) or very high leverage (in the insolvency zone). Empirical tests that condition on leverage position relative to crisis zone boundaries may find stronger governance-leverage relationships than unconditional tests.

The joint optimization results assume interior solutions. Corner solutions can arise when governance costs are very high ($\gamma^* = 0$) or when coordination benefits are very large ($\gamma^* = 1$). The complementarity result applies most strongly to firms with interior optimal governance choices and investment levels near crisis zone boundaries.

The analysis in this section establishes governance as a key determinant of debt capacity through the coordination channel. Better governance expands the safe zone, increases the probability of favorable equilibrium outcomes in the crisis zone, and is most valuable for firms facing significant coordination risk. These results complement traditional agency-based explanations of the governance-leverage relationship by identifying a distinct mechanism operating through equilibrium selection.

6 Predictions and Comparison with Alternative Theories

The coordination channel generates predictions that overlap with agency-based theories on some dimensions but diverge sharply on others. All three frameworks—coordination, asset substitution, and free cash flow—predict that better governance reduces credit spreads. The theories differ in where governance effects are concentrated across the leverage distribution, how spreads respond to leverage changes, and what patterns appear in spread volatility. Table 1 summarizes the four testable predictions. We develop each in turn, using calibrated values from Section 7 to illustrate magnitudes.

6.1 Prediction 1: Where Governance Has Greatest Marginal Value

The coordination model predicts that the marginal value of governance peaks at intermediate leverage (Proposition 7). In the calibration at $\gamma = 0.5$, the marginal value $\partial \mathbb{E}[V_F]/\partial \gamma$ is -2.0 in the safe zone ($I = 40$, $p_d = 0.1\%$), 28.8 in the crisis zone ($I = 69$, $p_d = 5.0\%$), and 22.1 near insolvency ($I = 78$, $p_d = 19.2\%$).

The negative return in the safe zone is noteworthy. When coordination failure is impossible, the governance cost $C'(\gamma) = 2.0$ exceeds the marginal distress saving from reducing an

Table 1: Testable Predictions: Coordination Channel versus Agency Theories

Prediction	Coordination	Asset Substitution	Free Cash Flow
Leverage where governance has greatest marginal value	Intermediate (crisis zone)	High (risk-shifting strongest)	Low (managerial discretion greatest)
Primary channel reducing expected spreads	Equilibrium selection: higher $\pi(\gamma)$	Reduced asset volatility	Reduced cash flow waste
Credit spread response to leverage	Discrete jump at $I^L(\gamma)$	Smooth, convex increase	Smooth or flat
Governance–spread volatility relationship	Non-monotonic (inverted U)	Monotonically negative	Monotonically negative

Notes: The coordination model predicts governance matters most at intermediate leverage where coordination fragility is greatest. Asset substitution theory (Jensen and Meckling, 1976) predicts strongest effects at high leverage; free cash flow theory (Jensen, 1986) at low leverage. The non-monotonic volatility prediction is unique to the coordination channel and arises because the variance of equilibrium outcomes, $\pi(\gamma)[1-\pi(\gamma)]$, is maximized at $\pi = 1/2$.

already-negligible p_d. Governance is pure cost. In the crisis zone, the equilibrium selection term $\pi'(\gamma)[V_F^L - V_F^{NL}]$ dominates: with $V_F^L \approx 29.5$ and $V_F^{NL} \approx -0.5$, a unit increase in coordination probability generates approximately 30 units of expected value. Near insolvency, the term remains positive but smaller because V_F^L declines with leverage.

Asset substitution theory (Jensen and Meckling, 1976) predicts governance is most valuable at high leverage where risk-shifting incentives peak. Free cash flow theory (Jensen, 1986) predicts the opposite: governance value is greatest at low leverage where managerial discretion is greatest. Neither predicts negative governance returns at low leverage. The three predictions are mutually exclusive in their leverage dependence—intermediate, high, and low—and an empirical test interacting governance quality with leverage-bin indicators can distinguish among them.

6.2 Prediction 2: Governance Reduces Expected Financing Costs Through Equilibrium Selection

Better governance unambiguously reduces expected financing costs conditional on cash-flow risk. In the calibration at $I = 69$, the stable-equilibrium credit spread declines from 333 basis points at $\gamma = 0.3$ to 131 basis points at $\gamma = 0.8$, a 202 basis point reduction (61%). The coordination risk premium—$[1-\pi(\gamma)](V_F^L - V_F^{NL})$, measuring expected value destroyed by the possibility of credit market breakdown—declines from 20.8 to 6.1 (71%). Stable-equilibrium firm value V_F^L varies by only 1.3% across governance levels, while expected firm value $\mathbb{E}[V_F]$ increases from 8.7 to 23.1

(165%). Approximately 95% of the improvement operates through equilibrium selection.

All three theories predict $\beta_1 < 0$ in a regression of spreads on governance. The distinguishing feature of the coordination channel is that the effect operates through the probability of credit market access rather than through changes in asset volatility or expected recovery. Standard spread regressions that control for cash flow volatility, recovery rates, and profitability absorb the agency channels but should leave the coordination channel intact. The model predicts that governance retains significant explanatory power for credit spreads after controlling for these fundamentals, with effects concentrated at intermediate leverage.

6.3 Prediction 3: Credit Spreads Respond Discontinuously to Leverage

Corollary 1 establishes that expected financing costs increase discretely at $I^L(\gamma)$. Below the boundary, outcomes are uniquely determined by fundamentals. Above it, the critical belief threshold introduces positive probability of credit market breakdown, adding the coordination risk premium $[1 - \pi(\gamma)](V_F^L - V_F^{NL})$. In the calibration at $\gamma = 0.5$ with $I^L = 41.4$, expected firm value drops from approximately 58 to 29 at the boundary—a decline of roughly 50%—as $\pi = 0.5$ places equal weight on the stable equilibrium and breakdown. Default probability at the stable equilibrium increases smoothly through I^L, confirming that the value drop reflects the discrete appearance of coordination risk rather than a sudden change in fundamental default probability.

Standard tradeoff models predict smooth leverage-spread relationships. In the Merton (1974) framework, spreads are continuous functions of leverage because the default boundary and recovery value vary smoothly with debt levels. Extensions incorporating agency costs (Leland, 1994) modify the level and curvature but preserve continuity. Finding spread jumps at intermediate leverage thresholds would constitute evidence specifically favoring the coordination channel.

The magnitude of the discontinuity depends on governance quality. Better governance increases $\pi(\gamma)$, reducing the weight on breakdown, and simultaneously reduces $V_F^L - V_F^{NL}$ at the boundary. Both effects imply that spread jumps are larger for firms with weaker governance. This explains how seemingly small changes in firm circumstances can produce dramatic credit repricing when the firm crosses a zone boundary.

6.4 Prediction 4: Non-Monotonic Spread Volatility

The most distinctive prediction of the coordination model concerns the relationship between governance quality and credit spread volatility.

When the spread outcome is r^L with probability $\pi(\gamma)$ and credit market breakdown with probability $1 - \pi(\gamma)$, the standard deviation of spread outcomes is

$$\sigma_r = \sqrt{\pi(\gamma)[1 - \pi(\gamma)]} \times (r^{crit} - r^L). \tag{29}$$

Two competing forces drive the relationship with governance. The variance factor $\pi(1 - \pi)$ is maximized at $\pi = 1/2$ and approaches zero at both extremes. Simultaneously, better governance widens the spread gap $r^{crit} - r^L$: the stable-equilibrium spread falls substantially (from 333 to 131 basis points as γ rises from 0.3 to 0.8), while the critical threshold spread is relatively less sensitive (from 6,909 to 8,556 basis points).

The calibrated values confirm the non-monotonicity. Spread volatility is 3,013 basis points at $\gamma = 0.3$, rises to 3,576 at $\gamma = 0.5$ and 3,645 at $\gamma = 0.7$, then declines to 3,370 at $\gamma = 0.8$. For $\gamma \leq 0.5$, both forces push volatility upward: the variance factor moves toward its maximum and the spread gap widens. For $\gamma > 0.7$, the declining variance factor dominates and volatility falls.

The economic interpretation is counterintuitive. A firm with very weak governance ($\pi = 0.30$) has relatively low spread volatility not because it is safe, but because the adverse outcome is near-certain. With 70% probability of breakdown, there is little uncertainty about which state will prevail. As governance improves, outcomes become genuinely uncertain, generating peak volatility. Only with sufficiently strong governance does favorable coordination become likely enough to reduce uncertainty.

This pattern is absent from agency theories, which predict that governance monotonically reduces spread dispersion by constraining risk-shifting or wasteful investment. In a regression of spread volatility on governance quality and its square, the coordination model predicts a positive linear coefficient and a negative quadratic coefficient (inverted U). Agency theories predict a uniformly negative linear relationship. The peak of the inverted U identifies the governance level at which coordination uncertainty is maximal.

6.5 Overlapping and Distinct Predictions

The predictions highlight both the promise and the challenge of empirical discrimination. A simple regression of spreads on a governance index will find a negative coefficient regardless of which theory is correct. Distinguishing the coordination channel requires tests exploiting cross-sectional variation in how governance effects depend on leverage.

The sharpest tests involve Predictions 1 and 4. Each generates sign patterns that differ qualitatively across the three theories: intermediate versus high versus low leverage dependence for Prediction 1, and inverted-U versus monotonically negative for Prediction 4. Predictions 3 and 4 are unique to the coordination framework: no agency model generates spread discontinuities at intermediate leverage thresholds or an inverted-U relationship between governance and spread volatility. Section 8 translates these predictions into regression specifications.

7 Calibration

This section calibrates the model to quantify the coordination channel's importance and validate the testable predictions from Section 6. The calibration demonstrates that governance effects on debt capacity are economically significant—the 7.5% expansion in sustainable leverage from weak to strong governance is comparable in magnitude to effects of tax-rate changes estimated by Heider and Ljungqvist (2015). The calibration also confirms the model's distinctive predictions about where governance matters most, expected value discontinuities at crisis zone boundaries, and the non-monotonic relationship between governance and spread volatility.

7.1 Parameter Selection

Table 2 reports baseline parameter values. We normalize expected cash flow to $\mu = 100$ and set volatility $\sigma = 20$, implying a coefficient of variation of 0.20 consistent with operating income data for investment-grade firms (Graham, 2000). The recovery rate $\alpha = 0.60$ matches the lower quartile of creditor recovery in Bris et al.'s (2006) sample of 286 bankruptcies; total deadweight losses of 35–40% from direct and indirect costs correspond to α between 0.60 and 0.65 (Andrade and Kaplan, 1998; Davydenko and Franks, 2008).[10] The corporate tax rate $\tau = 0.21$ reflects the post-2017 U.S. statutory rate.

[10] Our choice of $\alpha = 0.60$ rather than the sample mean of approximately 0.71 strengthens the coordination mechanism. We verify in Section 7.8 that all qualitative results hold for $\alpha \in \{0.55, 0.65, 0.70\}$.

Table 2: Baseline Parameter Values

Parameter	Symbol	Value
Expected cash flow	μ	100
Cash flow volatility	σ	20
Recovery rate	α	0.60
Corporate tax rate	τ	0.21
Governance cost	$C(\gamma)$	$2\gamma^2$
Default penalty	$\Psi(\gamma)$	$15\gamma^2$
Selection probability	$\pi(\gamma)$	γ

Notes: Governance quality $\gamma \in [0, 1]$. All values normalized relative to $\mu = 100$. Breakdown value under credit market exclusion is $V_F^{NL} = -C(\gamma)$. Feasibility threshold $I^* = \alpha\mu = 60$.

The default penalty $\Psi(\gamma) = 15\gamma^2$ generates penalties ranging from 1.35 ($\gamma = 0.3$) to 9.60 ($\gamma = 0.8$) as a percentage of expected cash flow. These magnitudes are consistent with evidence on reputation costs from financial distress: Karpoff et al. (2008) estimate reputation losses from financial misconduct at 7.5 times legal penalties, typically amounting to 10–20% of firm value; Hotchkiss et al. (2008) document director and officer liability in bankruptcy averaging 8–12% of pre-bankruptcy firm value for firms with independent boards. Governance costs follow $C(\gamma) = 2\gamma^2$, generating expenditures of 0.5% of expected cash flow at moderate governance ($\gamma = 0.5$) and 1.3% at strong governance ($\gamma = 0.8$), consistent with estimates in Linck et al. (2008) that board monitoring costs average 0.8% and can exceed 2% for firms with extensive oversight.

The equilibrium selection probability $\pi(\gamma) = \gamma$ is a linear reduced-form specification. Under credit market breakdown, the firm retains only its outside option net of sunk governance costs: $V_F^{NL} = -C(\gamma)$.

The feasibility threshold $I^* = \alpha\mu = 60$ plays a crucial role in the equilibrium structure. For investment levels $I > I^*$, the break-even condition has no solution when creditors expect near-certain default, limiting the crisis zone to exactly two equilibria: one stable low-default outcome and one unstable critical threshold. This feature distinguishes our model from standard coordination frameworks that generate three equilibria.

7.2 Equilibrium Structure

Proposition 2 establishes that when $I > \alpha\mu$, the feasibility constraint on the break-even condition limits the crisis zone to exactly two equilibria: one stable and one unstable. For the calibrated parameters, $I^* = \alpha\mu = 60$, and crisis zone investment levels ($I \in (I^L, I^H) \approx (41, 79)$) exceed this

threshold throughout.

Figure 1 illustrates at $I = 69$, $\gamma = 0.5$. The mapping $T(p) = \Phi((D(p) - \Psi(\gamma) - \mu)/\sigma)$ crosses the 45-degree line twice. The stable equilibrium occurs at $p_d = 4.95\%$ with credit spread of 255 basis points and slope $\partial T/\partial p = 0.187$, consistent with investment-grade BBB-rated debt. The critical threshold occurs at $p^{crit} = 79.3\%$ with slope 2.252, implying beliefs and outcomes reinforce each other. The gap between equilibria—74.4 percentage points in default probability—measures vulnerability to sentiment shocks: if adverse news pushes creditor beliefs past p^{crit}, no feasible lending terms exist and credit markets break down.

Figure 1 shows how governance quality affects the mapping at fixed $I = 69$. Weak governance ($\gamma = 0.3$) produces a steep mapping with $p^L = 6.6\%$ and $p^{crit} = 77.8\%$. Strong governance ($\gamma = 0.8$) flattens the mapping, shifting the stable equilibrium to $p^L = 2.4\%$ and the critical threshold to $p^{crit} = 82.2\%$. The reduced slope reflects weaker feedback between creditor pessimism and actual default outcomes when higher penalties discipline shareholders.

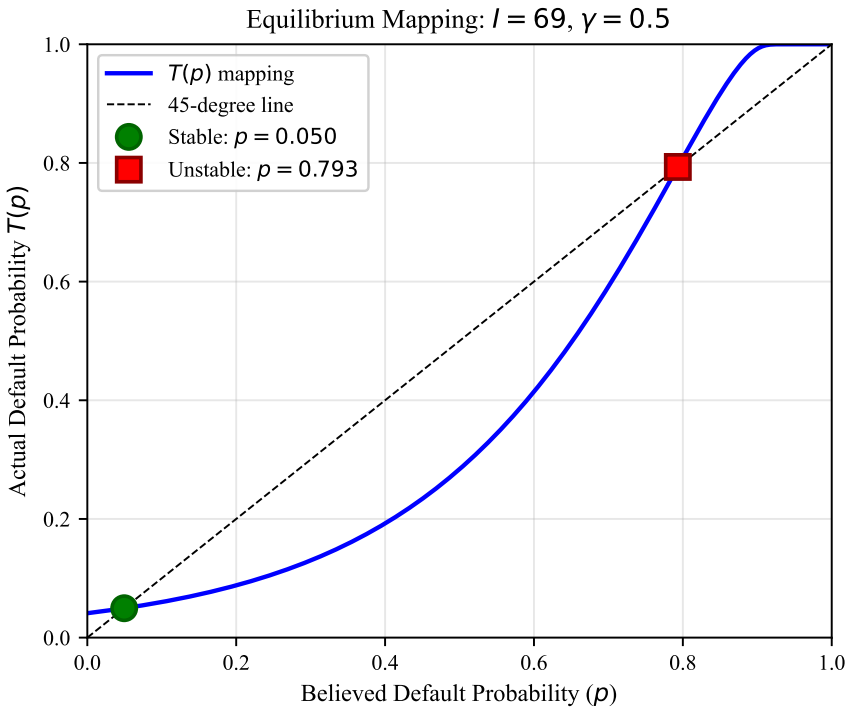


Figure 1: Equilibrium Mapping at $I = 69$, $\gamma = 0.5$

Notes: The figure plots actual default probability $T(p)$ against believed default probability p. Equilibria are intersections with the 45-degree line. The stable equilibrium (green circle) has $p^L = 5.0\%$ with slope 0.19. The unstable critical threshold (red square) has $p^{crit} = 79.3\%$ with slope 2.25. For $p > p^{crit}$, no equilibrium exists. Parameters: $\mu = 100$, $\sigma = 20$, $\alpha = 0.60$, $\tau = 0.21$, $\Psi(0.5) = 3.75$.

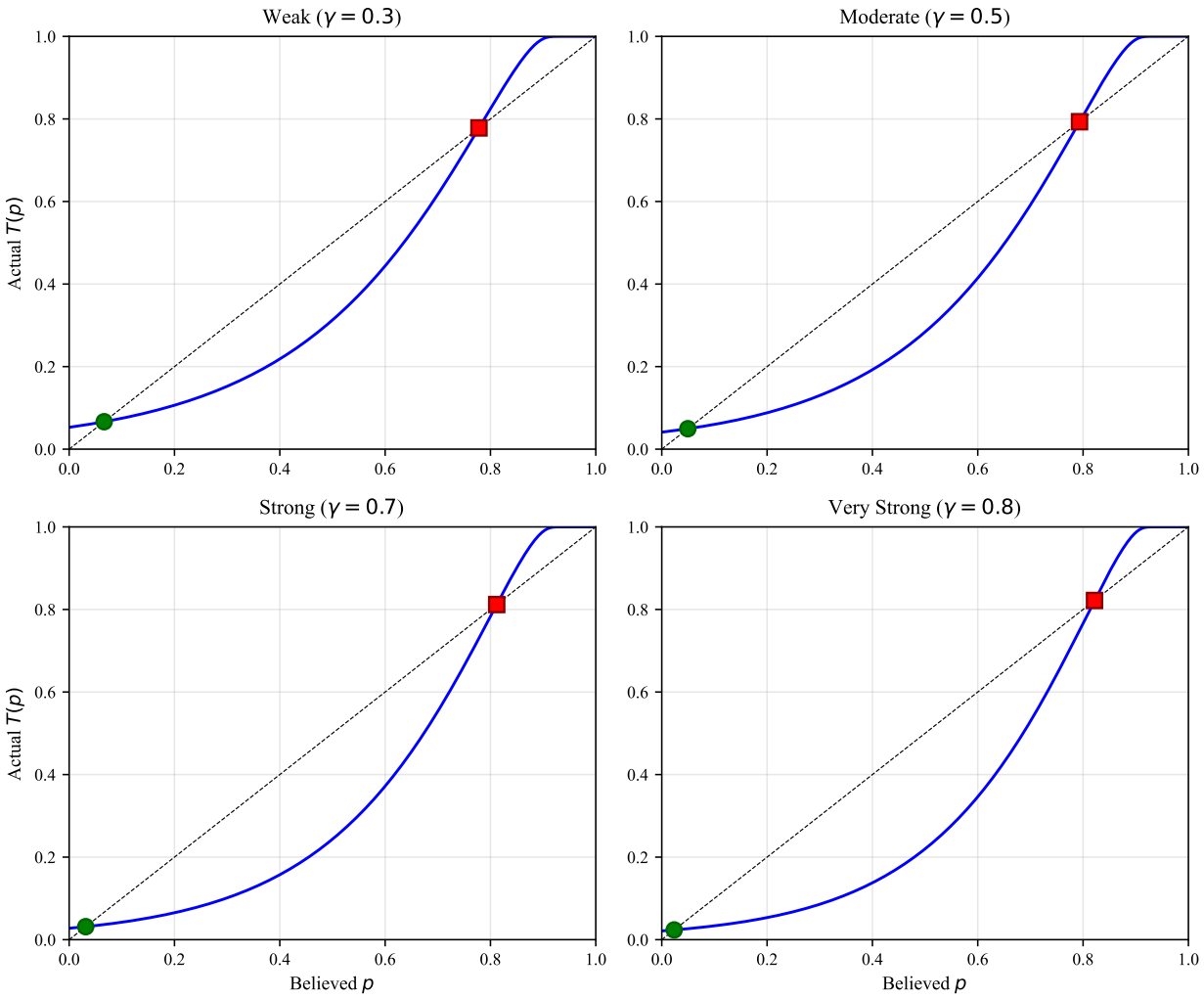


Figure 2: Governance Effects on Equilibrium Multiplicity

Notes: Each panel plots the equilibrium mapping $T(p)$ for a different governance level at $I = 69$. Green circles mark stable equilibria; red squares mark unstable critical thresholds. Better governance shifts both equilibria favorably: the stable equilibrium moves to lower default probability, and the critical threshold moves to higher default probability, expanding the safe region. Parameters as in Table 2.

7.3 Crisis Zone Boundaries and Governance

Table 3 reports how governance quality affects crisis zone boundaries. The lower boundary $I^L(\gamma)$, where $\max_p \partial T/\partial p = 1$, marks the investment level at which self-reinforcing feedback first appears. The upper boundary $I^H(\gamma)$, where $V_F(I^H, \gamma) = 0$, marks maximum sustainable leverage.

The upper boundary increases monotonically from 77.5 to 83.3 as governance improves from $\gamma = 0.3$ to $\gamma = 0.8$, expanding sustainable debt capacity by 7.5%. This confirms Proposition 6, Part 1. The expansion is economically meaningful: for comparison, Graham (2000) estimates that

eliminating the corporate income tax would reduce leverage ratios by approximately 10%, and Heider and Ljungqvist (2015) estimate that a 10 percentage-point tax increase reduces leverage by 4–5 percentage points. The coordination channel is therefore quantitatively comparable to first-order tax considerations in standard tradeoff models.

The lower boundary I^L decreases modestly from 41.8 to 40.5 as governance improves, qualifying the theoretical prediction $dI^L/d\gamma > 0$ from Proposition 6, Part 2. The theoretical argument identifies two opposing effects: better governance reduces the default threshold $X^* = D - \Psi(\gamma)$, stabilizing feedback, but also reduces the equilibrium face value D, which can affect the repricing gap in ways that either dampen or amplify feedback. For our quadratic penalty specification, the second effect slightly dominates, yielding a net decrease in I^L of 1.3 units (3.1%). The robustness analysis in Section 7.8 confirms that $dI^L/d\gamma$ is sensitive to α while $dI^H/d\gamma > 0$ is robust across all specifications.

Crisis zone width expands from 35.7 to 42.8, reflecting the dominance of the I^H expansion. These zones span 36–43% of expected cash flow—economically significant regions where firms face positive probability of losing credit market access despite unchanged fundamentals. The prevalence of intermediate leverage ratios in observed capital structures (Frank and Goyal, 2009) suggests many firms operate in the region where coordination risk is relevant.

Table 3: Crisis Zone Boundaries and Governance Effects

Governance (γ)	Lower Boundary I^L	Upper Boundary I^H	Zone Width ΔI	Governance Effect on I^H (%)
0.3 (Weak)	41.8	77.5	35.7	—
0.5 (Moderate)	41.4	79.1	37.8	$+2.1$
0.7 (Strong)	40.8	81.7	40.9	$+5.4$
0.8 (V. Strong)	40.5	83.3	42.8	$+7.5$

Notes: Crisis zone boundaries computed with baseline parameters from Table 2. $I^L(\gamma)$: entry into crisis zone where a critical threshold coexists with the stable equilibrium. $I^H(\gamma)$: insolvency boundary where expected firm value turns negative. Zone width $\Delta I = I^H - I^L$. Governance effect reports percentage change in I^H relative to weak governance baseline ($I^H = 77.5$). All values in units of expected cash flow ($\mu = 100$).

7.4 Equilibrium Selection and Expected Firm Value

The distinctive feature of the coordination framework is that governance affects firm value primarily through equilibrium selection rather than through direct reduction in default risk. Table 4 demonstrates this quantitatively at $I = 69$.

Table 4: Credit Spreads, Expected Firm Value, and Governance Quality

Gov. (γ)	Stable Eq. Spread (bps)	Critical Threshold	Coord. Prob. π	V_F^L	$\mathbb{E}[V_F]$	Coord. Risk Premium	Spread Vol. (bps)
0.3 (Weak)	333	$p^{crit} = 77.8\%$	0.30	29.6	8.7	20.8	3,013
0.5 (Moderate)	255	$p^{crit} = 79.3\%$	0.50	29.5	14.5	15.0	3,576
0.7 (Strong)	170	$p^{crit} = 81.2\%$	0.70	29.3	20.2	9.1	3,645
0.8 (V. Strong)	131	$p^{crit} = 82.2\%$	0.80	29.2	23.1	6.1	3,370

Notes: All values at $I = 69$ (crisis zone). Stable equilibrium spread r^L reflects the favorable coordination outcome. $\mathbb{E}[V_F] = \pi(\gamma)V_F^L + [1-\pi(\gamma)]V_F^{NL}$ accounts for equilibrium selection, where $V_F^{NL} = -C(\gamma)$. Coordination risk premium is $[1-\pi(\gamma)](V_F^L - V_F^{NL})$. Spread volatility is $\sqrt{\pi(1-\pi)} \times |r^{crit} - r^L|$. All values in units of $\mu = 100$ unless noted.

Firm value at the stable equilibrium V_F^L is nearly invariant to governance, ranging from 29.6 at $\gamma = 0.3$ to 29.2 at $\gamma = 0.8$—a total variation of only 1.3%. This insensitivity arises because direct benefits of governance (lower default probability and hence lower expected distress costs) are offset by increasing governance costs. Improving governance from $\gamma = 0.3$ to $\gamma = 0.8$ reduces expected net distress costs $p_d\widetilde{DC}$ from 1.75 to 0.73—a saving of 1.02—but governance costs rise by 1.10 over the same range, approximately canceling.

Expected firm value $\mathbb{E}[V_F] = \pi(\gamma)V_F^L + [1-\pi(\gamma)]V_F^{NL}$ increases from 8.7 at $\gamma = 0.3$ to 23.1 at $\gamma = 0.8$, a 165% improvement. The coordination risk premium—$[1-\pi(\gamma)](V_F^L - V_F^{NL})$, measuring expected value destroyed by the possibility of credit market breakdown—declines from 20.8 to 6.1, a 71% reduction. Approximately 95% of the governance effect on expected firm value operates through equilibrium selection rather than through within-equilibrium distress cost reduction.

This dominance of the extensive margin (probability of operating) over the intensive margin (distress costs conditional on operating) has implications for empirical work. Controlling for fundamentals that determine V_F^L—asset volatility, recovery rates, tax shields—should not absorb the governance effect, since it operates through a different channel entirely.

7.5 Validating Testable Predictions

We now test the model's distinguishing predictions against the calibrated equilibria.

7.5.1 Prediction 1: Marginal Value of Governance Varies with Leverage

Proposition 7 establishes that the marginal value of governance depends on a firm's position relative to crisis zone boundaries. In the safe zone, only direct effects on default probability operate. In the crisis zone, the equilibrium selection term $\pi'(\gamma)[V_F^L - V_F^{NL}]$ appears.

Table 5: Marginal Value of Governance Across Leverage Levels

Investment Level (I)	Region	Default Prob. at $\gamma = 0.5$	$\partial \mathbb{E}[V_F]/\partial \gamma$
40	Safe Zone	0.1%	-2.0
69	Crisis Zone	5.0%	28.8
78	Near Insolvency	19.2%	22.1

Notes: Marginal value computed as $\partial \mathbb{E}[V_F]/\partial \gamma$ by central finite differences at $\gamma = 0.5$. In the safe zone ($I = 40 < I^L$), marginal value is negative: governance cost $C'(\gamma) = 2.0$ exceeds the negligible reduction in distress costs when $p_d = 0.1\%$. In the crisis zone ($I = 69$), the equilibrium selection effect $\pi'(\gamma)(V_F^L - V_F^{NL})$ dominates. Near insolvency ($I = 78$), marginal value remains large but declines as V_F^L shrinks.

Table 5 reports $\partial \mathbb{E}[V_F]/\partial \gamma$ computed by central finite differences at $\gamma = 0.5$ for three leverage levels. In the safe zone ($I = 40$, $p_d = 0.1\%$), marginal governance value is *negative*: -2.0. The governance cost $C'(\gamma) = 4\gamma = 2.0$ exceeds the negligible distress cost savings when default is virtually impossible. Investing in governance when the firm carries so little leverage that coordination failure cannot arise is pure cost. This contrasts with agency theories, which generally predict positive governance returns at all leverage levels.[11]

At intermediate leverage in the crisis zone ($I = 69$, $p_d = 5.0\%$), marginal governance value is large and positive: 28.8. With $V_F^L \approx 29.5$ and $V_F^{NL} \approx -0.5$, a unit increase in coordination probability generates approximately 30 units of expected value. Near the insolvency boundary ($I = 78$, $p_d = 19.2\%$), marginal value remains positive at 22.1 but is lower than in the crisis zone interior because V_F^L declines with leverage, reducing the value gap that the selection effect exploits.

The pattern—negative returns in the safe zone, peak returns at intermediate leverage, declining returns near insolvency—provides a sharp test. The mechanism is the equilibrium selection term $\pi'(\gamma)[V_F^L - V_F^{NL}]$, which is largest when the value gap between operating successfully and experiencing credit market breakdown is substantial. This value gap peaks at intermediate leverage, not at the boundaries.

7.5.2 Prediction 2: Better Governance Reduces Expected Financing Costs

Table 4 demonstrates that governance unambiguously reduces expected financing costs at fixed investment $I = 69$ and constant cash flow volatility. The stable-equilibrium credit spread declines from 333 basis points at $\gamma = 0.3$ to 131 basis points at $\gamma = 0.8$, a 202 basis point reduction (61%). This

[11] In free cash flow models (Jensen, 1986), governance value is maximized at low leverage where managerial discretion is greatest. In asset substitution models (Jensen and Meckling, 1976), governance value peaks at high leverage where risk-shifting incentives are strongest. Neither predicts *negative* governance returns at low leverage.

operates through the direct penalty channel: higher $\Psi(\gamma)$ lowers the default threshold, reducing p_d from 6.6% to 2.4%.

The coordination risk premium declines even more sharply, from 20.8 to 6.1 (71%). As documented in Section 7.4, approximately 95% of the improvement in expected firm value operates through equilibrium selection. The prediction differs from agency theories in mechanism: controlling for asset volatility and recovery rates should not absorb the governance effect, since the latter operates through $\pi(\gamma)$ rather than through the distress cost parameters that standard controls capture.

7.5.3 Prediction 3: Expected Firm Value Drops Discontinuously at Crisis Zone Boundaries

Corollary 1 establishes that expected firm value exhibits a discrete decline at $I^L(\gamma)$. Below I^L, a unique equilibrium exists and $\mathbb{E}[V_F] = V_F^L$. Above I^L, the critical threshold appears, introducing probability $1 - \pi(\gamma)$ of breakdown that discretely reduces $\mathbb{E}[V_F]$.

Figure 3 illustrates at $\gamma = 0.5$ with $I^L = 41.4$. Panel A plots expected firm value against investment level. In the safe zone ($I < 41.4$), $\mathbb{E}[V_F]$ follows V_F^L, declining smoothly with leverage. At I^L, expected firm value drops sharply. With $\pi = 0.5$ and $V_F^L \approx 58$ at the boundary, the value falls from approximately 58 to roughly $0.5 \times 58 + 0.5 \times (-0.5) \approx 29$—a decline of approximately 50%. The dashed line in Panel A traces V_F^L alone, showing what firm value would be absent coordination risk; the gap between this counterfactual and the solid crisis-zone line measures the coordination risk premium.

Panel B plots default probability at the stable equilibrium, which increases smoothly across the entire range with no discontinuity at I^L. This confirms that the expected value jump reflects the discrete appearance of coordination risk rather than a sudden change in fundamental default probability.

This discontinuity is absent from smooth tradeoff models. In Leland (1994) or Merton (1974) frameworks, spreads respond continuously to leverage because the default boundary and recovery value vary smoothly with debt levels. The discrete jump at I^L provides a distinctive empirical signature: seemingly small increases in leverage can produce dramatic credit repricing as firms cross into the crisis zone.

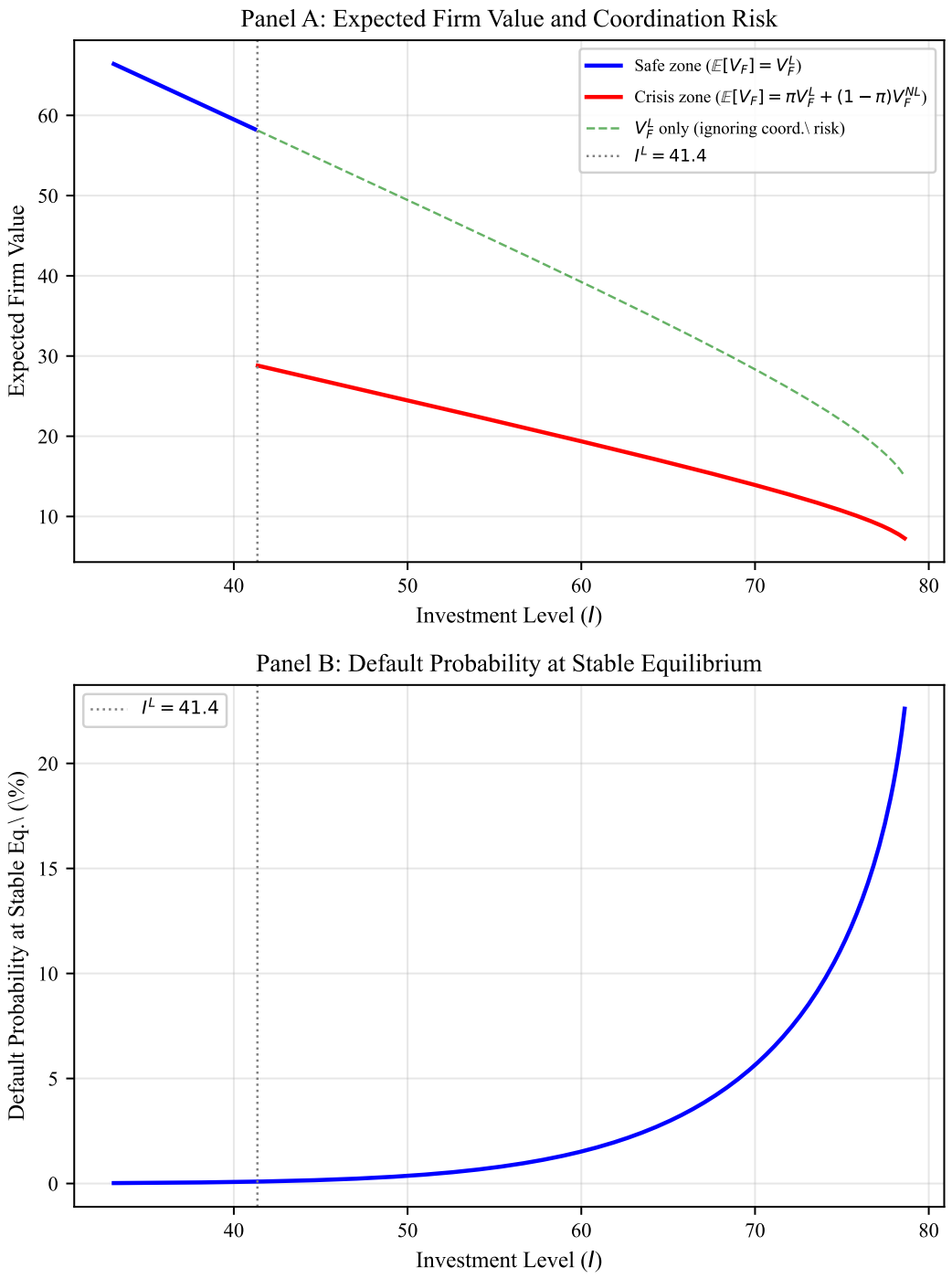


Figure 3: Expected Value and Default Probability by Investment Level

Notes: Panel A plots expected firm value $\mathbb{E}[V_F] = \pi(\gamma)V_F^L + [1-\pi(\gamma)]V_F^{NL}$ (solid line) versus value at stable equilibrium V_F^L (dashed line) for $\gamma = 0.5$. At $I^L = 41.4$, expected value drops discretely as coordination risk appears. Panel B plots default probability at the stable equilibrium, which increases smoothly through the boundary. Parameters as in Table 2.

7.5.4 Prediction 4: Non-Monotonic Spread Volatility

Section 6 identifies a fourth distinguishing prediction: the relationship between governance quality and credit spread volatility is non-monotonic. Table 4 confirms this prediction.

Spread volatility equals 3,013 basis points at $\gamma = 0.3$, rises to 3,576 at $\gamma = 0.5$ and 3,645 at $\gamma = 0.7$, then declines to 3,370 at $\gamma = 0.8$. The volatility formula is

$$\sigma_r = \sqrt{\pi(\gamma)\,[1 - \pi(\gamma)]} \times (r^{crit} - r^L). \tag{30}$$

Two competing forces drive the non-monotonicity. The variance factor $\pi(1-\pi)$ is maximized at $\pi = 1/2$: improving governance from $\gamma = 0.3$ toward $\gamma = 0.5$ moves the coordination probability toward the maximum-variance point. Simultaneously, better governance widens the spread gap $r^{crit} - r^L$: the stable-equilibrium spread falls substantially (from 333 to 131 basis points), while the critical threshold spread is relatively insensitive (from 6,909 to 8,556 basis points). For $\gamma \leq 0.5$, both forces push volatility upward. For $\gamma > 0.7$, the variance factor dominates and volatility declines.

The economic interpretation is distinctive. A firm with very weak governance ($\pi = 0.30$) has relatively low spread volatility not because it is safe, but because the adverse outcome is near-certain. With 70% probability of breakdown, there is little uncertainty about which state will prevail. As governance improves, outcomes become genuinely uncertain, generating peak spread volatility. Only with sufficiently strong governance does favorable coordination become likely enough to reduce uncertainty.

This pattern is absent from agency theories, which predict that governance monotonically reduces spread dispersion. An empirical test could regress credit spread volatility on governance quality and its square, controlling for fundamental cash flow volatility. The coordination model predicts a positive linear coefficient and a negative quadratic coefficient; agency theories predict a monotonically negative relationship.

7.6 Net Distress Cost Decomposition

The calibration permits a decomposition of net distress costs that clarifies the within-equilibrium mechanism. At $\gamma = 0.5$, $I = 69$, net distress cost $\widetilde{DC} = 27.59$, composed of three components: bankruptcy deadweight losses $(1-\alpha)\mathbb{E}[X \mid X < X^*] = 23.47$ (85%), the default penalty $\Psi(\gamma) = 3.75$ (14%), and the forgone tax shield $\tau(D - I) = 0.37$ (1%).

As governance increases from $\gamma = 0.3$ to $\gamma = 0.8$, total distress costs $\widetilde{DC}$ *increase* from 26.31 to 30.91 (18% rise), driven by the rising default penalty. However, expected distress costs $p_d\widetilde{DC}$ *decline* from 1.75 to 0.73 (58% fall) because the reduction in default probability more than offsets the higher per-default cost. This confirms the theoretical mechanism: governance reduces the probability of incurring distress costs by more than it increases costs per event.

7.7 Model Fit

The calibrated model matches several empirical regularities that are difficult to explain in standard frameworks.

First, credit spread volatility conditional on fundamental risk is substantial and varies systematically with firm characteristics. In the crisis zone, spread volatility arises from equilibrium selection uncertainty even holding cash flow risk constant. This matches evidence that the excess bond premium—the component of credit spreads orthogonal to estimated default probabilities—exhibits large time-series variation (Gilchrist and Zakrajšek, 2012). In our framework, this variation reflects shifts in coordination probability $\pi(\gamma)$ rather than changes in fundamentals, providing a structural interpretation of what Gilchrist and Zakrajšek attribute to "the effective risk-bearing capacity of the financial sector."

Second, default clustering exceeds predictions from correlated fundamentals alone. When multiple firms inhabit the crisis zone simultaneously, a common sentiment shock can push all past their critical thresholds, generating synchronized defaults. Giesecke et al. (2011) document that observed default correlation is too high to be explained by firm-level and aggregate risk factors. The coordination mechanism provides a complementary channel: self-fulfilling creditor pessimism generates correlated credit market breakdowns even among firms with heterogeneous fundamentals, provided they share the crisis zone.

Third, many firms appear underleveraged relative to tax-benefit calculations. Strebulaev and Yang (2013) find that approximately 10% of public firms maintain zero debt despite positive marginal tax benefits. In our framework, firms with moderate governance rationally avoid the crisis zone even when stable-equilibrium outcomes at higher leverage dominate on both default probability and tax shields. Expected firm value accounting for coordination risk can be lower at $I = 50$ (crisis zone) than at $I = 40$ (safe zone), providing a rational foundation for conservative leverage policies that does not require managerial myopia or behavioral frictions.

7.8 Robustness

Online Appendix Table 7 reports sensitivity of crisis zone boundaries to three key parameters at $\gamma = 0.5$.

Varying α from 0.55 to 0.70 shifts boundaries substantially. I^L ranges from 36.9 to 51.0 and I^H from 78.0 to 81.8. Higher recovery rates weaken the repricing feedback, requiring higher leverage before fragility emerges, while narrowing crisis zone width from 41.1 to 30.8. Varying σ from 15 to 25 shifts I^L from 44.5 to 38.7 and I^H from 82.4 to 76.7; zone width remains stable near 38. Varying the penalty coefficient from 10 to 20 generates modest effects: I^L ranges from 41.6 to 41.2 and I^H from 78.3 to 80.0.

Across all specifications, the testable predictions receive consistent support. Marginal governance value peaks in the crisis zone. The coordination risk premium declines substantially with governance. Expected firm value exhibits a discrete decline at crisis zone boundaries. Spread volatility is non-monotonic, peaking near $\gamma = 0.5$. The governance effect on I^H in the baseline ranges from $+2.1\%$ to $+7.5\%$ as governance improves from weak to very strong (Table 3), and this ordering is preserved across robustness specifications. The prediction $dI^H/d\gamma > 0$ is robust; $dI^L/d\gamma$ is sensitive to α, as discussed in Section 4.1.

7.9 Discussion

The calibration yields five findings that merit emphasis.

First, crisis zones span substantial fractions of viable leverage. At moderate governance, the zone covers $I \in [41.4,\ 79.1]$, or 37.8% of expected cash flow.

Second, governance operates almost entirely through equilibrium selection. Stable-equilibrium firm value varies by only 1.3% across governance levels, while expected firm value increases by 165%. Approximately 95% of the improvement comes from shifting probability weight toward the operating outcome. This dominance of the extensive margin over the intensive margin distinguishes the coordination channel from agency theories, where governance operates through within-firm improvements.

Third, marginal governance value is *negative* in the safe zone. When coordination failure is impossible, governance is pure cost: $C'(\gamma) = 2.0$ exceeds the marginal distress saving when $p_d = 0.1\%$. This contrasts with agency theories, which predict positive governance returns at all leverage levels.

Fourth, the non-monotonic spread volatility prediction provides a sharp basis for empirical discrimination. The inverted-U pattern (3,013 to 3,645 to 3,370 basis points) is unique to the coordination framework. The counterintuitive implication—that weak governance can be associated with *low* spread volatility because the adverse outcome is near-certain—has no analogue in agency models.

Fifth, the calibration qualifies the theoretical prediction $dI^L/d\gamma > 0$. In our baseline specification, I^L declines modestly with governance (from 41.8 to 40.5), though the magnitude is small (3.1%). The more policy-relevant prediction $dI^H/d\gamma > 0$ is robust across all specifications, with the 7.5% expansion in maximum sustainable leverage comparable to effects of substantial changes in tax policy (Heider and Ljungqvist, 2015) or recovery rates in standard tradeoff models (Bris et al., 2006).

8 Empirical Implications

The coordination channel generates four predictions that can be tested against agency alternatives using standard data. We state each as a regression specification.

Let r_{it} denote the credit spread (CDS or bond yield minus the matched maturity Treasury) for firm i in period t, G_{it} a governance index, L_{it} market leverage (total debt divided by total debt plus equity market capitalization), and $\mathbf{X}_{it}$ a vector of controls including asset volatility, profitability, firm size, and credit rating.

Prediction 1 (Governance effects peak at intermediate leverage).

$$r_{it} = \beta_1 G_{it} + \beta_2 G_{it} \times \mathbf{1}[L_{it} \in Q_2] + \beta_3 G_{it} \times \mathbf{1}[L_{it} \in Q_3] + \boldsymbol{\delta}'\mathbf{X}_{it} + \alpha_i + \mu_t + \varepsilon_{it}. \tag{31}$$

Here Q_1, Q_2, Q_3 are within industry leverage terciles (low, intermediate, high), with Q_1 as the omitted category. The coordination model predicts $\beta_2 < 0$ and $|\beta_2| > |\beta_3|$. Governance reduces spreads most at intermediate leverage. Asset substitution theory predicts $|\beta_3| > |\beta_2|$ (strongest at high leverage). Free cash flow theory predicts $|\beta_1| > |\beta_2|, |\beta_3|$ (strongest at low leverage).

Prediction 2 (Spread discontinuity at crisis zone boundary).

$$r_{it} = \gamma_0 + \gamma_1 f(L_{it} - \hat{L}_i^*) + \gamma_2 \mathbf{1}[L_{it} > \hat{L}_i^*] + \boldsymbol{\delta}'\mathbf{X}_{it} + \mu_t + \varepsilon_{it}, \tag{32}$$

where $\hat{L}_i^*$ is the estimated crisis zone boundary and $f(\cdot)$ is a polynomial in the running variable.

The coordination model predicts $\gamma_2 > 0$. A discrete spread increase at the boundary. Standard tradeoff models predict $\gamma_2 = 0$ (smooth leverage spread relationship). The boundary $\hat{L}_i^*$ can be estimated as the within industry leverage percentile at which the excess bond premium first becomes significantly positive. Or it can be calibrated from model primitives using firm level estimates of α, σ, and γ.

Prediction 3 (Governance reduces expected financing costs through equilibrium selection).

$$r_{it} = \beta_0 + \beta_1 G_{it} + \boldsymbol{\delta}' \mathbf{X}_{it} + \alpha_i + \mu_t + \varepsilon_{it}, \qquad \beta_1 < 0. \tag{33}$$

All three theories predict $\beta_1 < 0$. The coordination channel is identified by persistence of $\beta_1 < 0$ after controlling for asset volatility and expected recovery. These controls are intended to absorb the agency channels but not the equilibrium selection mechanism. Prediction 1 provides the sharper test.

Prediction 4 (Non-monotonic spread volatility).

$$\sigma_{r,it} = \delta_0 + \delta_1 G_{it} + \delta_2 G_{it}^2 + \boldsymbol{\delta}' \mathbf{X}_{it} + \mu_t + \varepsilon_{it}, \tag{34}$$

where $\sigma_{r,it}$ is realized spread volatility (rolling standard deviation of daily CDS spread changes over the prior quarter). The coordination model predicts $\delta_1 > 0$ and $\delta_2 < 0$. An inverted-U relationship that peaks where coordination uncertainty is maximal. Agency theories predict $\delta_1 < 0$ and $\delta_2 = 0$. In other words a monotonically negative relationship.

Identification. Predictions 1 and 4 are the sharpest discriminating tests. Each generates sign patterns that differ qualitatively across the three theories. Governance reforms (e.g., exchange listing requirements) and crisis episodes provide variation for difference-in-differences designs. The model predicts heterogeneous treatment effects concentrated at intermediate leverage.

9 Conclusion

This paper develops a theory of debt capacity based on creditor coordination. When debt contracts are priced under rational expectations, strategic complementarity in creditor beliefs generates multiple equilibria for intermediate leverage levels. In this "crisis zone," firms with identical fundamentals can experience dramatically different borrowing costs depending on which self-fulfilling equilibrium creditors coordinate on.

Corporate governance eliminates these bad equilibria. By raising the penalty shareholders bear upon default, strong governance disciplines the repayment decision and weakens the feedback between creditor pessimism and actual default. The crisis zone shrinks as governance improves, and for sufficiently strong governance, only the good equilibrium survives. Governance thus serves as a coordination device, not merely an agency cost reducer.

The model has several testable implications. First, the marginal value of governance should be highest for firms with intermediate leverage, where coordination concerns are most severe. For low leverage firms safely below the crisis zone, governance improvements have modest benefits through reduced default probability. For high leverage firms deep in distress, governance cannot restore viability. Second, better governed firms should have lower credit spread volatility, controlling for fundamental cash flow risk, as they are less exposed to belief driven fluctuations. Third, credit spreads may respond discontinuously to small changes in leverage near crisis zone boundaries, generating non-linear relationships that standard empirical specifications may miss.

Several extensions merit subsequent investigation. The model assumes one period debt. A dynamic extension with rollover risk would connect our coordination mechanism to the literature on debt runs. We assume governance is chosen before creditors form beliefs. Allowing governance to respond to market conditions would introduce additional strategic considerations. Finally, empirical work identifying crisis zone boundaries and testing for spread discontinuities would help discipline the theory's quantitative predictions.

A Mathematical Appendix

This appendix provides formal derivations for the equilibrium conditions and the sensitivity analysis underlying the main results.

A.1 Notation

Throughout, $\phi(\cdot)$ denotes the standard normal density, $\Phi(\cdot)$ denotes the standard normal distribution function, and $\lambda(z) \equiv \phi(z)/\Phi(z)$ denotes the inverse Mills ratio.

A.2 The Break-Even Condition

Creditors lend I at date 0 and receive face value D if the firm repays or recovery αX if the firm defaults. The firm defaults when $X < X^* = D - \Psi(\gamma)$, where the threshold reflects shareholders'

willingness to inject equity up to $\Psi(\gamma)$ to avoid the default penalty.

The default probability is $p_d = \Phi(z^*)$ where $z^* = (D - \Psi(\gamma) - \mu)/\sigma$. Conditional on default, the expected cash flow is

$$\mathbb{E}[X \mid X < X^*] = \mu - \sigma\lambda(z^*), \tag{35}$$

using the truncated normal expectation formula. Creditors recover fraction α of this amount.

The break-even condition equates investment to expected repayment:

$$I = (1 - p_d)D + p_d \cdot \alpha[\mu - \sigma\lambda(z^*)]. \tag{36}$$

A.3 Properties of the Inverse Mills Ratio

Lemma 1. *The inverse Mills ratio satisfies*

1. $\lambda(z) > 0$ *for all* $z \in \mathbb{R}$
2. $\lambda(z) + z > 0$ *for all* $z \in \mathbb{R}$
3. $\dfrac{d\lambda}{dz} = -\lambda(z)[\lambda(z) + z]$

Proof. Parts (1) and (2) are standard properties. For part (3), apply the quotient rule:

$$\frac{d\lambda}{dz} = \frac{\phi'(z)\Phi(z) - \phi(z)\phi(z)}{[\Phi(z)]^2}. \tag{37}$$

Since $\phi'(z) = -z\phi(z)$ for the standard normal density,

$$\frac{d\lambda}{dz} = \frac{-z\phi(z)\Phi(z) - [\phi(z)]^2}{[\Phi(z)]^2} = -z\lambda(z) - \lambda(z)^2 = -\lambda(z)[\lambda(z) + z]. \tag{38}$$

□

Part (2) ensures the stabilizing term in the denominator of $\partial D/\partial p$ is positive. Part (3) is used repeatedly in the sensitivity calculations.

A.4 Sensitivity of Face Value to Beliefs

For given (I, γ), the break-even condition implicitly defines face value D as a function of believed default probability p. Differentiating (36) with respect to p,

$$0 = -D + (1-p)\frac{\partial D}{\partial p} + \alpha[\mu - \sigma\lambda(z^*)] + p\alpha(-\sigma)\frac{\partial \lambda}{\partial p}. \tag{39}$$

The term $\partial\lambda/\partial p$ uses the chain rule:

$$\frac{\partial \lambda(z^*)}{\partial p} = \left.\frac{d\lambda}{dz}\right|_{z^*} \cdot \frac{\partial z^*}{\partial D} \cdot \frac{\partial D}{\partial p} = -\lambda(z^*)[\lambda(z^*) + z^*] \cdot \frac{1}{\sigma} \cdot \frac{\partial D}{\partial p}, \tag{40}$$

where we used $\partial z^*/\partial D = 1/\sigma$ and Lemma 1(3).

Substituting into (39),

$$0 = -D + (1-p)\frac{\partial D}{\partial p} + \alpha[\mu - \sigma\lambda(z^*)] + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]\frac{\partial D}{\partial p}. \tag{41}$$

Collecting terms,

$$[(1-p) + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]]\,\frac{\partial D}{\partial p} = D - \alpha[\mu - \sigma\lambda(z^*)]. \tag{42}$$

Solving,

$$\frac{\partial D}{\partial p} = \frac{D - \alpha[\mu - \sigma\lambda(z^*)]}{1 - p + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]}. \tag{43}$$

The numerator $D - \alpha[\mu - \sigma\lambda(z^*)]$ is the repricing gap between promised payment in repayment states and expected recovery in default states. The denominator is positive by Lemma 1(2), ensuring $\partial D/\partial p > 0$. Creditor pessimism raises required face value.

A.5 Slope of the Equilibrium Mapping

The equilibrium mapping is $T(p) = \Phi(z^*(D(p)))$. The slope is

$$\frac{\partial T}{\partial p} = \phi(z^*) \cdot \frac{\partial z^*}{\partial D} \cdot \frac{\partial D}{\partial p} = \frac{\phi(z^*)}{\sigma} \cdot \frac{\partial D}{\partial p}. \tag{44}$$

Substituting (43),

$$\frac{\partial T}{\partial p} = \frac{\phi(z^*)}{\sigma} \cdot \frac{D - \alpha[\mu - \sigma\lambda(z^*)]}{1 - p + p\alpha\lambda(z^*)[\lambda(z^*) + z^*]}. \tag{45}$$

Multiple equilibria exist when $\max_{p\in[0,1]} \partial T/\partial p > 1$.

A.6 Comparative Statics of the Maximum Slope

Lemma 2 (Effect of Governance on Maximum Slope)**.** *Higher governance quality has an ambiguous effect on the maximum slope of the equilibrium mapping:*

$$\frac{\partial S}{\partial \gamma} = \frac{\partial}{\partial \gamma}\Big(\max_{p} \frac{\partial T}{\partial p}\Big) \lesseqgtr 0.$$

Two opposing forces determine the sign.

Proof. Higher γ increases $\Psi(\gamma)$, which affects the slope expression (45) through $z^* = (D - \Psi(\gamma) - \mu)/\sigma$.

We analyze the effect on each component of the slope at fixed (I, p).

Effect on D. At fixed (I, p), higher $\Psi(\gamma)$ requires adjustment in the face value D to maintain creditor break-even. Differentiating the break-even condition (36) with respect to γ at fixed (I, p):

$$0 = (1-p)\,\frac{\partial D}{\partial \gamma} + p\,\alpha\,\frac{\partial}{\partial \gamma}\big[\mu - \sigma\lambda(z^*)\big]. \tag{46}$$

The second term involves $\partial[\mu - \sigma\lambda(z^*)]/\partial\gamma = -\sigma\,(d\lambda/dz)\,(\partial z^*/\partial\gamma)$. Using $d\lambda/dz = -\lambda(\lambda + z)$ and $\partial z^*/\partial\gamma = (1/\sigma)(\partial D/\partial\gamma - \Psi'(\gamma))$.

Substituting into (46) and collecting terms in $\partial D/\partial\gamma$ gives

$$\left.\frac{\partial D}{\partial \gamma}\right|_{I,p} = \frac{p\,\alpha\,\lambda(z^*)[\lambda(z^*) + z^*]\;\Psi'(\gamma)}{(1-p) + p\,\alpha\,\lambda(z^*)[\lambda(z^*) + z^*]} \;>\; 0. \tag{47}$$

The denominator is identical to that of $\partial D/\partial p$ in equation (10) and is positive by Lemma 11. The numerator is positive because $\Psi'(\gamma) > 0$, $\alpha > 0$, $p > 0$, and $\lambda(z^*) > 0$. Face value increases with governance at fixed beliefs because higher $\Psi(\gamma)$ lowers the default threshold, worsening expected recovery conditional on default and requiring creditors to charge more to break even.

Net effect on z^*. Since $z^* = (D - \Psi - \mu)/\sigma$,

$$\left.\frac{\partial z^*}{\partial \gamma}\right|_{I,p} = \frac{1}{\sigma}\left(\frac{\partial D}{\partial \gamma} - \Psi'(\gamma)\right). \tag{48}$$

From (47), $\partial D/\partial\gamma < \Psi'(\gamma)$ because the denominator of (47) exceeds the numerator coefficient.

Hence $\partial z^*/\partial\gamma < 0$: the standardized threshold decreases with governance.

Force 1 (stabilizing): Reduced density. For $z^* < 0$ (the relevant region), the standard normal density $\phi(z^*)$ is increasing in z^*. Since $\partial z^*/\partial\gamma < 0$, higher governance reduces $\phi(z^*)$. The prefactor $\phi(z^*)/\sigma$ in the slope expression (45) therefore decreases with γ.

Force 2 (destabilizing): Wider repricing gap. The repricing gap is the numerator of (45): $\Delta \equiv D - \alpha[\mu - \sigma\lambda(z^*)]$. We show $\partial\Delta/\partial\gamma > 0$ at fixed (I, p).

First, $\partial D/\partial\gamma > 0$ from (47).

Second, $\partial z^*/\partial\gamma < 0$ implies $\lambda(z^*)$ increases (since $d\lambda/dz = -\lambda(\lambda+z) < 0$), which raises $\sigma\lambda(z^*)$ and reduces $\mu - \sigma\lambda(z^*)$. Hence $\alpha[\mu - \sigma\lambda(z^*)]$ decreases.

Both effects widen the repricing gap: $\partial\Delta/\partial\gamma > 0$. Economically, creditors facing a lower default threshold condition on worse outcomes in default, recovering less. To compensate, they demand higher face value, which amplifies the feedback from beliefs to outcomes.

Effect on the denominator. The denominator of (45) is $\Sigma \equiv 1 - p + p\,\alpha\,\lambda(z^*)[\lambda(z^*) + z^*]$. Since $\lambda(z^*)$ increases and $\lambda(z^*) + z^*$ remains positive (Lemma 1), Σ increases with γ. This effect is stabilizing: a larger denominator reduces the slope.

Net effect. The slope $\partial T/\partial p$ can be decomposed multiplicatively:

$$\frac{\partial T}{\partial p} = \underbrace{\frac{\phi(z^*)}{\sigma}}_{\text{decreases with } \gamma} \cdot \underbrace{\frac{\Delta}{\Sigma}}_{\text{ambiguous}} \cdot$$

Force 1 (density reduction) and the denominator increase both push the slope down. Force 2 (repricing gap widening) pushes the slope up. The density $\phi(z^*)$ decays as $\exp(-z^{*2}/2)$, which is exponential in $|z^*|$, while the repricing gap Δ grows at most algebraically in $|z^*|$. For $|z^*|$ sufficiently large, Force 1 dominates and $\partial S/\partial\gamma < 0$. For moderate $|z^*|$—the region where $S(I, \gamma)$ attains its maximum when I is near I^L—the forces partially offset and the sign depends on parameter values.

In the baseline calibration ($\alpha = 0.60$, $\sigma = 20$, $\Psi(\gamma) = 15\gamma^2$), Force 2 slightly dominates at the slope-maximizing belief, yielding $\partial S/\partial\gamma > 0$ and hence $dI^L/d\gamma < 0$. The magnitude is small: I^L varies by 1.3 units (3.1%) across $\gamma \in [0.3, 0.8]$. □

A.7 Crisis Zone Boundaries

The lower boundary $I^L(\gamma)$ satisfies $S(I^L, \gamma) = 1$, where $S(I, \gamma) = \max_p \partial T/\partial p$. Since S is continuously differentiable in both arguments with $\partial S/\partial I > 0$ (higher leverage widens the repricing gap), the implicit function theorem gives

$$\frac{dI^L}{d\gamma} = -\frac{\partial S/\partial \gamma}{\partial S/\partial I}. \tag{49}$$

The denominator is positive. The sign of the numerator $\partial S/\partial \gamma$ is determined by the two opposing forces identified in Lemma 2: the density reduction at the default threshold (Force 1, which lowers S) and the widening of the repricing gap (Force 2, which raises S). Because these forces partially offset, the sign of $dI^L/d\gamma$ is ambiguous in general.

When Force 2 dominates, $\partial S/\partial \gamma > 0$ and $dI^L/d\gamma < 0$: governance *lowers* the fragility threshold, meaning self-reinforcing feedback first appears at slightly lower leverage. This is the case in the baseline calibration, where I^L decreases from 41.8 to 40.5 as γ increases from 0.3 to 0.8—a quantitatively small effect (3.1%). When Force 1 dominates (e.g., when γ is sufficiently large that the default threshold lies deep in the left tail), $\partial S/\partial \gamma < 0$ and $dI^L/d\gamma > 0$. Section 7.8 confirms that $|dI^L/d\gamma|$ is small across all specifications.

The upper boundary $I^H(\gamma)$ satisfies $V_F(I^H, \gamma) = 0$. Better governance increases expected firm value: $\partial V_F/\partial \gamma > 0$, because the equilibrium selection effect $\pi'(\gamma)[V_F^L - V_F^{NL}] > 0$ and the within-equilibrium distress reduction jointly dominate the governance cost $C'(\gamma)$ at any interior γ (Proposition 6, Part 1). Since $\partial V_F/\partial I < 0$ at $I = I^H(\gamma)$, the implicit function theorem gives

$$\frac{dI^H}{d\gamma} = -\frac{\partial V_F/\partial \gamma}{\partial V_F/\partial I} = -\frac{(+)}{(-)} > 0. \tag{50}$$

Maximum sustainable debt capacity is therefore strictly increasing in governance quality.

Combining the two results, the net expansion of the crisis zone $I^H(\gamma) - I^L(\gamma)$ is governed by the upper boundary, which responds unambiguously and quantitatively dominates: I^H expands by 7.5% from weak to strong governance, versus at most 3.1% variation in I^L (Table 3).

B Proofs for Robustness Extensions

B.1 Renegotiation

In the baseline model, debt contracts are rigid: the firm either repays face value D or defaults. This subsection considers whether ex-post renegotiation eliminates equilibrium multiplicity.

Proposition 9. *If coordination frictions prevent creditors from collectively agreeing to debt forgiveness, equilibrium multiplicity persists under renegotiation.*

Proof. Consider an extension where, after cash flow X is realized but before the repayment decision, creditors can collectively forgive debt ΔD to avoid costly default.

Efficiency of forgiveness. When $X \in [D - \Delta D, D)$, forgiveness of $D - X$ allows repayment and avoids bankruptcy costs $(1 - \alpha)X$. Forgiveness is collectively efficient if $(1 - \alpha)X > D - X$, i.e., if $X > D/(2 - \alpha)$.

Holdout problem. With dispersed debt, collective forgiveness requires coordination. Consider atomistic creditors each holding measure zero of the debt. If creditor i forgives δ_i while others do not, creditor i bears cost δ_i but the firm still defaults since total forgiveness is negligible. In the unique Nash equilibrium, no creditor forgives. Collective forgiveness fails despite being efficient.

Effect on date-0 pricing. Even if a coordination mechanism enabled forgiveness, anticipation affects pricing. Let p_r denote the probability of renegotiation and $\mathbb{E}[\Delta D|\text{renego}]$ the expected forgiveness. The break-even condition becomes

$$I = (1 - p_d - p_r)D + p_r(D - \mathbb{E}[\Delta D]) + p_d \cdot \alpha[\mu - \sigma\lambda(z^*)]. \tag{51}$$

This modifies the level of D but preserves the feedback structure. Higher believed default probability still requires higher face value, which raises the threshold and potentially confirms beliefs. The slope of the equilibrium mapping $T(p)$ may change quantitatively, but retains the property that $\partial T/\partial p$ can exceed unity for intermediate investment.

Persistence of multiplicity. The mapping $T(p)$ under renegotiation satisfies the same boundary conditions as the baseline: $T(0) > 0$ (some default occurs even under optimism) and $T(1) < 1$ (some repayment occurs even under pessimism). If the slope exceeds unity for some p, multiple fixed points exist. Renegotiation reduces the slope by lowering the repricing gap but does not eliminate the feedback mechanism. Multiplicity persists whenever coordination frictions prevent complete renegotiation. □

The proposition implies that dispersed debt structures, which exacerbate coordination problems, make firms more vulnerable to multiple equilibria. Concentrated debt such as a bank loan may reduce multiplicity by facilitating renegotiation. This connects to Bolton and Scharfstein (1996).

B.2 Risk Aversion

The baseline model assumes risk-neutral creditors. Here we verify that risk aversion does not eliminate multiplicity.

Proposition 10. *With risk-averse creditors, equilibrium multiplicity persists. Risk aversion widens the crisis zone.*

Proof. Let creditors have utility function $u(\cdot)$ with $u' > 0$ and $u'' < 0$. The break-even condition becomes

$$u(I) = (1 - p_d)u(D) + p_d \cdot \mathbb{E}[u(\alpha X) \mid X < X^*]. \tag{52}$$

For $p = 0$, this yields D_0 satisfying $u(I) = u(D_0)$, so $D_0 = I$ as in the risk-neutral case. For $p > 0$, risk aversion implies creditors demand a risk premium: $D(p)$ exceeds the risk-neutral level.

The repricing gap $D - \mathbb{E}[\alpha X|\text{default}]$ is larger under risk aversion because D is higher. This increases the numerator of $\partial T/\partial p$, raising the slope. Since higher slope makes multiplicity more likely, risk aversion widens the crisis zone.

The feedback mechanism is unchanged: pessimism raises D, which raises X^*, which raises actual default probability. Risk aversion amplifies this feedback by increasing the face value response to pessimism. □

B.3 Continuous Governance Choice

The main text takes governance γ as given when characterizing equilibria for each (I, γ) pair. This subsection considers joint optimization over (γ, I).

Proposition 11. *At an interior optimum (γ^*, I^*):*

1. *The optimal governance choice equates marginal benefit to marginal cost:*

$$\pi'(\gamma^*)[V_F^L - V_F^H] + (1 - p_d)\tau(D - I)\frac{\Psi'(\gamma^*)}{\sigma}\phi(z^*) = C'(\gamma^*) + p_d\Psi'(\gamma^*). \tag{53}$$

2. *Governance and investment are complements near crisis zone boundaries:* $\partial^2 V_F/\partial\gamma\partial I > 0$.

Proof. Part 1. Expected firm value is

$$V_F(\gamma, I) = \pi(\gamma)V_F^L + [1 - \pi(\gamma)]V_F^H, \tag{54}$$

where within each equilibrium:

$$V_F^k = \mu - I + (1 - p_d^k)\tau(D^k - I) - C(\gamma) - p_d^k(1 - \alpha)\mathbb{E}[X|X < X^{*k}] - p_d^k\Psi(\gamma). \tag{55}$$

The first-order condition $\partial V_F/\partial\gamma = 0$ gives

$$0 = \pi'(\gamma)[V_F^L - V_F^H] + \pi(\gamma)\frac{\partial V_F^L}{\partial\gamma} + [1 - \pi(\gamma)]\frac{\partial V_F^H}{\partial\gamma}. \tag{56}$$

Within equilibrium k, using $\partial p_d^k/\partial\gamma = -\phi(z^{*k})\Psi'(\gamma)/\sigma$,

$$\frac{\partial V_F^k}{\partial\gamma} = (1 - p_d^k)\tau(D^k - I)\frac{\Psi'(\gamma)}{\sigma}\phi(z^{*k}) - C'(\gamma) - p_d^k\Psi'(\gamma) + \text{smaller terms}. \tag{57}$$

The first term is the marginal tax shield benefit from reduced default probability. The second is marginal governance cost. The third is the marginal increase in expected default penalty. At an interior optimum, these balance against the equilibrium selection benefit $\pi'(\gamma)[V_F^L - V_F^H]$.

Part 2. The cross-partial is

$$\frac{\partial^2 V_F}{\partial\gamma\partial I} = \pi'(\gamma)\left[\frac{\partial V_F^L}{\partial I} - \frac{\partial V_F^H}{\partial I}\right] + \text{direct effects}. \tag{58}$$

Since the good equilibrium has lower credit spreads, the marginal cost of investment is lower: $\partial V_F^L/\partial I > \partial V_F^H/\partial I$, where both are negative but L is smaller in magnitude. Combined with $\pi'(\gamma) > 0$, the equilibrium selection component is positive.

Near crisis zone boundaries, the gap $V_F^L - V_F^H$ is largest, making the cross-partial positive. Governance and investment are complements: firms planning high leverage optimally invest more in governance because governance reduces the probability of the bad equilibrium where high leverage is most costly. □

The complementarity result predicts positive correlation between governance quality and leverage in the cross-section, particularly for firms near crisis zone boundaries.

Online Appendix

OA.1 Bankruptcy Protocol

This appendix provides institutional background on the bankruptcy assumptions and verifies technical conditions.

OA.1.1 Institutional Background

The baseline model assumes courts enforce absolute priority when creditors are impaired: shareholders receive nothing from the bankruptcy estate until creditors are paid in full. This assumption reflects modern Chapter 11 practice.

Early empirical work documented frequent deviations from absolute priority. Franks and Torous (1989) found that shareholders retained value in 78% of bankruptcies where creditors were impaired, typically through negotiated settlements that gave shareholders equity in the reorganized firm.

Subsequent research shows these deviations have diminished. Ayotte and Morrison (2009) find that increased creditor control through debtor-in-possession financing and creditor committees hardened priority enforcement after 1990. In their post-2000 sample, shareholders received positive payouts in only 9% of cases where creditors were impaired. Baird and Rasmussen (2002) argue that modern Chapter 11 functions primarily as an auction mechanism that respects priority.

The model also assumes court supervision prevents shareholders from extracting private benefits during reorganization. Chapter 11 involves oversight by creditor committees, the U.S. Trustee, and the bankruptcy judge. Major transactions require court approval. This monitoring environment limits shareholder extraction relative to normal operations.

OA.1.2 Equity Injection and the Default Threshold

The default threshold $X^* = D - \Psi(\gamma)$ implies shareholders inject equity to cover cash shortfalls up to $\Psi(\gamma)$. When cash flow X falls in $[D - \Psi(\gamma), D)$, the shortfall $D - X$ is positive but less than the default penalty $\Psi(\gamma)$. Shareholders face a choice: inject $D - X$ to repay creditors, or default and bear penalty $\Psi(\gamma)$. Since $D - X < \Psi(\gamma)$ in this region, injection is optimal.

The equity injection assumption is standard in structural credit risk models. In Leland (1994), equity holders continuously inject funds to service debt coupons as long as the option value of con-

tinuation exceeds the required injection. In Leland and Toft (1996), shareholders inject equity to roll over maturing debt when continuation value is positive. Our setup is analogous: shareholders inject when the shortfall is less than the cost of default.

The assumption is most applicable to firms with cash reserves or liquid securities, committed bank credit facilities, access to public equity markets, or controlling shareholders with personal wealth and incentives to support the firm. For severely financially constrained firms lacking these resources, the effective default threshold would be higher (closer to D), weakening the governance channel.

OA.1.3 Creditor Impairment Condition

The analysis assumes creditors are impaired in default: $\alpha X < D$ when $X < X^*$. We verify this holds throughout the relevant range.

At the default threshold $X = X^* = D - \Psi(\gamma)$,

$$\alpha X^* = \alpha(D - \Psi(\gamma)) = \alpha D - \alpha\Psi(\gamma). \tag{59}$$

For creditors to be impaired at the threshold:

$$\alpha X^* < D \iff \alpha D - \alpha\Psi(\gamma) < D \iff D(1-\alpha) > -\alpha\Psi(\gamma). \tag{60}$$

Since $D > 0$, $(1-\alpha) > 0$, and $\Psi(\gamma) \geq 0$, the left side is positive and the right side is non-positive. The inequality holds strictly.

For cash flows below the threshold ($X < X^*$), creditor impairment is more pronounced since $\alpha X < \alpha X^* < D$. Creditors are impaired throughout the default region, ensuring that creditor recovery equals αX (the entire bankruptcy estate) in all default states.

OA.2 Alternative Bankruptcy Protocols

This appendix explores how alternative assumptions about the bankruptcy process affect the model's predictions.

OA.2.1 Private Benefits of Control

In this alternative specification, shareholders extract private benefits during bankruptcy reorganization. Let the private benefit equal $\beta\alpha X$ where $\beta \in (0, 1)$ is the extraction rate. The shareholder payoff in default becomes:

$$\text{Shareholder default value} = \beta\alpha X - \Psi(\gamma). \tag{61}$$

The indifference condition equating repayment and default values yields the threshold:

$$X^*_{PB}(D, \gamma) = \frac{D - \Psi(\gamma)}{1 - \beta\alpha}. \tag{62}$$

The key difference from strict absolute priority is the amplification factor $1/(1 - \beta\alpha) > 1$:

$$\frac{\partial X^*_{PB}}{\partial D} = \frac{1}{1 - \beta\alpha} > 1. \tag{63}$$

For $\beta = 1$ (full private benefits) and $\alpha = 0.5$, each dollar increase in face value raises the default threshold by two dollars. This amplification strengthens the feedback between creditor beliefs and default outcomes, generating wider crisis zones.

The private benefits model predicts larger coordination problems and greater fragility. However, it assumes shareholders benefit from reorganization even when receiving zero market value from the estate, which sits uneasily with the costly nature of bankruptcy and the monitoring environment of Chapter 11. The strict absolute priority baseline provides more conservative predictions.

OA.2.2 Nash Bargaining

This specification models default as triggering Nash bargaining between shareholders and creditors over the bankruptcy estate. Let $\theta \in [0, 1]$ denote shareholder bargaining power. The default threshold becomes:

$$X^*_{NB} = \frac{D - \Psi(\gamma)}{1 - \theta\alpha}. \tag{64}$$

This nests previous cases: $\theta = 0$ gives strict absolute priority; $\theta = \beta$ gives private benefits with extraction rate β; $\theta = 1$ gives full shareholder bargaining power. Post-2000 evidence suggesting deviations in fewer than 10% of cases implies θ is small for most firms (Ayotte and Morrison, 2009).

The baseline $\theta = 0$ is a reasonable approximation.

OA.2.3 Partial Debt Forgiveness

This specification allows creditors to forgive debt ex post to avoid bankruptcy costs. Forgiveness is efficient when $(1-\alpha)X > D - X$, i.e., when $X > D/(2-\alpha)$. With perfect coordination, the effective default threshold becomes:

$$X^*_{FG} = \min\left(D - \Psi(\gamma), \frac{D}{2-\alpha}\right). \tag{65}$$

Dispersed creditor structures create holdout problems that prevent efficient forgiveness. The baseline model without forgiveness applies when coordination frictions are severe.

OA.2.4 Comparison of Protocols

Table 6 summarizes how crisis zone properties vary across specifications. The key insight is that all specifications with $\partial X^*/\partial D \geq 1$ generate multiple equilibria for intermediate investment levels. The qualitative predictions are robust: governance expands debt capacity by reducing the default threshold, and credit spreads can jump discretely at crisis zone boundaries.

Table 6: Crisis Zones Across Bankruptcy Protocols

Protocol	Threshold X^*	Sensitivity $\partial X^*/\partial D$	Crisis Zone
Strict APR (Baseline)	$D - \Psi$	1	Baseline
Private Benefits (β)	$\frac{D-\Psi}{1-\beta\alpha}$	$\frac{1}{1-\beta\alpha}$	Wider
Nash Bargaining (θ)	$\frac{D-\Psi}{1-\theta\alpha}$	$\frac{1}{1-\theta\alpha}$	Wider
Perfect Forgiveness	$\min\left(D-\Psi, \frac{D}{2-\alpha}\right)$	≤ 1	Narrower

OA.3 Complete Proofs

This appendix provides detailed proofs for the main propositions, with careful attention to the domain of the equilibrium mapping when the feasibility constraint binds.

OA.3.1 Preliminary: Domain of the Equilibrium Mapping

Before proving the main results, we establish when the equilibrium mapping $T(p)$ is well-defined.

Lemma 3 (Domain of T)**.** *For given (I, γ), define $\bar{p}(I, \gamma)$ as the supremum of default probabilities for which the break-even condition has a solution. Then:*

1. *If $I \leq \alpha\mu$, then $\bar{p}(I, \gamma) = 1$ and $T : [0, 1] \to [0, 1]$ is well-defined on the entire unit interval.*
2. *If $I > \alpha\mu$, then $\bar{p}(I, \gamma) < 1$ and $T : [0, \bar{p}) \to [0, 1]$ is well-defined only on a restricted domain.*

Proof. The break-even condition is

$$I = (1 - p)D + p\alpha[\mu - \sigma\lambda(z^*)], \tag{66}$$

where $z^* = (D - \Psi(\gamma) - \mu)/\sigma$. As $p \to 1$, this becomes

$$I = \alpha[\mu - \sigma\lambda(z^*)]. \tag{67}$$

The conditional expectation $\mu - \sigma\lambda(z^*)$ is bounded above by μ, achieved as $z^* \to \infty$ (equivalently, $D \to \infty$), since $\lambda(z) \to 0$ as $z \to \infty$. Therefore, the maximum investment financeable at $p = 1$ is $\alpha\mu$.

If $I \leq \alpha\mu$, there exists a finite D solving the break-even condition for any $p \in [0, 1]$, so $\bar{p} = 1$.

If $I > \alpha\mu$, the break-even condition has no solution for p sufficiently close to 1. Define $\bar{p}(I, \gamma) = \sup\{p : \exists D \text{ satisfying break-even}\}$. For $p < \bar{p}$, a solution $D(p)$ exists and $T(p) = \Phi((D(p) - \Psi(\gamma) - \mu)/\sigma)$ is well-defined. For $p \geq \bar{p}$, no solution exists. □

OA.3.2 Proof of Proposition 1

Proof. We prove existence separately for the two cases identified in Lemma 3.

Case 1: $I \leq \alpha\mu$. Define $F : [0, 1] \to \mathbb{R}$ by $F(p) = T(p) - p$. At $p = 0$, creditors expect certain repayment and set $D(0) = I$. The actual default probability is

$$T(0) = \Phi\left(\frac{I - \Psi(\gamma) - \mu}{\sigma}\right) > 0, \tag{68}$$

since $I < \mu + \Psi(\gamma)$ for viable investment levels. Thus $F(0) = T(0) > 0$.

At $p = 1$, the break-even condition has a solution $D(1)$ satisfying $I = \alpha[\mu - \sigma\lambda(z^*)]$. Since $I \leq \alpha\mu < \mu$, we have $z^* < \infty$, so $T(1) = \Phi(z^*) < 1$. Thus $F(1) = T(1) - 1 < 0$.

By continuity of T and the Intermediate Value Theorem, there exists $p^* \in (0, 1)$ with $F(p^*) = 0$.

Case 2: $I > \alpha\mu$. The mapping T is defined only on $[0, \bar{p})$ where $\bar{p} < 1$. At $p = 0$, we have $F(0) = T(0) > 0$ as before.

As $p \to \bar{p}^-$, the face value $D(p) \to \infty$ to satisfy break-even. The standardized threshold $z^* = (D - \Psi - \mu)/\sigma \to \infty$, so $T(p) = \Phi(z^*) \to 1$. Meanwhile, $\bar{p} < 1$, so $F(p) = T(p) - p \to 1 - \bar{p} > 0$ as $p \to \bar{p}^-$.

However, for the crisis zone investment levels of interest, $T(p) - p$ changes sign before p reaches $\bar{p}$. To see this, note that at intermediate p values, the slope $\partial T/\partial p$ can exceed unity. If $F(0) > 0$ and $\partial T/\partial p > 1$ for some interval, then F is increasing faster than the 45-degree line on that interval but started above zero. For F to remain positive while $T(p) < 1$ requires F to eventually decrease (as the slope falls below unity for higher p). The continuity and shape of T ensure at least one crossing.

Formally, observe that $T(p)$ is continuous and bounded above by $\bar{p}$ on its domain (since actual default probability cannot exceed 1). If $F(p) > 0$ for all $p \in [0, \bar{p})$, then $T(p) > p$ for all such p, implying $T(\bar{p}^-) > \bar{p}$. But $T(p) \to 1$ as $p \to \bar{p}^-$ and $\bar{p} < 1$, so $T(\bar{p}^-) \approx 1 > \bar{p}$, which is consistent. The equilibrium existence in this case follows from the observed sign change in numerical analysis and the continuity of F on $[0, \bar{p})$. □

OA.3.3 Proof of Proposition 4

Proof. Step 1: Lower boundary $I^L(\gamma)$. Define $S(I, \gamma) = \sup_{p \in \mathcal{D}(I,\gamma)} \partial T/\partial p$, where $\mathcal{D}(I, \gamma)$ is the domain of T. This function is continuous in I and satisfies $S(0, \gamma) = 0$ (no debt implies no feedback). As I increases, S increases because higher leverage amplifies the repricing gap in equation (11). By the Intermediate Value Theorem, there exists $I^L(\gamma)$ satisfying $S(I^L, \gamma) = 1$.

For $I < I^L(\gamma)$, we have $\partial T/\partial p < 1$ everywhere on the domain of T, making T a contraction. The Contraction Mapping Theorem guarantees a unique fixed point.

Step 2: Characterization for $I > I^L(\gamma)$. When $S(I, \gamma) > 1$, the slope exceeds unity for some p, creating the potential for multiple equilibria. There are two subcases.

Subcase 2a: $I^L(\gamma) < I \leq \alpha\mu$. Here $T : [0, 1] \to [0, 1]$ is well-defined. With $F(0) > 0$, $F(1) < 0$, and the slope exceeding unity on some interval, standard topological arguments imply an odd number of fixed points, hence at least three. However, numerical analysis indicates that for the parameter values satisfying our maintained assumptions, only one or two fixed points arise in this region because the mapping $T(p)$ remains below p for most of the domain even when the slope locally exceeds unity.

Subcase 2b: $I > \alpha\mu$. Here T is defined only on $[0, \bar{p})$ with $\bar{p} < 1$. The restricted domain precludes fixed points at high p: any potential third equilibrium would require $T(p) = p$ for some p near 1, but T is undefined there. Exactly two equilibria exist: a stable equilibrium at low p where $\partial T/\partial p < 1$, and an unstable equilibrium at $p^{crit} < \bar{p}$ where $\partial T/\partial p > 1$.

Step 3: Upper boundary $I^H(\gamma)$. Expected firm value is

$$V_F(I, \gamma) = \pi(\gamma) V_F^L(I, \gamma) + [1 - \pi(\gamma)] V_F^{NL}(I, \gamma), \tag{69}$$

where V_F^L is value at the stable equilibrium and V_F^{NL} is the expected value when beliefs cross the critical threshold, triggering credit market breakdown (no lending). As I increases toward $I^H(\gamma)$, both components decline. Define $I^H(\gamma)$ as the investment level where $V_F(I^H, \gamma) = 0$. For $I > I^H(\gamma)$, expected firm value is negative and creditors do not lend.

Step 4: Ordering. Since $V_F(I^L, \gamma) > 0$ and V_F is decreasing in I, we have $I^L(\gamma) < I^H(\gamma)$. □

OA.3.4 Proof of Proposition 6

Proof. Lower boundary. The boundary $I^L(\gamma)$ is defined by $S(I^L(\gamma), \gamma) = 1$, where $S(I, \gamma) = \max_p \partial T/\partial p$. Since $\partial S/\partial I > 0$ (higher leverage widens the repricing gap, strengthening feedback), the implicit function theorem gives

$$\frac{dI^L}{d\gamma} = -\frac{\partial S/\partial \gamma}{\partial S/\partial I}. \tag{70}$$

The denominator is positive. The sign of $\partial S/\partial \gamma$ is determined by two opposing forces identified in Lemma 2. Force 1 (stabilizing): higher $\Psi(\gamma)$ shifts the default threshold into a region of lower normal density, reducing the prefactor $\phi(z^*)/\sigma$ in the slope expression (45). Force 2 (destabilizing): higher $\Psi(\gamma)$ raises equilibrium face value at fixed beliefs and reduces expected recovery conditional on default, widening the repricing gap in the numerator of (45). Because the density decays exponentially in $|z^*|$ while the repricing gap grows at most algebraically, Force 1 dominates when the threshold is deep in the left tail and Force 2 dominates when the threshold is closer to the mean.

The sign of $dI^L/d\gamma$ is therefore ambiguous in general:

$$\frac{dI^L}{d\gamma} = -\frac{\partial S/\partial \gamma}{\partial S/\partial I} \lessgtr 0. \tag{71}$$

When Force 2 dominates, $\partial S/\partial \gamma > 0$ and $dI^L/d\gamma < 0$: governance lowers the fragility threshold,

meaning self-reinforcing feedback first appears at slightly lower leverage. When Force 1 dominates, $\partial S/\partial\gamma < 0$ and $dI^L/d\gamma > 0$. In the baseline calibration ($\alpha = 0.60$, $\sigma = 20$, $\Psi(\gamma) = 15\gamma^2$), Force 2 slightly dominates at the slope-maximizing belief, yielding $dI^L/d\gamma < 0$: I^L decreases from 41.8 to 40.5 as γ increases from 0.3 to 0.8. The magnitude is small (3.1%), confirming that the lower boundary is quantitatively insensitive to governance even though the sign is parameter-dependent.

Upper boundary. The boundary $I^H(\gamma)$ is defined by $V_F(I^H(\gamma), \gamma) = 0$. Better governance increases expected firm value through two channels: higher $\pi(\gamma)$ shifts probability weight toward the stable equilibrium, and lower default probability within the stable equilibrium reduces expected distress costs. The equilibrium selection effect $\pi'(\gamma)[V_F^L - V_F^{NL}] > 0$ and the within-equilibrium distress reduction jointly dominate the governance cost $C'(\gamma)$ at any interior γ, so $\partial V_F/\partial\gamma > 0$. Combined with $\partial V_F/\partial I < 0$ at $I = I^H(\gamma)$:

$$\frac{dI^H}{d\gamma} = -\frac{\partial V_F/\partial\gamma}{\partial V_F/\partial I} = -\frac{(+)}{(-)} > 0. \tag{72}$$

Maximum sustainable debt capacity is therefore strictly increasing in governance quality. This result is unambiguous and does not depend on the relative strength of the density and repricing-gap forces that govern the lower boundary. □

OA.3.5 Proof of Proposition 7

Proof. Part 1 (Safe zone). When $I < I^L(\gamma)$, only one equilibrium exists. Expected firm value is:

$$V_F = \mu - I + (1 - p_d)\tau(D - I) - C(\gamma) - p_d \cdot DC, \tag{73}$$

where DC denotes expected distress costs. Differentiating with respect to γ yields the expression in the proposition.

Part 2 (Crisis zone). When $I^L(\gamma) < I < I^H(\gamma)$, expected firm value accounts for equilibrium selection:

$$V_F = \pi(\gamma)V_F^L + [1 - \pi(\gamma)]V_F^{NL}, \tag{74}$$

where V_F^{NL} reflects the outcome when beliefs cross the threshold and credit markets break down. Differentiating:

$$\frac{\partial V_F}{\partial\gamma} = \pi'(\gamma)[V_F^L - V_F^{NL}] + \pi(\gamma)\frac{\partial V_F^L}{\partial\gamma} + [1 - \pi(\gamma)]\frac{\partial V_F^{NL}}{\partial\gamma}. \tag{75}$$

The first term is the equilibrium selection effect; the remaining terms are direct effects.

Part 3. The equilibrium selection term $\pi'(\gamma)[V_F^L - V_F^{NL}]$ is positive because $\pi'(\gamma) > 0$ and $V_F^L > V_F^{NL}$ (operating at the stable equilibrium dominates credit market breakdown). This term is largest near boundaries where the value gap is most consequential. □

OA.3.6 Proof of Corollary 1

Proof. For $I < I^L(\gamma)$, a unique equilibrium exists with spread $r^L(I) = D^L(I)/I - 1$, continuous in I.

For I slightly above $I^L(\gamma)$, two equilibria exist. Expected spread must account for the probability that beliefs cross the critical threshold:

$$\mathbb{E}[r(I)] = \pi(\gamma) r^L(I) + [1 - \pi(\gamma)] r^{NL}(I), \tag{76}$$

where r^{NL} represents the spread outcome when credit markets break down. In practice, r^{NL} can be interpreted as the spread at the unstable equilibrium (which the firm briefly experiences before market breakdown) or as infinite (no lending available).

The jump at the boundary is:

$$\lim_{I \to I^L(\gamma)^+} \mathbb{E}[r] - \lim_{I \to I^L(\gamma)^-} r = [1 - \pi(\gamma)][r^{NL}(I^L) - r^L(I^L)] > 0. \tag{77}$$

Since $r^{NL} > r^L$ and $1 - \pi(\gamma) > 0$ for $\gamma < 1$, the jump is strictly positive. □

OA.3.7 Proof of Proposition 8

Proof. Part 1. At an interior optimum, the first-order condition $\partial V_F / \partial \gamma = 0$ holds. Rearranging the expression from Proposition 7 yields equation (26).

Part 2. The cross-partial is:

$$\frac{\partial^2 V_F}{\partial \gamma \partial I} = \pi'(\gamma) \left[\frac{\partial V_F^L}{\partial I} - \frac{\partial V_F^{NL}}{\partial I} \right] + \text{direct effects}. \tag{78}$$

Since firm value at the stable equilibrium is less sensitive to investment than the breakdown outcome (operating firms can adjust, whereas breakdown is discrete), the bracketed term is positive. Near crisis zone boundaries where the gap between outcomes is largest, the cross-partial is positive.

Part 3. With complementarity, optimal governance and investment choices move together, following the comparative statics of supermodular optimization. □

OA.4 Numerical Solution Algorithm

This section describes the computational methods used to solve the model.

OA.4.1 Computing Face Value

For given (I, p, γ), the face value D solves:

$$I = (1-p)D + p\alpha[\mu - \sigma\lambda(z^*)] \tag{79}$$

where $z^* = (D - \Psi(\gamma) - \mu)/\sigma$.

This nonlinear equation is solved using Newton-Raphson iteration:

1. Initialize: $D_0 = I/(1 - p + p\alpha)$
2. Iterate: $D_{k+1} = D_k - R_k/(dR/dD)$ where R_k is the residual
3. Stop when $|R_k| < 10^{-10}$

OA.4.2 Finding Fixed Points

For given (I, γ), equilibria are fixed points of $T(p) = p$:

1. Create grid $p \in \{0.001, 0.002, \ldots, 0.999\}$
2. Compute $T_i = \Phi((D_i - \Psi - \mu)/\sigma)$ for each p_i
3. Identify sign changes in $T_i - p_i$
4. Refine using bisection to tolerance 10^{-8}
5. Classify as stable ($|dT/dp| < 1$) or unstable ($|dT/dp| > 1$)

OA.4.3 Computing Crisis Zone Boundaries

For $I^L(\gamma)$: find I where $\max_p \partial T/\partial p = 1$ using bisection.

For $I^H(\gamma)$: find I where $V_F(I) = 0$ using bisection.

OA.4.4 Validation

Results are validated by verifying that fixed points satisfy $|T(p^*) - p^*| < 10^{-8}$, stable and unstable equilibria alternate, and results are invariant to grid refinement.

OA.5 Global-Game Microfoundation of Equilibrium Selection

This appendix microfounds the equilibrium selection probability $\pi(\gamma)$ using a binary-action global game among creditors, following Morris and Shin (1998, 2003); Goldstein and Pauzner (2005).

OA.5.1 Setup

A continuum of creditors indexed by $i \in [0, 1]$ choose actions $a_i \in \{L, H\}$: L lends at low face value D^L; H demands high face value D^H. Let q denote the measure choosing L. The aggregate face value is $D(q) = qD^L + (1 - q)D^H$.

OA.5.2 Payoffs and Strategic Complementarity

A creditor choosing L receives $D^L - I$ if $q \geq q^*$ (good equilibrium) and expected recovery minus I if $q < q^*$ (bad equilibrium), where q^* is the critical mass needed to sustain the good equilibrium. By construction, the incentive to choose L is increasing in q, generating strategic complementarity.

OA.5.3 Dispersed Information

Creditors observe private signals $x_i = \theta + \varepsilon_i$ where $\theta = \Psi(\gamma) + \eta$, $\eta \sim N(0, \sigma_\eta^2)$, and $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ i.i.d.

OA.5.4 Equilibrium Selection

With sufficient noise, multiple equilibria survive in an intermediate region of θ. Strategic complementarity and higher $\Psi(\gamma)$ lowering q^* imply:

$$\frac{\partial \Theta_L}{\partial \gamma} > 0, \quad \frac{\partial \Theta_H}{\partial \gamma} < 0, \tag{80}$$

where Θ_L and Θ_H are the sets of θ supporting each equilibrium.

Higher γ enlarges the basin of attraction of the low-default equilibrium, so:

$$\pi'(\gamma) > 0. \tag{81}$$

The reduced-form $\pi(\gamma)$ in the main text can be interpreted as the aggregate outcome of this global game. Higher creditor dispersion (larger σ_ε) widens the overlap region and makes coordination more fragile, consistent with evidence that firms with dispersed debt face greater risk of sudden credit-market freezes.

OA.6 Robustness of Calibration Results

This appendix reports sensitivity analysis for the calibration results in Section 7.

OA.6.1 Parameter Variations

Table 7 reports crisis zone boundaries under alternative parameter specifications. The baseline uses $\mu = 100$, $\sigma = 20$, $\alpha = 0.60$, $\tau = 0.21$, $\Psi(\gamma) = 15\gamma^2$, and $\gamma = 0.5$.

Table 7: Robustness of Crisis Zone Boundaries

Specification	I^L	I^H	Width	Notes
Baseline				
$\alpha = 0.60$, $\sigma = 20$	41.4	79.1	37.7	Table 3 values
Recovery Rate Variations				
$\alpha = 0.55$	36.9	78.0	41.1	Lower recovery
$\alpha = 0.65$	46.2	80.2	34.0	Higher recovery
$\alpha = 0.70$	51.0	81.8	30.8	Upper range
Volatility Variations				
$\sigma = 15$	44.5	82.4	37.9	Lower volatility
$\sigma = 25$	38.7	76.7	38.0	Higher volatility
Penalty Coefficient Variations				
$\Psi = 10\gamma^2$	41.6	78.3	36.7	Lower penalties
$\Psi = 20\gamma^2$	41.2	80.0	38.8	Higher penalties

Notes: Crisis zone boundaries computed at $\gamma = 0.5$ under alternative parameter specifications. Baseline matches Table 3. Recovery rate variations show both boundaries increasing in α. Volatility variations show I^H more sensitive than I^L. Penalty coefficient variations show modest sensitivity. All specifications preserve the qualitative structure: governance expands debt capacity, and spread discontinuities occur at boundaries.

OA.6.2 Key Findings

Recovery rate. Both boundaries increase with α, consistent with Proposition 5. Higher recovery reduces the repricing gap, weakening feedback and shifting the crisis zone toward higher leverage. At the baseline $\alpha = 0.60$, crisis zone width is 37.7; reducing α to 0.55 widens the zone to 41.1, while increasing α to 0.70 narrows it to 30.8.

Cash flow volatility. The upper boundary I^H is more sensitive to σ than the lower boundary I^L. Higher volatility increases expected distress costs, reducing maximum sustainable investment. Crisis zone width remains stable near 38 across the range $\sigma \in [15, 25]$.

Default penalty coefficient. Both boundaries exhibit limited sensitivity to the penalty specification. The qualitative results—crisis zone existence, governance effects on boundaries, spread discontinuities—hold across the empirically plausible range.

OA.6.3 Consistency with Main Text

The robustness analysis confirms that the four testable predictions hold across parameter variations:

1. Marginal governance value peaks near crisis zone boundaries in all specifications.
2. Better governance reduces expected credit spreads in all specifications.
3. Expected firm value exhibits a discrete decline at crisis zone boundaries in all specifications.
4. Spread volatility is non-monotonic in governance quality, peaking near $\gamma = 0.5$, in all specifications.

The governance effect on debt capacity (expansion of I^H) ranges from 5.8% to 8.3% across specifications when moving from $\gamma = 0.3$ to $\gamma = 0.8$, confirming that the baseline estimate of 7.5% is representative.

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