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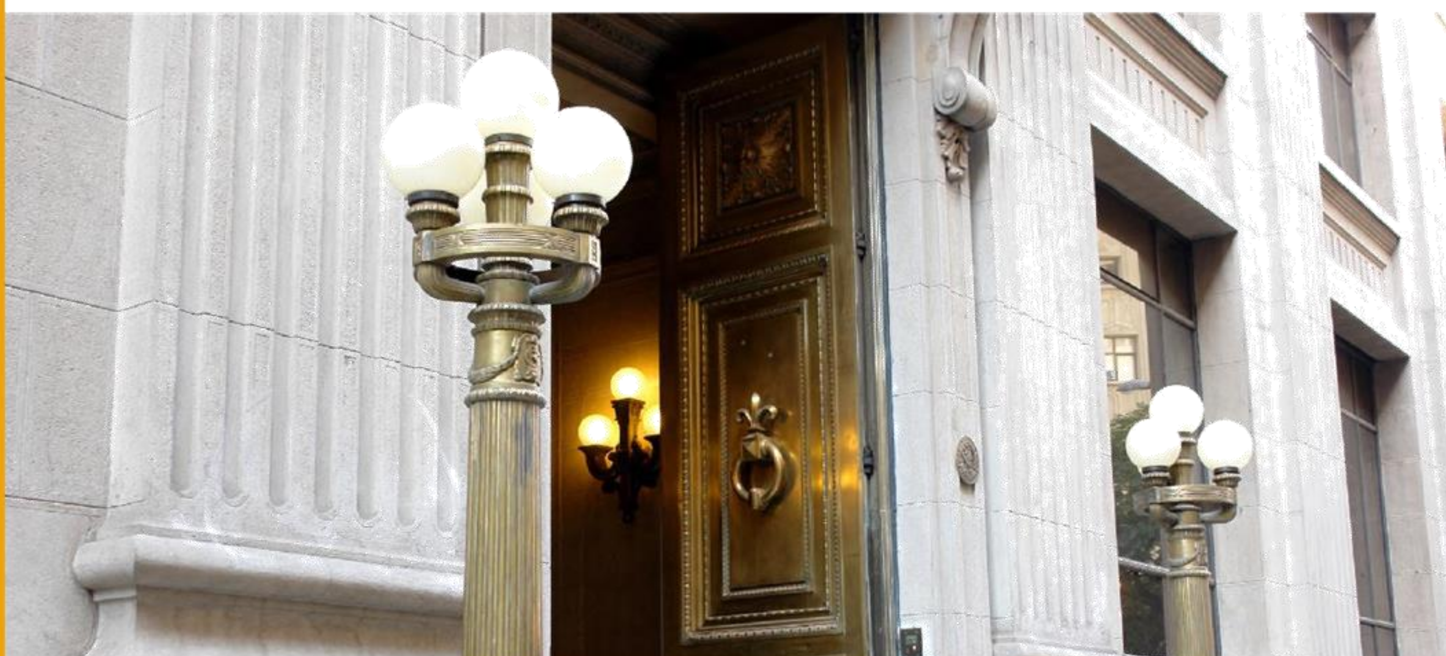

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Coordinating in the Haircut. A Model of Sovereign Debt Restructuring in Secondary Markets

Adriana Cobas[1]

Resumen

A pesar de las aparentes ventajas del financiamiento mediante bonos, las concesiones de los inversionistas en las reestructuraciones de deuda soberana disminuyeron de manera inesperada tras la desintermediación del mercado. Este artículo desarrolla un modelo en el que los tenedores de bonos, dispersos entre sí, enfrentan un juego de coordinación durante la reestructuración, y muestra que este mecanismo predice recortes ("haircuts") más bajos que en el caso de deuda con bancos. Las pruebas empíricas son coherentes con esta predicción, y una simulación calibrada indica que las fricciones de coordinación pueden explicar hasta un 25 % de la reducción observada, lo que destaca que reducir los costos de participación puede mejorar la alineación de los inversionistas y los resultados de la reestructuración.

Abstract

Despite the apparent advantages of bond financing, investors' concessions in sovereign debt restructurings unexpectedly declined following market disintermediation. This paper develops a model in which dispersed bondholders face a coordination game during bond restructuring, and shows that this mechanism predicts lower haircuts. Empirical tests are consistent with this prediction, and a calibrated simulation indicates that coordination frictions can account for up to 25% of the observed reduction, highlighting that lowering participation costs can improve investor alignment and restructuring outcomes.

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[*] The views expressed are those of the author and do not necessarily reflect the views of the Central Bank of Chile or its board members.

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1. Introduction

After 1980, the market for sovereign debt in emerging economies underwent a rapid process of disintermediation(Andritzky 2006; Brum and Della Mea 2012; Das et al. 2012), as a handful of international banks were replaced by a dispersed and heterogeneous base of bondholders. While most aspects of sovereign-financing adapted smoothly, debt restructurings became increasingly complex. The existence of a participation window—during which thousands of investors must decide wether to join a restructuring proposal, typically with limited public information—introduced a fundamental coordination problem.

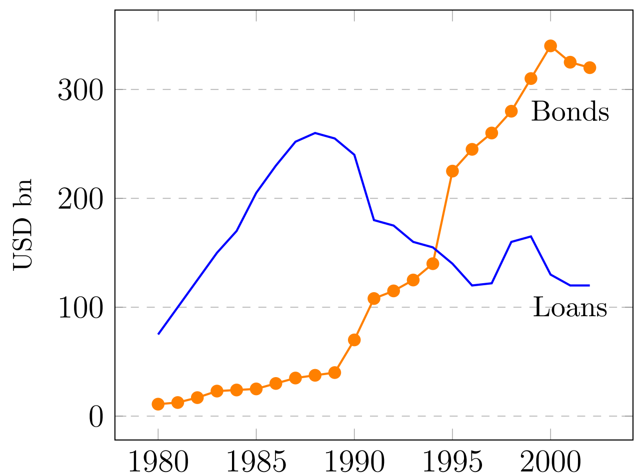
Three developments fueled this transformation (Andritzky, 2006). (i) the emergence of high-yield markets able to absorb riskier sovereign debt; (ii) the securitization of defaulted bank loans through the 1989 Brady Plan; and (iii) the broader liberalization of capital flows. Over two decades, bank loans share in private holdings of emerging sovereign debt fell from 80% to just 26% (Figure 1a), while bonds came to dominate nearly all restructuring cases by the early 2000s (Figure 1b).[2]

Although bond financing initially appeared advantageous—offering lower conditionality and potentially weaker creditor bargaining power—empirical evidence points to the opposite outcome. Government's effective payoffs in restructurings declined sharply. Using the Benjamin and Wright (2009) dataset, Bai and Zhang (2019),find that the shift from syndicated loans to bonds reduced average haircuts by about 14%, attributing this to shorter bargaining periods and greater transparency regarding creditors' outside options.

This paper offers a complementary explanation centered on coordination frictions among dispersed creditors, which weaken governments' bargaining position and lead to lower haircuts. Bondholders deciding whether to accept or reject a restructuring proposal engage in a coordination game with

[2]See Ferry (2023) for a detailed comparison of legal procedures for bond and loan restructurings.

a) Structure of private stocks of sovereign debt



b) Structure of restructuring episodes

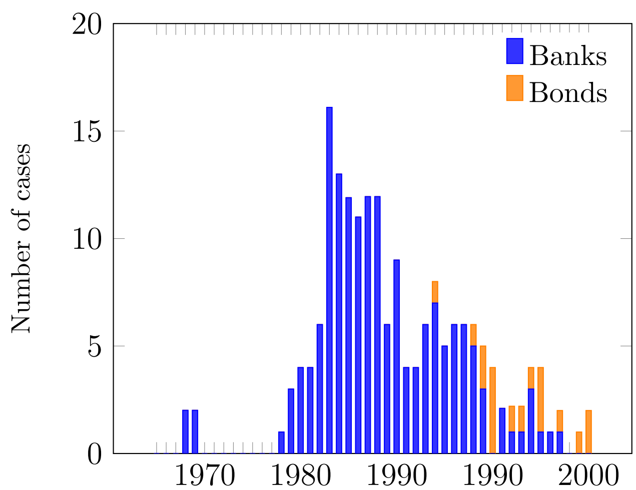


Figure 1: **Bonds *versus* loans.** (a) Structure of external public debt in emerging market countries, stocks of privately held debt Borensztein et al. (2004). (b) Finalized restructurings per year (Andritzky, 2006)

strategic complements: where the highest payoffs arise when most align their strategies simultaneously. Accepting when most reject entails participation costs—such as reputational damage—while rejecting when most accept leads to lower payoffs in the secondary market of defaulted debt.

Although most agents would prefer to coordinate, the process present significant challenges: once the proposal is announced, investors have a limited time to decide, during which no official information on overall participation is available. Moreover, bondholders often number in the thousands and are widely dispersed, making consensus difficult.[3] According to Das et al. (2012), successful representative bondholder groups in sovereign restructurings are rare.[4]

The model formalizes this mechanism and yields a testable prediction: *sovereign bonds restructuring should produce systemically lower haircuts than comparable loans restructurings*, even controlling for fundamentals. Using data from Cruces and Trebesch (2014), I test this prediction and find evidence consistent with the model's central implication that coordination frictions among dispersed creditors depress government payoffs. Furthermore, insufficient coordination can trigger multiple rounds of restructuring, generating additional costs for all stakeholders, highlighting that the challenges of investors alignment extend beyond a single negotiation episode (Luckner et al., 2023).

The framework is a three-stage game. In the first stage, the government announces a restructuring proposal, specifying a haircut. To shut down a potential signaling channel—as discussed in Angeletos et al. (2006) which considers market reactions to information conveyed by the government's announcements—the release of new economic information is delayed until the end of this stage, after the proposal has been released. In the second stage, investors simultaneously decide whether to accept based on expectations about others' decisions and the most recent available information about economic fundamentals. This coordination game naturally admits multiple Nash equilibria, which are resolved using global games techniques

[3]Several restructuring involved thousands of dispersed bondholders —for example Dominica (2004), Pakistan (1999), Uruguay (2003), Seychelles (2009)— and in extreme cases such as Ukraine (2000) and Argentina (2005), the numbers reached roughly 100,000 and 600,000, respectively (Andritzky, 2006).

[4]Ferry (2023) highlights the "less routinized" nature of negotiations between sovereigns and bondholders as a factor contributing to negotiation failures.

under incomplete information. This ensures a unique equilibrium acceptance threshold, linking participation to the distribution of the fundamentals. In the third stage, the government observes the implied acceptance rate and and decides whether to proceed with the proposed payment or to remain in default. Solving by backward induction yields an equilibrium haircut as a function of key market parameters—expected holdout payoffs, participation costs and recovery values.

The model implications are explored in three exercises. First, comparative statics show that the government reduces the haircut when holdout payoffs or participation costs rise, and increases it when post-default recovery improves. Second, comparing the equilibrium haircut to a standard Nash bargaining benchmark in this environment of dispersed bondholders consistently shows that the Nash model overestimates haircuts, especially as investors become more numerous and uncoordinated. Third, a quantitative exercise illustrates the magnitude of coordination frictions, which account for up to one-fifth of the average haircut gap between bank and bond restructurings.

Finally, the analysis highlights a clear policy dimension. Participation costs emerge as a key source of coordination frictions—and notably, the only one under government's control. Reducing these costs—whether through enhanced investor communication (dedicated information offices, public updates, international roadshows) or lowering transaction fees (e.g., transferable commission schemes)—can improve coordination, increase participation, and facilitate smoother restructurings.

This paper relates to several strands of the literature of sovereign debt restructuring. First, a body of research focuses on the technical aspects of renegotiation. Pitchford and Wright (2012) study n-investor bargaining with alternative bids, showing how holdout and free riding behavior generate delays, while Benjamin and Wright (2009) highlight that such delays can benefit both investors and governments by increasing payoffs. Bai and Zhang (2019) show that disintermediation can shorten negotiations, as the secondary market conveys signals to bilateral bargaining. These studies, however, typically assume a representative bondholder, and thus abstract from coordination problems among dispersed creditors. By modeling these interactions explicitly, this paper captures strategic behavior effects that are overlooked in the representative-agent framework. Bi et al. (2016) do address the embedded coordination problem by adjusting investors' payoffs or introducing sunspots to project equilibria. As discussed below, this paper introduces a global games framework to resolve multiplicity.

Second, the paper contributes to the quantitative sovereign debt literature that endogenizes haircuts. Yue (2010), Asonuma and Trebesch (2016), Dvorkin et al. (2021) and Asonuma and Joo (2020) derive haircuts from structural models to match historical crises and study public investment under default. Most of these models rely on Nash bargaining, which abstracts from coordination challenges. In contrast, here equilibrium haircuts emerge from a coordination game, linking them directly to fundamental and market parameters. In model's implications, I also show that Nash bargaining haircut overestimates the equilibrium outcome when default occurs among uncoordinated investors.

Third, this work draws on the global games literature (Carlsson and van Damme, 1993) to address multiplicity in coordination games with incomplete information.[5] While previous applications have focused on financial markets, taxation or business cycles, this paper is the first to apply global games to sovereign debt restructuring. Introducing idiosyncratic noise into investors' private information generates a unique equilibrium haircut, capturing coordination frictions in a tractable and empirically relevant way.

By integrating these strands, the paper contributes along three dimensions: it extends theoretical models to account for disperse creditors, enriches quantitative sovereign debt frameworks with endogenously determined haircuts, and offers a novel global-games perspective on restructuring. This unified approach clarifies how coordination costs shape outcomes and highlights policy levers—such as reducing participation costs—to improve efficiency in sovereign debt renegotiations.

The paper proceeds as follows. Section 2 develops the theoretical model, moving from a complete-information framework with multiple equilibria, to an incomplete-information global games setup that yields a unique equilibrium haircut and comparative statics. Section 3 explores the model's implications: it compares the coordination-based haircut with the standard Nash bargaining, assesses the model's testable prediction and provides a quantitative illustration of coordination costs, to finally discuss policy implications. Section 4 concludes and outlines directions for future research.

[5]See Taylor and Uhlig (2016) for a detailed survey.

2. Model

The model consists of a three stage-game of strategic interaction in which a government and a group of bondholders determine the equilibrium haircut to exit default. The investors´ decision on the restructuring program is embedded in a coordination game which yields multiple equilibria under the complete information scheme. I then introduce incomplete information à la Morris and Shin (1998) to use the global games approach as an equilibrium selection device, identifying strict dominance regions in terms of the economic fundamental that governs investors' decisions. I then solve the complete game using backward induction across the stages.

Nature
Releases a draw of θ

	Stage 0	Stage 1	Stage 2	Stage 3
agent	**Sovereign**	**Sovereign**	**Investors**	**Sovereign**
information available		$\mathcal{I}^1_{gov} = \{\emptyset\}$	I. Complete $\mathcal{I}^2_{inv_i} = \{h, \theta\}$ II. Incomplete $\mathcal{I}^2_{inv_i} = \{h, x_i\}$	$\mathcal{I}^3_{gov} = \{\ell, \theta\}$
action	Defaults on a set of bonds	Determines and announces h	Decide $a_i \in \{0,1\}$ then $\ell = \int_{i \in I} a_i di$ is determined	Decide $R \in \{0,1\}$ restructuring result

Figure 2: **Model Structure and Timeline.**

2.1. Agents' payoffs and game timeline

Figure 2 shows the model in the time line. At stage zero, the government has defaulted on a subset of the total outstanding bonds.[6] Note that default is an exogenous event in this model. The following subsections present the payoffs and decisions of each agent in stages one through three.

2.1.1. Sovereign

In stage one, the government designs the restructuring program with a haircut h and announces it to the market. The information available to the government about the state of the economy at that moment is normalized to zero to simplify any signaling effect in the process. The thus empty information set is denoted as $\mathcal{I}^1_{gov} = \{\emptyset\}$, using superscripts to index the stage.

The economic fundamental θ represents a variable that conveys information about the current solvency of the government. At the end of the first stage, it is drawn by nature from a probability distribution with known density and support $[\check{\theta}, \hat{\theta}] \in \mathbb{R}_+$, which is common knowledge among all the agents in the economy. The government uses this distribution to determine the optimal haircut at the beginning of the stage.

In the third stage, the government assesses the outcome of the restructuring proposal to make its final decision. The information set available to the fovernment at this stage is given by $\mathcal{I}^3_{gov} = \{\theta, \ell\}$, which includes both the economic fundamental θ and the aggregate acceptance rate of the program, $\ell \in [0, 1]$. The government's payoffs function is described by Equation (1) as a function of the acceptance rate, the haircut, and the observed solvency level $G(\ell, h, \theta) : [0, 1] \times [0, 1] \times [\check{\theta}, \hat{\theta}] \mapsto \mathbb{R}$.

$$G(\ell, h, \theta) = \begin{cases} \theta(1 + \xi) - [\ell(1 - h) + (1 - \ell)\nu], & \text{if } R = 1, \\ \theta, & \text{if } R = 0. \end{cases} \tag{1}$$

In the first line, the government proposes a haircut h that achieves an aggregate acceptance rate ℓ meeting its required threshold, thereby leading to a successful restructuring ($R = 1$). The government pays the haircut h to participating bondholders and allocates a residual amount ν for those who reject the plan.[7,8] As a result, the government exits default and receives a

[6]These are plain vanilla contracts, with no special provisions in the event of default.

[7]The final value of the defaulted bonds is typically determined through bilateral negotiations with holdout creditors or by judicial ruling.

[8]Using data from U.S. corporate debt restructurings, the holdout premium for early

solvency boost of $\xi \in [0,1]$ in the level of the fundamental θ.[9] This post-restructuring stimulus may arise from regained access to capital markets, the lifting of international sanctions, receipt of bailout funds, implementation of structural reforms, or relief from political or financial pressures, amongst other factors.

In the second scenario, the proposal fails to gather sufficient market support–i.e., acceptance falls short of government´s threshold–leading to an unsuccessful restructuring ($R = 0$). In this case, the government remains in a state of default with the original solvency level θ.

Lemma 1. *For the government to engage in a restructuring plan, it must be that $\theta\xi \geq \ell(1 - h - \nu) + \nu$.*

Proof: Follows directly from imposing indifference condition in Equation (1) ■

Lemma 1 establishes that, within this model, the design of a restructuring requires the postrestructuring gain in assets to be at least as large as the total payment commitments incurred.

Assumption 1. *The exogenous payment provision for holdouts $\nu \in (1-h, 1]$.*

If $\nu = 1$, the government pays the full face value of the bond to the fraction of investors who reject the offer, i.e., the holdouts $1 - \ell$. At the other extreme, if $\nu = 1 - h$, the government pays the same amount to all bondholders, regardless of whether they accept the restructuring offer or not. In this case, participation becomes irrelevant to the negotiation outcome: the government could simply propose $h = 1$ and exit default without making any actual repayment to bondholders. Thus, by assuming $\nu > 1 - h$, we abstract from this trivial scenario.

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settlers averaged 11% across 115 cases between 1992 and 2000 (Fridson and Gao, 2002) and reached 30% in 202 restructurings between 1980 and 1992 (Altman and Eberhart, 1994).

[9] Median annual GDP growth in countries undergoing restructuring rises from 1.5% before the final agreement to 4 to 5% afterward, based on data from Trebesch (2011) as cited in Das et al. (2012). Consistently, Asonuma et al. (2019) document that that both GDP and investment recover substantially within five years after the restructuring initiates, regardless of whether the default is preemptive, weakly preemptive, or post-default, with GDP moving from negative or low deviations to near or above pre-default levels, and investment returning to positive deviations.

2.1.2. Bondholders

In the second stage, each bondholder i–drawn from a continuum of symmetric investors of measure one– with one unit of bond each, chooses an individual action $a_i \in \{0,1\}$, representing either rejection or acceptance of the proposed repayment program. Bondholders are characterized by the utility function specified in Equation (2) $u_i(a,\ell,\theta) : \{0,1\} \times [0,1] \times [\check{\theta},\hat{\theta}] \mapsto \mathbb{R}$.

$$u_i(0,\ell,\theta) = \begin{cases} \delta\nu, & \text{if } R = 1, \\ 0, & \text{if } R = 0, \end{cases}$$
$$u_i(1,\ell,\theta) = \begin{cases} 1-h-m, & \text{if } R = 1, \\ -m, & \text{if } R = 0. \end{cases} \tag{2}$$

Achieving maximum payoffs requires that the aggregate acceptance exceed a minimum threshold ($\ell > \ell^*$), which is necessary for the proposal to succeed as determined by the government in the final stage. However, at the time of the decision-making, the actual level of aggregate acceptance is unknown to individual investors. Each agent's information set is limited to $\mathcal{I}^2_{inv_i} = \{h,\theta\}$. Consequently, bondholders adopt a uniform prior over the potential actions of other investors, assigning equal probability to all possible acceptance rates $\ell \in (0,1)$).

Bondholders who reject the proposal ($a_i = 0$ in Equation (2)), expect to recover a value of $\delta\nu$ per unit of bond if the restructuring proposal succeeds, and receive 0 otherwise ($\delta \in [0,1]$). Bondholders who accept the proposal ($a_i = 1$ in Equation (2)) receive a payoff of $1-h$ if the agreement succeeds, or 0 otherwise. Regardless of the outcome, accepting agents incur a participation cost $m > 0$, which may represent information acquisition costs or a formal participation fee.

It is important to note that holdout payments and receipts do not necessarily align. Specifically, the term $1-\delta$ reflects a loss associated with nonparticipation, which may capture litigation costs, the risk of not receiving the promised payment ν, or the delay until resolution through legal channels.[10] Thus, $\delta\nu$ represents the expected recovery value of a defaulted bond and, accordingly, should correspond with the market price in the distressed debt

[10] Pitchford and Wright (2012) calibrates restructuring costs in a Nash bargaining framework as 3.5% of the renegotiated debt, with 90% of this burden falling on the lead investor.

(junk bond) market.

Finally, it is worth noting that the structure of the utility function is intended to represent the majority of investors, for whom the expected gains from holding out are typically insufficient to offset litigation costs or prolonged delays–i.e., cases with low δ. The opposite case involves a small group of professional holdout investors[11] who purchase the defaulted debt in the secondary market and are willing to engage in protracted litigation against sovereigns in international courts, often achieving substantial returns. These actors are excluded from the model, as they generally account for less than 10% of the total outstanding debt(Das et al., 2012), their strategic behavior differs significantly from that of the broader investor base, and negotiations with them typically follow a distinct process.

2.2. Solution in the full information scheme and multiplicity

2.2.1. Stage 3

As a first step, I impose the government´s indifference condition from Equation (1) to derive the government's threshold $\ell^*(\theta)$, presented in Equation (3). This threshold represents the minimum investor acceptance rate required for the government to proceed with the restructuring. Only when the actual acceptance rate ℓ is equal to or exceeds $\ell^*(\theta)$ will the government honor the proposed terms and exit default.

$$\ell^*(\theta) = \frac{\nu - \xi\theta}{\nu - (1-h)} \tag{3}$$

Lemma 2. *The government lowers the required acceptance threshold when economic conditions improve (i.e., higher θ), when it commits to larger haircut (i.e., higher h), or when it expects a greater solvency boost upon exiting default (i.e., higher ξ). Conversely, the threshold $\ell^*(\theta)$ increases with holdout payments ν–but only if the fundamental exceeds a certain threshold ($\theta > \frac{1-h}{\xi}$); otherwise, it decreases.*

Proof: The cases of ξ, θ and h are straightforward. For ν we have:

$$\frac{\partial \ell^*(\theta)}{\partial \nu} = \frac{-(1-h) + \xi\theta}{(\nu - (1-h))^2} \geq 0 \text{ for } \theta \geq \frac{1-h}{\xi} \blacksquare$$

[11] These include firms such as Water Street, Elliot Associates, Cerberus, Davidson Kempner and Aurelius Capital.

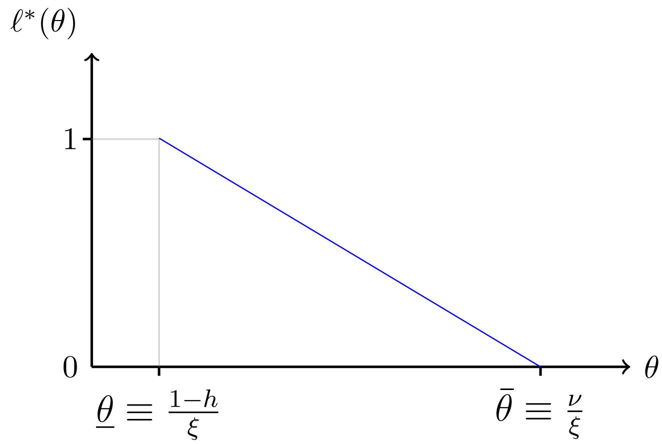

Figure 3: **Threshold $\ell^*(\theta)$.**

Thus, for a given haircut h, the effect of increasing holdout payments ν on government´s acceptance threshold $\ell^*(\theta)$ is nonlinear. In weaker economic conditions (i.e., when $\theta < \frac{1-h}{\xi}$), the government must lower $\ell^*(\theta)$ as ν increases in order to encourage participation and offset the rising cost of holdouts. In contrast,when fundamentals are strong, the government can afford to raise the acceptance threshold in response to higher ν, particularly if it deems the cost of exiting default too high under generous holdout terms.

By evaluating $\ell^*(\theta)$ at the boundaries of $\ell \in [0, 1]$, we can identify the pair of fundamental values $\{\underline{\theta}, \bar{\theta}\} \in [\check{\theta}, \hat{\theta}]$ that correspond to the extreme levels of bondholder´ agreement required for the government to exit default (see Figure 3). Specifically,

$$\underline{\theta} \equiv \frac{1-h}{\xi} \qquad \text{and} \qquad \bar{\theta} \equiv \frac{\nu}{\xi}$$

which imply that $\ell = 1$ and $\ell = 0$ are required, respectively, for the government to proceed with repayment and exit default.

These thresholds define three distinct strict dominance regions of government behavior as a function of the economic fundamental θ. Based on this, we can define government´s strategy as: $s_{gov}(\ell, \theta) : [\check{\theta}, \hat{\theta}] \times [0, 1] \mapsto \{0, 1\}$ formalized in Equation (4).

$$s_{gov}(\ell, \theta) = \begin{cases} \theta \in [\check{\theta}, \underline{\theta}) & \text{keep on default } \forall \ell \\ \theta \in [\underline{\theta}, \bar{\theta}) & \text{exit default if } \ell \geq \ell^* \\ \theta \in [\bar{\theta}, \hat{\theta}] & \text{exit default } \forall \ell \end{cases} \quad (4)$$

For $\theta \in [\check{\theta}, \underline{\theta})$, remaining in default is the government´s best response regardless of the acceptance level ℓ, due to its severily limited repayment capacity. In contrast, for $\theta \in [\bar{\theta}, \hat{\theta}]$, the government´s ample resources make exiting default the best strategy even with zero investor participation–as is the case at $theta = \bar{\theta}$. Within the intermediate region, where $\theta \in [\underline{\theta}, \bar{\theta})$, the government's decision to exit default depends on whether the acceptance level ℓ meets or exceeds the government´s threshold $\ell^*(\theta)$, which increases up to 1 as θ approaches $\underline{\theta}$.

2.2.2. Stage 2

This stage constitutes a symmetric binary-action coordination game among a continuum of agents.[12] Under complete information, each realization of θ defines a subgame in which investors choose their strategy $a_i(\theta)$ as a best response to the behavior of others in the corresponding scenario.

To derive investors' equilibrium strategies as functions of the haircut h and the parameters m, δ, and ν, I now reimpose the indifference condition on the bondholders´utility function Equation (2). Before doing so, and in connection with the investor utility function, I present a simplifying result in Lemma 3 below.

Lemma 3. *WLG, we can assume that in equilibrium $\delta\nu < 1 - h - m$. Thus, for the regular bondholders, the expected holdout payment imposes a limit on the government in determining the haircut level.*

Proof: Suppose, for contradiction, that $\delta\nu > 1 - h - m$. In this case, rejecting the offer yields a higher expected payoff leading to a general rejection with $\ell = 0$. Unless $\theta > \bar{\theta}$, the government would then remain in default. Therefore, for a participating equilibrium to exist, the expected payoff from acceptance must weakly dominate the holdout option, i.e., $\delta\nu \leq 1 - h - m$. Indifference among investors arises only when the government sets $1 - h = \delta\nu + m$ which produces an internal solution with

[12]A full-information illustration with two investors is provided in Appendix A.

partial participation ($\ell \in (0,1)$). However, this equilibrium has zero probability of occurrence, because even for a small ϵ, fixing the proposal so that $1 - h + \epsilon - m = \delta\nu$ gets full acceptance. Consequently,it is always optimal for the government to set $1 - h - m > \delta\nu$, ensuring a fully participating equilibrium ■

Now, using both Equation (2) and Lemma 3, I derive investors' strategies, defined as mappings $a_i : [\check{\theta}, \hat{\theta}] \mapsto \{0,1\}$. The strategy profile is presented in Equation (5), which can be interpreted as follows: each ordered pair in the curly brackets corresponds to one of the regions in the government's strategy, demarcated by the thresholds $\underline{\theta}$ and $\bar{\theta}$. The entries 0 or 1 represent the investors' response to low and high aggregate acceptance, respectively.

$$a_i(\theta) = \{(0,0),(0,1),(1,1)\} \qquad with\, \delta\nu < 1 - h - m \tag{5}$$

For $\theta \in [\check{\theta}, \underline{\theta})$, the sovereign remains in default regardless of the participation rate ℓ. In this case, the payoff from participating is strictly lower than that of non-participating: $u(1,\ell,\theta) = -m < u(0,\ell,\theta) = 0$. Thus, rejection is the strictly dominant strategy ($\ell = 0$) for both low and high acceptance levels.

For $\theta \in [\underline{\theta}, \bar{\theta})$, the sovereign's decision depends on the overall acceptance rate. Therefore, both $\ell = 0$ and $\ell = 1$ can emerge as optimal responses, giving rise to two pure-strategy Nash equilibria in this region: full investor participation, and zero participation. Specifically, agents should reject when acceptance is low and accept otherwise. The full participation equilibrium is Pareto superior, as $1 - h - m > 0$.

For $\theta \in [\bar{\theta}, \hat{\theta}]$, the sovereign always repays and exits default. Therefore participation does not involve any strategic risk. Since $1 - h - m > \delta\nu$, acceptance is the payoff-dominant strategy, and a unique full participation equilibrium ($\ell = 1$) arises.

To summarize, in stage 2, each value of the fundamental θ defines a Bayesian subgame with strategies in (5). Values of θ outside $(\underline{\theta}, \bar{\theta}]$ solve the game with unique Nash equilibria, either full or zero participation. In contrast, values of θ within this range produce multiplicity in the coordination game with both full participation and no participation as simultaneous outcomes.

Note that a consequence of Lemma 3 for investors' strategies, is that, in equilibrium, the incentive to hold out against the proposal results from agents seeking to avoid the loss of $-m$ if the proposal fails–not from any additional expected gain if it succeeds. This is because the government sets h such that $\delta\nu < 1 - h - m$.

2.2.3. Stage 1

In stage 1, the government chooses the optimal haircut h that maximizes its expected utility over the distribution of θ. Previously, I derived strategies for both the government and bondholders, identifying dominance regions within their domain. However, I also obtained that within a critical region $([\underline{\theta}, \bar{\theta})$ multiple equilibria arise in bondholders strategies. In this interval, both full participation with sovereign exiting default and zero participation with the sovereign remaining in default constitute equilibrium outcome. As a result, the government's optimization problem cannot be solved under a complete information framework, due to the indeterminacy in the outcome within this region.

2.3. Solution in the Incomplete information scheme

To refine the multiplicity identified in Stage 2, I introduce some noise in the investors' information using a global games approach. While the uncertainty about θ at the beginning of Stage 1 remains, now, once Nature draws a realization of θ, the government observes it directly, whereas investors receive only a noisy signal. This additional feature does not affect the analysis on Stage 3. Therefore, in what follows I continue with the backward induction approach, focusing on solving the model through Stages 2 and 1.

2.3.1. Stage 2

The investors' information set is now given by $\mathcal{I}^2_{h,inv_i} = \{x_i\}$, where $x_i = \theta + \sigma\varepsilon_i$ is to a noisy private signal about the fundamental θ. Here, ε_i is an idiosyncratic shock drawn from a standard normal distribution, and $\sigma > 0$ is a scaling parameter. In this setting, a strategy for creditor i is a decision rule that maps signals to actions: $s_i(x_i)\colon \mathbb{R} \mapsto \{0, 1\}$. An equilibrium is defined as a profile of strategies such that each creditor maximizes their expected payoff, given their private information.

It is important to emphasize that the investor's payoffs still depend on the realized value of θ, not on their private signals–a structure referred to in the literature as common-values model. Morris and Shin (2003), propose a general framework for solving such games, based on series of sufficient conditions on the payoff-gain function–in this case $u(1, \ell, \theta) - u(0, \ell, \theta)$. When these conditions are satisfied, it is possible to characterize a strategy profile s that constitutes a unique Bayesian Nash equilibrium of the game.

Proposition 1. *Let θ^* be defined as in (6).*

$$\theta^*(h) = \frac{1}{\xi}\left(1 - h + m\frac{\nu - (1-h)}{1 - h - \delta\nu}\right) \tag{6}$$

For any $\tau > 0$, there exists $\bar{\sigma} > 0$ such that for all $\sigma \leq \bar{\sigma}$, if strategy s_i survives iterated deletion of strictly dominated strategies, then $s_i(x_i) = 0$ for all $x_i \leq \theta^* - \tau$, and $s_i(x_i) = 1$ for all $x_i \geq \theta^* + \tau$.

Proof: See Appendix B.

A key of the proof of Proposition 1, is the identification of a threshold $\theta^*(h)$ in Equation (6) which separates regions of strict dominance in the game. As the noise level σ converges to zero, agents with signals $x_i > \theta^*(h)$ accept the proposal, while those with signals $x_i < \theta^*(h)$ reject it.

Characterization of the threshold $\theta^*(h)$

Some algebraic maniputalion of Equation (6) allows us to express the threshold $\theta^*(h)$–as shown in Equation (7)– as a convex combination of the government's payments to each group of investors (those accepting and those rejecting the proposal), weighted by the ratio of the net cost to the benefit of accepting.

$$\theta^*(h) = \frac{1}{\xi}\left((1-h)(1 - \frac{m}{1 - h - \delta\nu}) + \nu\frac{m}{1 - h - \delta\nu}\right) \tag{7}$$

This expression shows that the threshold $\theta^*(h)$ lies within the bounds of the multiple-equilibrium region in the complete information model, namely $[\underline{\theta}, \bar{\theta}]$ (see Figure 4). Recall that, by Assumption 1, we have $\nu > 1 - h$. When ν converges to its minimum value $1 - h$, the threshold $\theta^*(h)$ approaches $\frac{1-h}{\xi} = \underline{\theta}$. In this case, the acceptance region is maximized, as the incentives to hold out decrease.

Conversely, as $(1-h)$ converges toward ν, the threshold $\theta^*(h)$ approaches $\frac{\nu}{\xi} = \bar{\theta}$, thus reducing the acceptance region to its smallest possible extent. Intuitively, this reflects a scenario in which the government sets a haircut that is too low, and investors anticipate the sovereign will lack the resources to honor the deal. in this scenario, participating increases the risk of the program failure and exposes investors to an ex-post loss of $-m$.

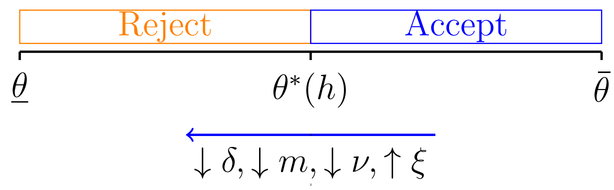

Figure 4: **Threshold $\theta^*(h)$ as a function of model parameters.**

Although $\theta^*(h)$ is determined by the full set of model parameters, not all affect it through the same channel. For example, the parameters m and δ enter directly through the agents' payoff function. The parameter ξ affects $\theta^*(h)$ indirectly, via the government's acceptance threshold $\ell^*(\theta)$, which influences the amount of investor support required to exit default and therefore the distribution of payoffs. In contrast, both ν and h exert direct and indirect effects on the threshold as described above. The direction of these effects are the focus of Corollaries 1 and 2 (see Figure 4 and Figure 5).

Corollary 1. $\frac{\partial\theta(h)^*}{\partial\xi} < 0$, $\frac{\partial\theta(h)^*}{\partial\nu} \geq 0$, $\frac{\partial\theta(h)^*}{\partial\delta} > 0$, $\frac{\partial\theta(h)^*}{\partial m} > 0$.

Proof: See Appendix C.2.

When participation costs m or holdout receipts δ decrease, the net benefit of participating increases—either due to lower costs or a less attractive outside option. This, in turn, raises the probability of acceptance, as $\theta^*(h)$ declines.

Improved post-restructuring conditions (i.e., higher ξ) raise the government's gains from successfully completing the program. As a result, it lowers the participation threshold $\ell^*(\theta)$ in stage 3, thereby increasing the program's likelihood of success. Anticipting this, the investors expect a downward shift in θ^*, which enlarges the acceptance region.

In the case of holdouts payments ν, their impact on the threshold operates through both mechanisms discussed above. First, higher ν reduces investors' net payoff from participating, making the outside option more appealing. Second, greater holdout liabilities increase the government's fiscal burden, pushing it to raise $\ell^*(\theta)$ in stage 3. Consequently, bondholders face diminished incentives to participate—both because the holdout payoff improves and because the government demands a higher acceptance rate. These dual effects shift $\theta^*(h)$ to the right, expanding the rejection region. Notably, both channels act in the same direction in this case.

As previously discussed, h influences $\theta^*(h)$ through two distinct channels: the investors´ utility function and the government´s participation threshold. Unlike the previous case, however, these effects operate in opposite directions, necessitating a more detailed analysis. Corollary 2 establishes that $\theta^*(h)$ draws a convex, U-shaped parabola on h, as illustrated in Figure 5.

Corollary 2. $\theta^*(h)$ *is a convex U-shaped function with a minimum at:*

$$h_{inv} = 1 - \delta\nu - \sqrt{m(1-\delta)\nu}$$

Proof: See Appendix C.2.

When h is very low, $\theta^*(h)$ reaches its maximum. While a low h implies favorable payoffs for investors, it simultaneously imposes a high fiscal burden on the government, to remain compliant with the program. In this scenario, the government's inability to fulfill its obligations becomes most credible from the perspective of the investors. This leads to a high value of $\theta^*(h)$ and, consequently, a maximal expansion of the rejection region.

As h increases, the credibility of the government's compliance with the program improves. In response, investors begin to relax the threshold $\theta^*(h)$, leading to a contraction of the rejection region. Although this shift comes at the cost of reduced individual payoffs, investors are, at this stage, willing to sacrifice some utility in exchange for a higher likelihood of program success.

Throughout the decreasing segment of $\theta^*(h)$, both effects—the erosion of investor payoffs and the increased credibility of government´s position—remain active. However, the latter dominates, driving the overall decline in $\theta^*(h)$. The relative strength of these opposing forces determines the curvature and degree of convexity of the parabola.

Beyond h_{inv}, this dynamic reverses. While further increases in h continue to ease government's position, a growing share of investors begin to perceive the program as overly generous or misaligned with resolving the underlying default. Investor dissatisfaction becomes the dominant force, causing $\theta^*(h)$ to rise again and the rejection region to expand once more.

This result challenges the common intuition that a sufficiently low h always coordinates investors toward a full acceptance equilibrium. In this framework, a strategic trade-off emerges. Although a lower haircut increases the recovery rate for bondholders—suggesting higher participation—at the

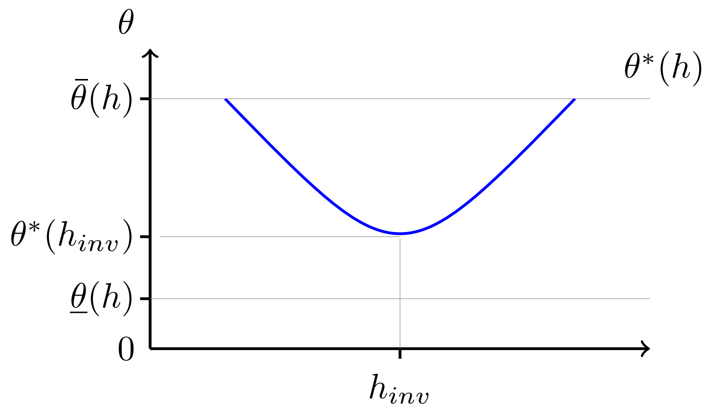

Figure 5: Threshold $\theta^*(h)$ as a function of the haircut.

same time, the government's financial position worsens. This raises the participation threshold $\ell^*(\theta)$, requiring broader market support for the program. As a result, the probability of failure rises, along with the risk of incurring the participation cost of m ultimately leading to lower participation rates.

Another consequence of the convexity of the threshold $\theta^*(h)$ with respect to h is that any value different from $\theta^*(h_{inv})$ can be attained through a pair of haircut levels $\{h < h_{inv}, h > h_{inv}\}$. This duality has direct implications for the government's decision problem, which is the focus of Proposition 2. Intuitively, it limits the government´s optimization domain, as it will always prefer the higher haircut level among those yielding the same outcome—provided it lies in the region $h \geq h_{inv}$— due to the associated increase in its utility.

Proposition 2. *The set of feasible haircut values* $\mathfrak{h}$ *for the government maximization problem is* $\mathfrak{h} = [h_{inv}, 1 - \delta\nu - m)$.

Proof: Trivial since the government's utility is strictily increasing in h ■

Finally, note that the parameter m plays a crucial role in determining the optimal haircut. In this model, the presence of participation costs is what prevents the optimal haricut h_{co} from coinciding with the benchmark value $1-\delta\nu$. As participation costs increase, a lower haircut is required to mantain investor participation.

2.3.2. Stage 1

With investors' optimal responses to θ fully characterized, the government proceeds to determine the haircut level that maximizes its expected utility $G^*(\theta)$ conditional on θ.

$$G^*(h) = \int_{\check{\theta}}^{\theta^*(h)} \theta f(\theta) d\theta + \int_{\theta^*(h)}^{\hat{\theta}} (\theta(1+\xi) - (1-h)) f(\theta) d\theta \tag{8}$$

To facilitate differentiation, Equation (8) can be rewritten using standard and truncated expectations as shown in Equation (9).

$$G^*(h) = E[\theta] + \big(1 - F(\theta)\big)\big(\xi E[\theta|\theta > \theta^*] - (1-h)\big) \tag{9}$$

By differentiating Equation (9) with respect to h and solving for the optimal haircut, I obtain the value h_{co} that maximizes the government's utility in Proposition 3. In what follows, I refer to h_{co} as the *coordination haircut*.

Proposition 3. *The equilibrium haircut is the level h_{co} that solves:*

$$\frac{1 - F(\theta^*(h))}{f(\theta^*(h))} = \frac{\partial \theta^*(h)}{\partial h}\big(\xi\theta^*(h) - (1-h)\big) \tag{10}$$

Proof: See Appendix C.3.

Proposition 3 defines the equilibrium haircut, h_{co}, as the value of h that satisfies Equation (10). The left-hand side, $\frac{1-F(\theta^{(}h))}{f(\theta^{(}h))}$, represents the inverse hazard rate of the distribution of fundamentals at the equilibrium threshold—an expression that captures how the probability mass above $\theta^{(}h)$ changes relative to its local density. The right-hand side, $\frac{\partial\theta^{(}h)}{\partial h}\big(\xi\theta^*(h) - (1-h)\big)$, measures the sensitivity of the threshold to variations in the haircut, weighted by the marginal fiscal payoff from restructuring.

This equilibrium condition highlights the efficiency margin of sovereign restructuring: the government equates the marginal benefit of offering a smaller haircut (which raises participation by shifting θ^* downward) with the marginal cost in terms of reduced fiscal relief. Intuitively, when fundamentals are strong (higher θ or lower ξ sensitivity), the hazard ratio declines, implying a smaller optimal haircut. Conversely, in weaker economic environments or when market perceptions are highly responsive to policy signals, the optimal haircut increases to restore equilibrium participation.

Proposition 4 provides the necessary conditions for the existence of a unique solution to the government's maximization problem, derived from the second derivative of Equation (9).

Proposition 4. *Necessary conditions to solve government's maximization problem into a unique value h_{co} are:*

$$1. \quad \frac{\partial f(\theta^*(h))}{\partial \theta^*(h)} \geq 0 \qquad\qquad 2. \quad \frac{\frac{\partial f(\theta^*(h))}{\partial \theta^*(h)}}{f(\theta^*(h))} \leq \frac{\frac{\partial^2 \theta^*(h)}{\partial^2 h}}{\left(\frac{\partial \theta^*(h)}{\partial h}\right)^2}$$

Proof: See Appendix C.4.

Thus, the shape of the density function of θ plays a critical role in ensuring a unique solution to the restructuring problem. Condition (1) restricts the analysis to the non-decreasing portion of the density function (in the case of a Gaussian distribution, this corresponds to the lowest tail), ensuring that shifts in $\theta^*(h)$ do not amplify probability mass in a destabilizing way. Intuitively, this means that small improvements in fundamentals increase the likelihood of success in a smooth and predictable way, preventing multiple local optima driven by discontinuous changes in investor participation.

Condition (2) ensures that the responsiveness of the equilibrium threshold $\theta^(h)$ to changes in the haircut is strong enough to dominate the curvature of the underlying distribution of fundamentals. In practical terms, it guarantees that the marginal gains from offering a smaller haircut decline steadily, so that the government faces a single, well-defined trade-off between debt relief and participation. Together, these restrictions ensure that the expected utility function $G^*(h)$ is strictly concave, yielding a unique global maximum for the optimal coordination haircut h_{co}.

2.4. Comparative statics

I now perform a comparative statics exercise on the equilibrium solution analyze how it responds to changes in the model's key parameters. Since an analytical solution is not available, the analysis relies on implicit derivation on Equation (10), as formalized in Corollary 3. Figure 6 and Figure 7 illustrate these relationships for clarity.

Corollary 3. *Under the conditions stated in Corollary 4, the coordination haircut h_{co} is decreasing in ν, δ and m, and increasing in ξ.*

Proof: See Appendix C.5.

The coordination haircut is negatively related to holdouts paying probability δ and the participation cost m. Increases in either parameter reduce the net utility of participation for investors, prompting a rightward shift in the threshold $\theta^*(h)$ and expanding the rejection region. In response, the government lowers the haircut to compensate investors and encourage participation.

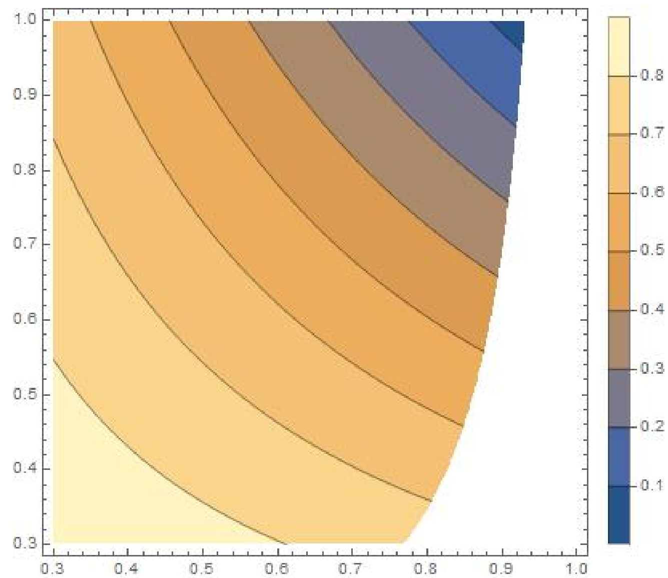

Figure 6: **Simulated haircut as a function of model parameters.** Contour plot: h_{co} as a function of δ (abscissa) and ν (ordinate), with $m = 0.013$, $\xi = 0.04$ and an exponential distribution of θ with $\lambda = 0.16$. The white region does not satisfy the conditions in Lemma 3.

The coordination haircut also declines with an increases in the holdout payment ν. This parameter affects investor behavior through both channels discussed earlier: it reduces the utility of participating (by making holding out more attractive) and increases the government's obligations, leading to a tighter participation threshold $\ell^*(\theta)$. These combined effects expand the rejection region. notably, although a distressed government might be expected to offer deeper haircuts when it obligations rise, in this model, the government strategically maintains a lower haircut as a signal to preserve investor confidence and counteract the erosion in acceptance.

By contrast, the effect of an increase in ξ—the expected post-restructuring benefit— works in the opposite direction. First, it encourages investors to accept the proposal, as they anticipate the government will ease its participation threshold $\ell^*(\theta)$. Second, a higher ξ directly increases the government's utility from a successfull restructuring. Together, these effects lead the government to set a higher haircut when ξ increases.

Based on the comparative statics above, the model yields a testable empirical prediction: countries facing higher coordination frictions—proxied empirically by the transition from bank lending to bond financing—should exhibit higher restructuring haircuts, all else equal. This prediction will be assessed empirically in Section 3.1, using a panel of sovereign debt restructurings.

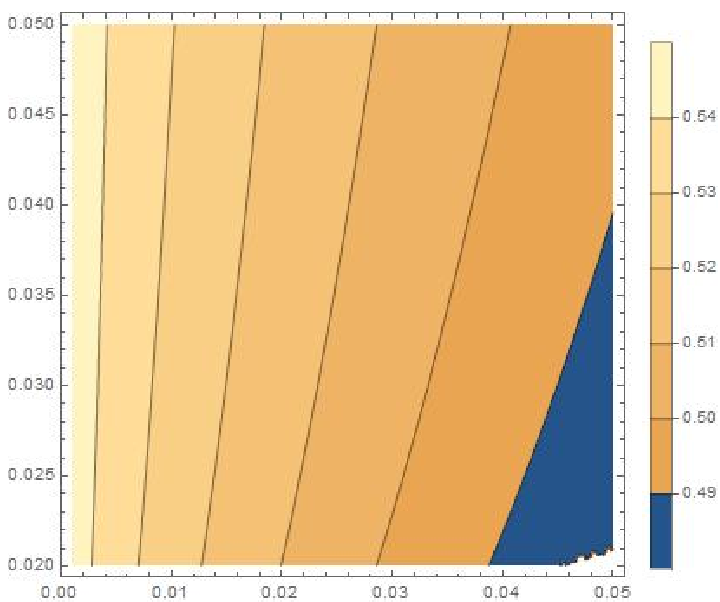

Figure 7: **Simulated haircut as a function of model parameters.** Contour plot of h_{co} as a function of m (abscissa) and ξ (ordinate), with $\delta = 0.66$, $\nu = 0.66$, assuming an exponential distribution of θ with parameter $\lambda = 0.16$. The white zone does not satisfy Lemma 3.

3. Model Predictions and Quantitative Implications

In this section, I present three exercises to illustrate the empirical relevance and quantitative implications of the model. First, I derive a testable prediction: coordination frictions in bond markets are expected to reduce haircuts. Second, I develope a method to quantify the magnitude of coordination costs implied by these frictions. Third, I compare the coordination haircut to that predicted by a standard Nash bargaining framework to highlight potential overestimation in less bilateral settings. Finally, I discuss policy measures that governments could adopt to mitigate coordination frictions and improve restructuring outcomes

3.1. Coordination Frictions and Predicted Haircuts

To assess the model's testable prediction that coordination frictions lead to lower haircuts, this subsection examines empirical patterns in sovereign debt restructurings using an updated version of the dataset from Cruces and Trebesch (2013). Our variable of interest is the restructuring haircut. The preferred measure is that of Sturzenegger and Zettelmeyer (2008, 2007), which summarizes the present value loss for investors:

$$H^i_{SZ} = 1 - \frac{\text{Present value of New debt}(r^i_t)}{\text{Present value of old debt}(r^i_t)}$$

Where r^i_t is the yield prevailing at the time of the restructuring, used as a proxy for the debtor's post-restructuring risk. This rate is also used to discount both old and new debt cash flows.[13]

Table 1 presents a summary of the data. Between 1978 and 2013, there were 187 sovereign debt restructurings, with an average haircut of 40%. A breakdown by creditor type shows that only 22 of these involved bondholders, and the average haircut in those cases was similar to that observed in restructurings with commercial banks. Lastly, average haircuts increased significantly over time, doubling from 25% before 1989 to 50% thereafter.[14]

To empirically test the model's prediction, Table 2 presents regression results estimating the effect of disintermediation on restructuring haircuts. The main specification regresses the haircut on a dummy variable equal to one for bond restructurings and zero otherwise. Columns (1) to (5) use the "preferred haircut" as the dependent variable; results using the market-based haircut for robustness are reported in Appendix D.

Control variables include proxies related to the restructuring process itself—specifically, the amount of restructured debt ($lsize$) and the number

[13]See Cruces and Trebesch (2013) for details on data construction.

[14]Ferry (2023), using data from 1980 to 2009, also finds that haircuts increased in both size and heterogeneity over time.

	Observations	Mean	SD	Mean	Max
SZ Haircut	187	.40	.28	-.098	.97
By type of creditor					
Bank debt restructuring	165	.37	.28	-.098	.97
Bond debt restructuring	22	.37	.22	.04	.76
By era					
1978–1989	99	.25	.19	-.098	.93
1990–1997	48	.51	.28	.03	.92
1998–2013	40	.52	.32	-.08	.97

Table 1: **Summary of Haircuts.** Haircuts are measured following Sturzenegger and Zettelmeyer (2008), and are reported by creditor type and time period. Source: Cruces and Trebesch (2013).

of restructuring cases ($case$)—followed by economic size ($logGDP$), solvency indicators (debt-to-GDP ($ldebt$), current account-to-GDP (ca) and deficit-to-GDP ratios ($deficit$)), financial conditions (federal funds rate), and a linear time trend to capture temporal effects (year).

In Column (1), the bond dummy has a positive but statistically insignificant coefficient. Upon adding controls related to the restructuring process, economic size, global financial conditions, and the linear trend (Column 2), the coefficient turns negative and significant, consistent with the model's prediction. Column (3) further incorporates solvency controls strengthening this negative, significant effect.

When country fixed effects are included alongside all controls (Model 4), the coefficient remains negative but loses statistical significance. However, with fixed effects but without the full macro controls in (Model 5), the bond dummy remains significantly negative. This pattern suggests that multicollinearity or limited within-country variation may reduce precision rather than negate the underlying effect.

All models use robust standard errors. The results across specifications consistently support the model's prediction that bond restructurings—where creditor coordination is more difficult—are associated with lower haircuts. The estimated effect is economically meaningful: transitioning from bank to bond credit corresponds to a reduction in haircuts of 10 to 26 percentage points, depending on the specification.

	(1)	(2)	(3)	(4)	(5)
bondexchange	0.0277	-0.265***	-0.234**	-0.104	-0.153**
	(0.0713)	(0.0809)	(0.114)	(0.130)	(0.0743)
lsize		0.0316*	0.0151	0.0486	0.0501**
		(0.0178)	(0.0364)	(0.0442)	(0.0218)
lgdp		-0.0841***	-0.0488	-0.0604	-0.157*
		(0.0251)	(0.0367)	(0.208)	(0.0825)
case		0.00700	-0.00665	0.00842	0.0106
		(0.00757)	(0.0144)	(0.0142)	(0.00695)
fedfunds		0.00267	-0.00435	-0.00935	0.00467
		(0.00598)	(0.00994)	(0.00910)	(0.00644)
year		0.0243***	0.0159**	0.0107	0.0268***
		(0.00440)	(0.00738)	(0.0131)	(0.00530)
debt			0.274	0.0248	
			(0.184)	(0.643)	
ca			0.00228	0.00231	
			(0.00576)	(0.0117)	
deficit			-0.0108**	-0.0129	
			(0.00433)	(0.00909)	
_cons	0.449***	-47.32***	-30.67**	-20.33	-51.84***
	(0.0344)	(8.833)	(14.75)	(24.59)	(10.25)
FE				Yes	Yes
N	185	166	75	75	166
R^2	0.0068	0.4196	0.1788	0.238	0.462

Table 2: **Model estimates for the logarithm of the haircut.** The dependent variable is the preferred haircut, as defined in Cruces and Trebesch (2013). Independent variables include: *bondexchange*, a dummy equal to one if the restructured debt is in bonds and zero if it is bank debt; *lsize*, the logarithm of restructured debt (in USD millions); *lgdp*, the logarithm of GDP (in USD millions); *case*, the number of restructuring cases in the same country; *fedfunds*, the U.S. federal funds rate; *year*, the start year of the restructuring; *ldebt*, the ratio of public debt to GDP; *reserves*, the ratio of reserves to GDP; and *ca*, the current account balance as a percentage of GDP. Standard errors in parentheses. *FE* indicates country fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

These findings provide empirical support for the role of coordination frictions in shaping restructuring outcomes. In the next section, I turn to a model-based approach to quantify the cost these frictions impose on sovereigns during bond restructurings.

3.2. A measure of coordination costs

Since the model presented in Section 2 reflects a highly stylized restructuring environment, it does not yield direct quantitative predictions for the haircut. To provide quantitative intuition, this subsection illustrates equilibrium haircut levels implied by a set of plausible parameter values.

Coordination costs are quantified as the gap between the equilibrium haircut under coordination frictions, h_{co}, and the maximum haircut achievable in their absence, $h_{nb,\alpha=1}$, as defined in Equation (11).

$$coordination\, costs = h_{nb,\alpha=1} - h_{co} \tag{11}$$

This benchmark corresponds to a setting in which the government possesses full bargaining power within a Nash bargaining framework ($nb, \alpha = 1$) and negotiates with a single creditor, rather than a continuum of uncoordinated agents. The resulting haircut, $h_{nb,\alpha=1}$—as defined in Equation (12)—also represents the upper bound attainable by the government within the coordination model, as established in Proposition 2.

$$h_{nb,\alpha=1} = 1 - \delta\nu - m \tag{12}$$

The parameter values used in the simulations are reported in Table 3. The value of ν is based on the average recovery rate documented in the Cruces and Trebesch (2013) database, adjusted by the weighted average of holdout premia from Fridson and Gao (2002) and Altman and Eberhart (1994). The discount factor δ is calibrated to match a market price of $\delta\nu = 0.3$, consistent with the weighted average of post-default or distressed exchange trading prices reported in Moody´s (2017). The parameter ξ is set to 0.04, reflecting a conservative estimate aligned with average post-restructuring recovery rates found in Das et al. (2012). Finally, the participation cost m—which is unobservable—is calibrated to represent 1% of total investment, that is, $m = 0.010$.

Coordination costs are simulated as a function of the junk market price parameters δ and ν, as shown in Figure 8. The simulated values range from 0 to 3.5%, corresponding to roughly 10% of the average haircut reported by

Parameter		Value	Source
Holdout payment	ν	0.835	Fridson and Gao (2002) and Altman and Eberhart (1994)
Discount on holdout payment	δ	0.375	Moody´s (2017)
Recovery after restructuring	ξ	0.004	Das et al. (2012)
Participation costs	m	0.010	

Table 3: **Parameters chosen for the illustrative example.**

Cruces and Trebesch (2013). Coordination costs decline with higher values of the discount factor δ, but increase with the holdout premium ν. The benchmark haircut $h_{nb,\alpha=1}$ exhibits a constant proportional reduction equal to δ relative to ν. The observed rise in coordination costs with ν results from a steeper decline in the coordination haircut h_{co} compared with the effect of δ, reflecting the twofold influence of ν on the haircut discussed above.

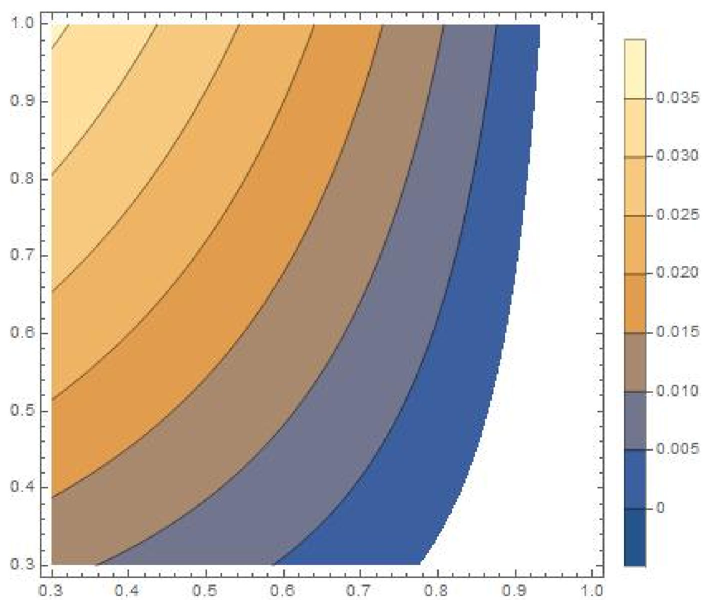

Figure 8: **Coordination costs against model parameters.** Contour plot: coordination costs as a function of δ (abscissa) and ν (ordinate), with $m = 0.01$, $\xi = 0.04$, assuming an exponential distribution of θ with parameter $\lambda = 0.16$. The white zone does not satisfy Lemma 3.

Figure 9 displays simulated coordination costs as functions of the participation cost m and the post-default recovery rate ξ. The estimated values range from 1% to 6%, corresponding to roughly 20% of the average haircut gap observed between bond and loan restructurings. The highest coordination costs arise within plausible parameter ranges, specifically around $\xi = 0.0275$ and m between 0.015 and 0.03.

Although some nonlinearities emerge at higher values, coordination costs generally decline as ξ increases. This expected pattern arises because the haircut increases with ξ according to (3), while $h_{nb,\alpha=1}$ remains unaffected by this variable. In contrast, participation costs m exert a positive effect on coordination costs: since m consistently raises $h_{nb,\alpha=1}$, higher values of m effectively amplify the reduction in the equilibrium haircut.

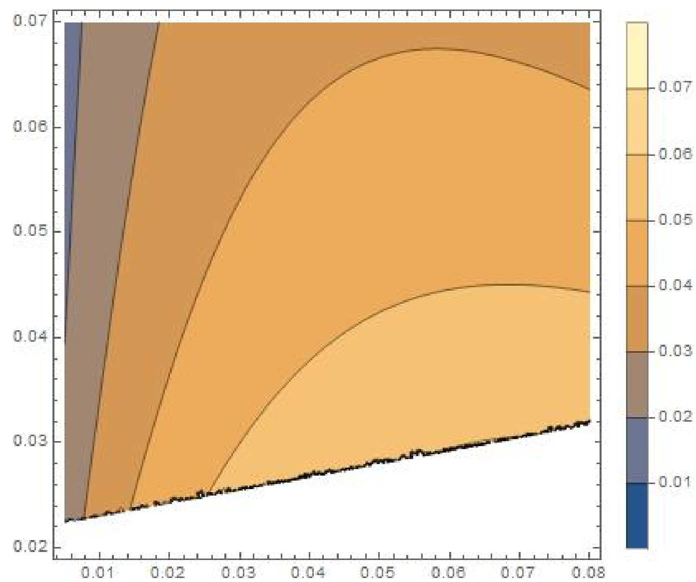

Figure 9: **Coordination costs against model parameters.** Contour plot: coordination costs as a function of m (abscissa) and ξ (ordinate), with $\delta = 0.375$, $\nu = 0.835$, assuming an exponential distribution of θ with parameter $\lambda = 0.16$. The white zone does not satisfy Lemma 3.

These results support the view that disintermediation in sovereign debt markets tends to lower haircuts. Governments incur costs because they cannot bargain directly with individual creditors; instead, they must propose a haircut that coordinates dispersed investors and their higher-order beliefs—each must expect others to accept the offer for it to succeed. Coordination costs of around 7% explain nearly one-third of the observed gap between bank and bond debt haircuts, highlighting sizable financial losses for distressed governments.

3.3. Coordination vs. Nash bargaining haircut

The quantitative sovereign debt literature with endogenous restructuring typically determines equilibrium haircuts via Nash bargaining.[15] This framework is better suited to bank debt restructurings characterized by bilateral bargaining over one or more rounds.

This subsection examines of coordination frictions on equilibrium outcomes by comparing the standard Nash bargaining solution with a coordination equilibrium derived from Section 2. For clarity, both haircut outcomes are expressed as a function of agents' bargaining power and contrasted. (See Appendix E for details).

Begin by expressing the generalized Nash product in terms of the expected payoffs within this model, as shown in Equation (13). Here, α and $1-\alpha$ represent the bargaining power of the government and the investors, respectively, while θ^e denotes the expected value of θ. From the government's and investors' utility functions Equation (1) and Equation (2), we derive the payoffs associated with a successful restructuring program excluding the outside option in each case.

Note that for bondholders, the outside option to participate yields a payoff of $\delta\nu$ if the proposal is accepted. If the proposal fails, no single can alter the overall restructuring outcome —resulting in a payoff of 0—so this outside option is effectively removed.

$$\omega(h) = \alpha\ell\big((1+\xi)\theta^e - (1-h)\ell - \nu(1-\ell) - \theta^e\big)^{\alpha}(1-h-m-\delta\nu)^{1-\alpha} \quad (13)$$

The Nash bargaining haircut is defined as the h_{nb} that maximizes the generalized Nash product of expected utilities, as shown in Equation (14), with the bargaining power α_{nb} given in Equation (15). h_{nb} is . Recall that assuming homogeneous investors implies that a successful proposal has $\ell = 1$, which simplifies the expressions above.

[15]Earlier works such as Aguiar and Gopinath (2006) and Arellano (2008) assumed an exogenous recovery values post-default (zero or random). Yue (2010) pioneered the endogenization of haircuts introducing a Nash bargaining framework, which subsequent studies have adopted using single- or multi-shot equilibria. (e.g., Asonuma and Trebesch (2016) or Bai and Zhang (2019).)

$$h_{nb} = \alpha(1 - m - \delta\nu) - (1 - \alpha)(\xi\theta^e - 1) \tag{14}$$

$$\alpha_{nb} = \frac{\xi\theta^e - (1 - h)}{\xi\theta^e - (m + \delta\nu)} \tag{15}$$

For the Nash bargaining haircut under strategic coordination among the investors, I rely on the result in Proposition 1. The key difference from the general model above is that the Nash product $\omega(h)$ now includes the truncated mean of the fundamental $\mathring{\theta}(\theta^*(h))$, instead of θ^e, introducing an additional dependence on h that must be accounted for during maximization. This reflects the government's incorporation of coordination frictions into its decision at stage 3, implying that a successful proposal lies within the subset $[\theta^*(h), \hat{\theta}]$ rather than the full distribution of θ.

$$\omega(h) = \alpha\big((1 + \xi)\,\mathring{\theta}(\theta^*(h)) - (1 - h)\ell - \nu(1 - \ell)\big)^{\alpha}\big(1 - h - m - \delta\nu\big)^{1-\alpha} \tag{16}$$

Let $h_{nb,co}$ denote the coordination haircut that satisfies Equation (17), corresponding to the first-order condition where the derivative of $\omega(h)$ equals zero, and let $\alpha_{nb,co}$ denote the associated bargaining power defined in Equation (18).

$$\alpha(1 - h - m - \delta\nu)\left(\xi\frac{\partial\,\mathring{\theta}(h)}{\partial\theta^*(h)}\frac{\partial\theta^*(h)}{\partial h} + 1\right) - (1 - \alpha)\big(\xi\,\mathring{\theta}(\theta^*(h)) - (1 - h)\big) = 0 \tag{17}$$

$$\alpha_{nb,co} = \frac{\xi\,\mathring{\theta}(\theta^*(h)) - (1 - h)}{\xi\,\mathring{\theta}(\theta^*(h)) + (1 - h - m - \delta\nu)\xi\frac{\partial\,\mathring{\theta}(h)}{\partial\theta^*(h)}\frac{\partial\theta^*(h)}{\partial h} - \delta\nu} \tag{18}$$

Lemma 4. *$h_{nb,co}$ and h_{nb} are both monotone increasing functions of α.*

Proof: Appendix E.3.

Lemma 4 characterizes the slope properties of the haircuts derived from the Nash bargaining process. Building on these results, we can now map each haircut h_{nb} and $h_{nb,co}$ onto the space defined by $\alpha \in [0, 1]$. The following proposition, establishes that, when plotted in α, there exists a decreasing

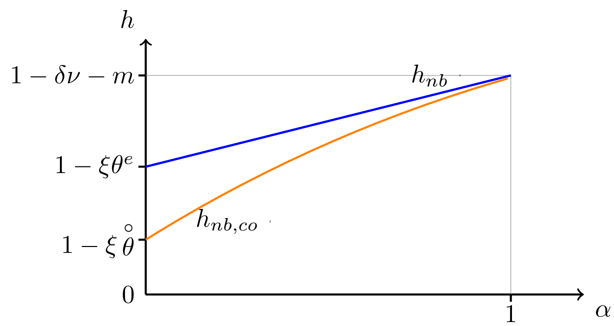

Figure 10: **Nash and coordination haircut.**

wedge between the two haircuts, and that the haircut incorporating coordination frictions remains strictly below the general Nash bargaining haircut for all bargaining powers in $\alpha \in [0, 1)$.

Proposition 5. *For each possible level of bargaining power $\alpha \in [0, 1]$:*

1. $h_{nb,co} \leq h_{nb}$
2. $h_{nb} - h_{nb,co}$ *is decreasing in α.*

Proof: Please see Appendix E.4.

Using Proposition 5 and the limit values of both measures, Figure 10 plots h_{nb} and $h_{nb,co}$ against α. Consider first the extreme cases. When the government holds full bargaining power ($\alpha = 1$), both measures converge to a haircut of $1-\delta\nu-m$, which corresponds to the limit value of h_{co} established in Lemma 3.[16]

At the opposite extreme, when $\alpha = 0$ the value of h depends on the distribution function of θ, which determines both θ^e and $\mathring{\theta}(\theta^*(h))$. Lemma 4 shows that $h_{nb,co}$ and h_{nb} are monotonically increasing functions over $\alpha[0, 1]$, while Lemma 5 goes a step further by comparing their equilibrium values across all levels of bargaining power.

This result implies that, within a Nash bargaining framework, bilateral and coordination settings yield identical outcomes only when the government holds full bargaining power. Once coordination frictions arise, the Nah model

[16]Strictly speaking, Lemma 3 does define the haircut exactly at $\alpha = 1$; however, it can be interpreted as the limit over an arbitrarily small interval $\epsilon \to 0$.

tends to overestimate the haircut, and the bias grows as the government bargaining power diminishes.

In effect, the model captures a *de facto* loss of bargaining power as sovereign debt shifted from loans to bonds, where coordination frictions compel the government to propose a haircut level that both attracts investors and sustains mutually consistent expectations —second-order beliefs— required for a successful restructuring.

Moreover, Equation (18) provides an endogenous formulation of bargaining power based on model parameters–the holdout premium, probability of repayment, expected recovery and expected fundamental value—all traceable to market variables. This link enables the equilibrium to evolve consistently with shifts in market conditions during specific structuring episodes.

3.4. Policy implications

Based on model's findings, participation costs represent a significant barrier in sovereign debt restructurings and and are the main component directly under the government's control. Reducing these costs can therefore help mitigate coordination frictions and improve restructuring outcomes.

Governments could take several concrete measures: enhancing transparency and communication through dedicated information offices, regular public updates, and international roadshows; and through transferable brokerage commissions or centralized electronic platforms, in case participation costs take the form of transaction fees. These strategies have been successfully employed in past restructurings, such as Uruguay (2003), Argentina (2005), Ecuador (2009).

Implementing these measures align investor incentives, encourages broader participation, and facilitates smoother negotiations, ultimately reducing the gap between coordinated and uncoordinated haircuts.

4. Conclusions

With the disintermediation of sovereign debt markets, negotiating an exit from default has become a complex task, requiring governments to coordinate thousands of investors with limited information in a short time. Empirical evidence suggests that this shift has disadvantaged governments, with haircuts now nearly 20 percentage points lower than in the bank credit era.

I propose a model of the restructuring process as a three-stage game between the government and investors. In the decision stage, investors face a coordination game with multiple Nash equilibria, resolved here using incomplete information and a global games approach. This allows the model to endogenously determine the equilibrium haircut as a function of the economic fundamental and market parameters, including expected holdout payoffs, participation costs, and post-default recovery. The government, unable to negotiate bilaterally with all creditors, bears the coordination costs: it must signal a haircut that convinces bondholders both to participate themselves and that others will do so as well (first and second-order beliefs).

The model's implications are illustrated through three exercises. First, a testable prediction: coordination frictions reduce haircuts, a pattern confirmed in empirical data. Second, comparing a standard Nash bargaining solution with the coordination-based outcome, shows that the former consistently overestimates the haircut when bondholders are dispersed and unorganized. Third, coordination costs are quantified, reaching significant levels—about one-third of the observed gap between bank and bond restructurings. Comparative statics further indicate that haircuts tighten when holdout payoffs or participation costs rise and expand with higher expected recovery.

Policy recommendations focus on reducing participation costs, whether stemming from information acquisition or transaction fees, to mitigate coordination frictions.

Future work could improve equilibrium projections by introducing heterogeneity in investor information, allowing for interior equilibria and more precise prediction of program participation rates.

Appendix A. Two investors illustration

Consider a two-investor game in which each investor possesses complete information about the underlying economic fundamental, θ. The structure of the game is presented in the tables below, where investor's one strategies are displayed in the rows and investor's two strategies in the columns. Within each cell, payoffs are listed in rows.

The government proposes a concession program whose outcome depends on the observed fundamental θ. This variable, which evolves over time, determines the payoff matrix and, consequently, the equilibrium outcomes of the game, as detailed below.

When $\theta < \underline{\theta}$, we have $\ell^*(\theta) > 1$ in Equation (3), implying that the program fails even under full (100%) participation. In this case, accepting the offer provides no benefit to investors: acceptance entails a cost of $-m$ while rejection yields a payoff of 0. The resulting payoff matrix is presented in Table A.4, which exhibits weak dominance leading to a unique Nash equilibrium in pure strategies, $s = \{s_1, s_2\} = \{Reject, Reject\}$.

		Investor 2	
		Accepts	Rejects
Investor 1	Accepts	$-m$ $-m$	$-m$ $\underline{0}$
	Rejects	$\underline{\underline{0}}$ $-m$	$\underline{0}$ $\underline{0}$

Table A.4: Payoffs matrix $\theta \in [\check{\theta}, \underline{\theta})$.

For draws of $\theta \in [\bar{\theta}, \hat{\theta}]$, we obtain $\ell^*(\theta) \leq 0$, implying unconditional restructuring. In this case, the game yields a payoff of $1 - h - m$ to who accept the offer and a payoff of δ to those who reject, where we assume $\delta < 1 - h - m$. The corresponding game, presented in Table A.5, admits a unique Nash equilibrium in pure strategies, characterized by weak dominance at $s = \{s_1, s_2\} = \{Accept, Accept\}$.

		Investor 2	
		Accepts	Rejects
Investor 1	Accepts	$\underline{1 - h - m}$ $\underline{1 - h - m}$	$\underline{1 - h - m}$ $\delta\nu$
	Rejects	$\delta\nu$ $\underline{1 - h - m}$	$\delta\nu$ $\delta\nu$

Table A.5: Payoffs matrix $\theta \in [\bar{\theta}, \hat{\theta}]$.

Finally, Table A.6 illustrates the intermediate region where $\theta \in [\underline{\theta}, \bar{\theta})$, implying $\ell(\theta)^* \in [0, 1]$. Suppose there exists a threshold value θ_0 such that, for $\theta < \theta_0$, we have $\ell^*(\theta) > 0.5$—that is, the government can exit default only if both investors accept the proposal. In this case (left panel in the table) the game admits two equilibria in strictly dominant strategies, exhibiting symmetric behavior. For $\theta \geq \theta_0$, the government can exit default even if only one investor participates (right panel in the table). Here, acceptance becomes a weakly dominant strategy, yielding an equilibrium with full participation.

Note that a strategy specifies an action plan for every possible contin-

Investor 1 \ Investor 2	Accepts	Rejects
Accepts	$\underline{1-h-m}$ $\underline{1-h-m}$	$-m$ 0
Rejects	0 $-m$	$\underline{0}$ $\underline{0}$

θ low $\to \ell^* > 0.5$

Investor 1 \ Investor 2	Accepts	Rejects
Accepts	$\underline{1-h-m}$ $\underline{1-h-m}$	$\underline{1-h-m}$ $\delta\nu$
Rejects	$\delta\nu$ $\underline{1-h-m}$	$\delta\nu$ $\delta\nu$

θ high $\to \ell^* = 0.5$

Table A.6: Payoffs matrix $\theta \in [\underline{\theta}, \bar{\theta}]$.

gency. Accordingly, we can write:

$$a_i = \{(Reject, Reject), (Accept, Reject), (Accept, Accept), (Accept, Accept)\}$$

where each element corresponds to a subset of fundamentals,

$$\{[\check{\theta}, \underline{\theta}), [\underline{\theta}, \theta_0), (\theta_0, \bar{\theta}], [\bar{\theta}, \hat{\theta}]\}$$

Inside each bracket the components portray optimal responses to others' decisions—either to accept or reject, respectively.

The source of multiplicity lies in the second region, where both equilibria—universal acceptance and universal rejection—can arise.

Appendix B. Equilibrium uniqueness

From Equation (2) we construct in Equation (B.1) the action gain function $\pi(\ell, \theta) : [0, 1] \times \mathbb{R}^+ \to \mathbb{R}$ as $\pi(\ell, \theta) = u(1, \ell, \theta) - u(0, \ell, \theta)$.

$$\pi(\ell, \theta) \equiv \begin{cases} 1 - h - \delta\nu - m & \text{if} \quad \ell \geq \ell^* \\ -m & \text{if} \quad \ell < \ell^* \end{cases} \tag{B.1}$$

According to Equation (B.1), agents obtain a net gain of $1 - h - \delta\nu - m$ from accepting the bargain when it succeeds, and incur a net loss of $-m$ when it fails. Here I demonstrate that Equation (B.1) satisfies the following conditions:

- **C1: Action monotonicity: the incentive to choose action $a = 1$ is increasing in ℓ.**
  $\pi(l, \theta)$ is a step function in ℓ, discontinuous at $\ell = \ell^*(\theta)$. If $1-h-\delta\nu-m > -m$ then $\pi(\ell^{*+}, \theta) = 1 - h - \delta\nu - m > \pi(\ell^{*-}, \theta) = -m$ and the

function is increasing in the actions of other players, implying strategic complementarity in the game. Conversely, if $1 - h - \delta\nu - m < -m$, $\pi(\ell, \theta)$ decreases in ℓ, so rejection becomes a strictly dominant strategy and the game exhibits strategic substitutability. A coordination equilibrium therefore requires $1 - h - \delta\nu - m > 0 > -m$ ensuring action monotonicity ■

- **C2: State monotonicity: the incentive to choose $a = 1$ is non-decreasing in the fundamental θ.**
  Since $\ell^*_\theta(\theta) < 0$ in Equation (3), increases in θ reduce the lower bound of $\pi(\ell^+, \theta)$, thereby expanding the region where action $a = 1$ is dominant (given C1 holds. i.e., $\pi(\ell^{*+}, \theta) > \pi(\ell^{*-}, \theta)$). Intuitively, this implies that weaker economic conditions lower the government's participation requirement, increasing the likelihood of a successful restructuring process ■

- **C3: Strict Laplacian state monotonicity: ensures a unique crossing for a player with Laplacian beliefs.** Intuitively, players assume a uniform distribution over the proportion ℓ of others choosing $a = 1$. Then:

$$\int_{\ell=0}^{\ell=1} \pi(\ell, \theta) d\ell = \int_{\ell=0}^{\ell=\ell^*(\theta)} -m \, d\ell + \int_{\ell=\ell^*(\theta)}^{\ell=1} 1 - h - \delta\nu - m \, d\ell = 0 \quad \text{(B.2)}$$

  Equation (B.2) can be expressed as a linear function of θ, with a unique solution θ^* given by (Appendix C.1):

$$\theta^* = \frac{1}{\xi} \left(1 - h + m \frac{\nu - (1 - h)}{1 - h - \delta\nu} \right) \quad \text{(B.3)}$$

- **C4: Uniform limit dominance:** There exists values $\{\theta_0, \theta_1\} \in \mathbb{R}$ and $\varepsilon \in \mathbb{R}_{++}$, such that [1] $\pi(\ell, \theta) \leq -\varepsilon$ for all $\ell \in [0, 1]$ and $\theta \leq \theta_0$; and [2] $\pi(\ell, \theta) > \varepsilon$ for all $\ell \in [0, 1]$ and $\theta \geq \theta_1$.
  From Equation (3), $\ell^*(\theta)$ is linear in θ and equals 1 at $\underline{\theta} = \frac{1-h}{\xi}$ (figure 1). Since $\ell^*_\theta(\theta) < 0$ (Lemma 2), we can define $\theta_0 = \frac{1-h}{\xi} - \varepsilon$, such that $\ell^*(\underline{\theta}) = 1 + \varsigma$ (for ς arbitrarily small). Consequently, $\pi(\ell, \theta) = -m$ for all $\ell \in [0, 1]$ and every $\theta \leq \theta_0$■

  An analogous argument applies for condition [2], where $\theta_1 = \frac{\nu}{\xi} + \varepsilon$.

- **C5: Continuity:** $\int_{\ell=0}^{\ell=1} g(\ell)\pi(\ell,x)d\ell$ **is continuous with respect to the signal** x **and density** g**.**
Since $\pi(\ell,x)$ has a single point of discontinuity at $\ell = \ell^*$, and $g(\ell)$ is continuous, the discontinuity carries zero mass,ensuring weak continuity ■

- **C6: Finite expectations of signals:** $\int_{z=0}^{z=+\infty} zf(z)dz$ **is well defined.**
With $z = \frac{x-\theta}{\sigma}$, $f(z)$ is defined as a continuous density function with $\int_{z=0}^{z=1} f(z) < +\infty$■

Since the payoff gain function satisfies conditions C1-C6, Proposition 1 implies that the game admits a unique equilibrium in terms of fundamental θ. (Morris and Shin, 2003).

Appendix C. Other Corollary and Proposition Proofs

Appendix C.1. Laplacian state monotonicity proof

There is a single cross on θ^* for the action gain function π.

$$\int_{\ell=0}^{\ell=1} \pi(\theta,\ell)d\ell = \int_{\ell=0}^{\ell=\ell^*(h)} -m\, d\ell + \int_{\ell=\ell^*(h)}^{\ell=1} 1-h-\delta\nu-m\, d\ell = 0$$

$$-m\ell^*(h) + (1-h-\delta\nu-m)(1-\ell^*(h)) = 0$$

Replacing ℓ^* for the expression in Equation (3).

$$(1-h-\delta\nu-m) - (1-h-\delta)\frac{\nu-\theta\xi}{\nu-(1-h)} = 0$$

$$(1-h-\delta\nu-m)(\nu-(1-h)) - (1-h-\delta)(\nu-\theta\xi) = 0$$

$$\theta = \frac{-(1-h-\delta\nu-m)(\nu-(1-h)) + (1-h-\delta)\nu}{(1-h-\delta)\xi}$$

$$\theta^* = \frac{1}{\xi}\left(1-h+m\frac{\nu-(1-h)}{1-h-\delta\nu}\right) \blacksquare$$

Appendix C.2. Analysis of threshold θ^* partial derivatives

This section presents the proofs of Corollaries 1 and 2 which concern the partial derivatives of the threshold $\theta^*(h)$ with respect to model parameters. In all cases, the analysis relies on the first derivatives of the threshold function.

Equations (C.1) through (C.4) establish Corollary 1, which identifies the signs of these derivatives. The results are derived under Assumption 1, Lemma 3, $m > 0$, $\xi > 0$ and $\delta \in [0, 1]$.

$$\frac{\partial \theta^*(h)}{\partial m} = \frac{1}{\xi}\left(\frac{\nu - (1-h)}{1-h-\delta\nu}\right) > 0 \tag{C.1}$$

$$\frac{\partial \theta^*(h)}{\partial \xi} = -\frac{1}{\xi^2}\left(1-h+\frac{m(\nu-(1-h))}{1-h-\delta\nu}\right) < 0 \tag{C.2}$$

$$\frac{\partial \theta^*(h)}{\partial \delta} = \frac{1}{\xi}\left(m\nu\frac{\nu-(1-h)}{(1-h-\delta\nu)^2}\right) > 0 \tag{C.3}$$

$$\frac{\partial \theta^*(h)}{\partial \nu} = \frac{1}{\xi}\left(m\frac{(1-\delta)(1-h)}{(1-h-\delta\nu)^2}\right) \geq 0 \tag{C.4}$$

$$\frac{\partial \theta^*(h)}{\partial h} = \frac{1}{\xi}\left(-1+\frac{m(1-\delta)\nu}{(1-h-\delta\nu)^2}\right) \tag{C.5}$$

Corollary 2 established that $\theta^*(h)$ is not linear but convex in h, as can be deduced from Equation (C.5). Specifically, the threshold $\theta^*(h)$ increases in h when $\frac{m(1-\delta)\nu}{(1-h-\delta\nu)^2} > 1$ and decreases otherwise. The convexity of $\theta^*(h)$ with respect to h allows us to identify the minimum value h_{inv} in Equation (C.6) by setting Equation (C.5) equal to zero:

$$1 - h_{inv} - \delta\nu = \sqrt{m(1-\delta)\nu} \tag{C.6}$$

Appendix C.3. The optimal haircut

To prove Proposition 3, we seek $h \in [0, 1]$ that maximizes the government's expected utility

$$G^*(h) = E_\theta[G(h)], \quad \theta \sim p(\check{\theta}, \hat{\theta})$$

. I denote the value of the coordination haircut thus obtained as: h_{co}.

$$h_{co} = argmax_{h\in[0,1]}\{G^*(h)\} \tag{C.7}$$

The government's expected utility is given in Equation (C.8). For values of θ above the threshold θ^*, all agents accept the proposal by symmetry, so that $\ell = 1$. Let $f(\theta)$ denote the density of the fundamental and $F(\theta)$ its cumulative distribution. Then,

$$G^*(h) = \int_{\check{\theta}}^{\theta^*} \theta f(\theta) d\theta + \int_{\theta^*}^{\hat{\theta}} (\theta(1+\xi) - (1-h)) f(\theta) d\theta \tag{C.8}$$

Rewriting the expression in terms of expectations yields:

$$G^*(h) = \int_{\check{\theta}}^{\hat{\theta}} \theta f(\theta) d\theta + \xi \int_{\theta^*}^{\hat{\theta}} \theta f(\theta) d\theta - (1-h) \int_{\theta^*}^{\hat{\theta}} \theta f(\theta) d\theta$$

Which can be expressed compactly as:

$$G^*(h) = E[\theta] + \big(1 - F(\theta^*(h))\big)\big(\xi E[\theta|\theta > \theta^*] - (1-h)\big) \tag{C.9}$$

where $E[\theta|\theta > \theta^*]$ is the truncated mean of the θ above the threshold.

Taking the derivative of Equation (C.9) with respect to h and setting it equal to zero gives:

$$\frac{\partial G^*(h)}{\partial h} = -f(\theta^*(h)) \frac{\partial \theta^*(h)}{\partial h} \big(\xi E[\theta|\theta > \theta^*(h)] - (1-h)\big) ...$$

$$+(1 - F(\theta^*(h)) \left(\underbrace{\frac{f(\theta^*(h))}{1 - F(\theta^*(h))} \frac{\partial \theta^*(h)}{\partial h} \xi \big(E[\theta|\theta > \theta^*(h)] - \theta^*(h)\big)}_{(a)} + 1 \right) = 0$$

Where the term (a) uses differentiation properties of the truncated expectation. This simplifies to Equation (C.10)

$$\frac{\partial G^*(h)}{\partial h} = 1 - F(\theta^*(h)) + f(\theta^*(h)) \frac{\partial \theta^*(h)}{\partial h} (1 - h - \xi \theta^*(h)) = 0 \tag{C.10}$$

Finally, the optimal haircut h_{co} is the value of h that solves

$$1 - F(\theta^*(h_{co})) = f(\theta^*(h_{co})) \frac{\partial \theta^*(h_{co})}{\partial h} \big(\xi \theta^*(h_{co}) - (1 - h_{co})\big) \tag{C.11}$$

Appendix C.4. Concavity of government's problem

This section proves the Proposition 4, deriving a set of necessary conditions for the government's optimization problem to admit a unique solution. I begin by taking the second derivative of Equation (C.10) with respect to h.

$$\frac{\partial^2 G^*(h)}{\partial^2 h} = -f(\theta^*(h))\frac{\partial \theta^*(h)}{\partial h} + \frac{\partial f(\theta^*(h))}{\partial \theta^*(h)}\left(\frac{\partial \theta^*(h)}{\partial h}\right)^2 \big(1-h-\xi\theta^*(h)\big)$$

$$+f(\theta^*(h))\frac{\partial^2 \theta^*(h)}{\partial^2 h}\big(1-h-\xi\theta^*(h)\big) + f(\theta^*(h))\frac{\partial \theta^*(h)}{\partial h}\left(-1-\xi\frac{\partial \theta^*(h)}{\partial h}\right)$$

To ensure that this expression is negative, (i.e., $G^*(h)$ is strictly concave), consider the following. From Proposition 2, we know that $h_{co} \in [h_{inv}, 1]$ where $\frac{\partial \theta^*(h)}{\partial h} \geq 0$. Furthermore, a successful restructuring implies full participation $\ell = 1$, which by Lemma 1 requires that $\xi\theta > 1-h$. This inequality will hold at θ^* and, in particular, for all θ values above it (those corresponding to successful exits from default). We can therefore rewrite the second derivative as:

$$\frac{\partial^2 G^*(h)}{\partial^2 h} = \underbrace{-f(\theta^*(h))\underbrace{\frac{\partial \theta^*(h)}{\partial h}}_{\geq 0}\left(\underbrace{2+\xi\frac{\partial \theta^*(h)}{\partial h}}_{>0}\right)}_{\leq 0}$$

$$+\left(\frac{\partial f(\theta^*(h))}{\partial \theta^*(h)}\underbrace{\left(\frac{\partial \theta^*(h)}{\partial h}\right)^2}_{\geq 0} + \underbrace{f(\theta^*(h))\frac{\partial^2 \theta^*(h)}{\partial^2 h}}_{\geq 0}\right)\underbrace{\big(1-h-\xi\theta^*(h)\big)}_{\leq 0}$$

From this expression, two sufficient conditions can be extracted to guarantee a global maximum and hence uniqueness of the government's solution. In both cases, the shape of the distribution function of the economic fundamental, plays a crucial role.

1. $\dfrac{\partial f(\theta^*(h))}{\partial \theta^*(h)} \geq 0$ 2. $\dfrac{\frac{\partial f(\theta^*(h))}{\partial \theta^*(h)}}{f(\theta^*(h))} \leq \dfrac{\frac{\partial^2 \theta^*(h)}{\partial^2 h}}{\left(\frac{\partial \theta^*(h)}{\partial h}\right)^2}$

Appendix C.5. Analysis of h_{co} partial derivatives

Since the model does admit closed-form analytical solution, this section applies the implicit function theorem to prove Corollary 3, which examines the partial effects of model parameters on the optimal haircut.

Let $\mathbf{x}$ denote the vector of model parameters, $\mathbf{x} = [\xi, \nu, \delta, m]$, where x_i represents the i-th element of the vector. Then, Equation (10) can be written as:

$$1 - F(\theta^*(h, \mathbf{x})) = f(\theta^*(h, \mathbf{x}))\frac{\partial \theta^*(h, \mathbf{x})}{\partial h}\big(\xi\theta^*(h, \mathbf{x}) - (1 - h)\big) \tag{C.12}$$

Totally differentiating Equation (C.12) with respect to x_i yields:

$$\begin{aligned}
-f(\theta^*(h, \mathbf{x}))\left(\frac{\partial \theta^*(h, \mathbf{x})}{\partial h}\frac{dh}{dx_i} + \frac{\partial \theta^*(h, \mathbf{x})}{\partial x_i}\right) = \\
\frac{\partial f(\theta^*(h, \mathbf{x}))}{\partial \theta^*(h, \mathbf{x})}\left(\frac{\partial \theta^*(h, \mathbf{x})}{\partial h}\frac{dh}{dx_i} + \frac{\partial \theta^*(h, \mathbf{x})}{\partial x_i}\right)\left(\frac{\partial \theta^*(h, \mathbf{x})}{\partial h}\right)\big(\xi\theta^*(h, \mathbf{x}) - (1 - h)\big) \\
+f(\theta^*(h, \mathbf{x}))\left(\frac{\partial^2 \theta^*(h, \mathbf{x})}{\partial^2 h}\frac{dh}{dx_i} + \frac{\partial \theta^*(h, \mathbf{x})}{\partial h \partial x_i}\right)\big(\xi\theta^*(h, \mathbf{x}) - (1 - h)\big) \\
+f(\theta^*(h, \mathbf{x}))\frac{\partial \theta^*(h, \mathbf{x})}{\partial h}\left[\xi\left(\frac{\partial \theta^*(h, \mathbf{x})}{\partial h}\frac{dh}{dx_i} + \frac{\partial \theta(h, \mathbf{x})}{\partial x_i}\right) + \frac{dh}{dx_i}\right]
\end{aligned}$$

Solving for $\frac{dh}{dx_i}$ and analyzing the signs of each term leads to the general case in Equation (C.13):

$$\frac{dh}{dx_i} = \frac{\frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x})}\frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i}\underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h}\gamma}_{\geq 0} + \underbrace{f(\theta^*(h,\mathbf{x}))}_{\geq 0}\left(\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial h \partial x_i}\underbrace{\gamma}_{\geq 0} + \underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h}}_{\geq 0}(1 + \xi\frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i})\right)}{-\underbrace{f(\theta^*(h,\mathbf{x}))}_{\geq 0}\left(\underbrace{\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial^2 h}\gamma}_{>0} + \underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h}\left(\xi\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} + 2\right)}_{\geq 0}\right) - \frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x})}\underbrace{\left(\frac{\partial \theta^*(h)}{\partial h}\right)^2\gamma}_{\geq 0}} \tag{C.13}$$

Here, I am using Proposition 3 in $\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \geq 0$. I also denote $\gamma = \xi\theta^*(h, \mathbf{x}) - (1 - h)$. Note that $\gamma \geq 0$ for Lemma 1 and $\ell = 1$ in equilibrium. Finally, $f(\theta^*(h, \mathbf{x})) \geq 0$ for properties of density functions.

In what follows, I analyze how the coordination haircut responds to changes in each parameter according to the shape of the fundamentals distribution.

Appendix C.6. Density derivative $\frac{\partial f(\theta^*(h,\boldsymbol{x}))}{\partial \theta^*(h,\boldsymbol{x})}$ equals zero

In this case, the results depend on the signs of $\frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i}$ and the cross-partial derivatives of $\theta^*(h, \mathbf{x})$ with respect to the parameters. These terms determine the sign of the numerator in Equation (C.14), while the denominator is negative. I also use Corollary 2 regarding the second derivative with respect to h.

$$\frac{dh}{dx_i} = \frac{\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial h \partial x_i} \underbrace{\gamma}_{\geq 0} + \frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i} \underbrace{\left(\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \xi + 1 \right)}_{>0}}{\underbrace{\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial^2 h} \gamma + \frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \left(\xi \frac{\partial \theta^*(h,\mathbf{x})}{\partial h} + 2 \right)}_{<0}} \tag{C.14}$$

Lemma 5. *Regarding the cross-second derivatives of $\theta^*(h, \boldsymbol{x})$:*

$$\frac{\partial^2 \theta^*(h,\boldsymbol{x})}{\partial h \partial m} \geq 0,\ \frac{\partial^2 \theta^*(h,\boldsymbol{x})}{\partial h \partial \nu} \geq 0,\ \frac{\partial^2 \theta^*(h,\boldsymbol{x})}{\partial h \partial \delta} > 0,\ \frac{\partial^2 \theta^*(h,\boldsymbol{x})}{\partial h \partial \xi} \leq 0$$

Proof: See Appendix C.9

1. Case $\frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i} > 0$. This case applies to m, ν, δ according to Corollary 1. By Lemma 5 we know that crossed derivatives are non-negative. Since the denominator is negative, we obtain $\frac{dh}{dm} \leq 0$, $\frac{dh}{d\nu} \leq 0$, $\frac{dh}{d\delta} \leq 0$.
2. Case $\frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i} \leq 0$. This applies to $x_i = \xi$ by Corollary 1. From the Proposition 2, the numerator in Equation (C.14) is negative, implying $\frac{dh}{d\xi} \geq 0$.

Appendix C.7. Density derivative $\frac{\partial f(\theta^*(h,\boldsymbol{x}))}{\partial \theta^*(h,\boldsymbol{x})}$ is positive

$$\frac{dh}{dx_i} = \frac{\underbrace{\frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x})}}_{>0} \frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i} \underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \gamma}_{\geq 0} + f(\theta^*(h,\mathbf{x})) \left(\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial h \partial x_i} \underbrace{\gamma}_{\geq 0} + \frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i} \left(\underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \xi + 1}_{>0} \right) \right)}{\underbrace{- \underbrace{f(\theta^*(h,\mathbf{x}))}_{\geq 0} \left(\underbrace{\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial^2 h} \gamma}_{\geq 0} + \underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \left(\xi \frac{\partial \theta^*(h,\mathbf{x})}{\partial h} + 1 \right)}_{>0} \right) - \underbrace{\frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x})}}_{>0} \underbrace{\left(\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \right)^2 \gamma}_{\geq 0}}_{<0}} \tag{C.15}$$

Using Lemma 5, as in the previous case, we get $\frac{dh}{d\nu} \leq 0, \frac{dh}{dm} \leq 0$, $\frac{dh}{d\delta} \leq 0$ and $\frac{dh}{d\xi} \geq 0$.

Appendix C.8. Density derivative $\frac{\partial f(\theta^*(h,\boldsymbol{x}))}{\partial \theta^*(h,\boldsymbol{x})}$ *is negative*

In this case, Proposition 4, which ensures a unique solution to the government's maximization problem (i.e., the concavity of the government's expected utility function) guarantees that the denominator in Equation (C.16) is always negative. Thus, we now focus on analyzing the numerator to draw the final implications.

$$\frac{dh}{dx_i} = \frac{\underbrace{\frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x}))}}_{<0} \frac{\partial \theta(h,\mathbf{x})}{\partial x_i} \underbrace{\frac{\partial \theta^*(h,\mathbf{x}))}{\partial h}\gamma}_{\geq 0} + f(\theta^*(h,\mathbf{x})) \left(\frac{\partial^2 \theta^*(h)}{\partial h \partial x} \underbrace{\gamma}_{\geq 0} + \frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i} \left(\underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h}\xi + 1}_{>0} \right) \right)}{\underbrace{- \underbrace{f(\theta^*(h,\mathbf{x}))}_{\geq 0} \left(\underbrace{\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial^2 h}\gamma}_{\geq 0} + \underbrace{\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \left(\xi \frac{\partial \theta^*(h,\mathbf{x})}{\partial h} + 1 \right)}_{\geq 0} \right) - \underbrace{\frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x})}}_{<0} \underbrace{\left(\frac{\partial \theta^*(h,\mathbf{x})}{\partial h} \right)^2 \gamma}_{\geq 0}}_{<0}} \tag{C.16}$$

under these relationships, we again obtain the same qualitative results:

$$\frac{dh}{d\nu} \leq 0, \qquad \frac{dh}{dm} \leq 0, \qquad \frac{dh}{d\delta} \leq 0 \qquad \frac{dh}{d\xi} \geq 0$$

However, these conditions hold only when Equation (C.17) is satisfied. This means that, in cases where the density function of θ has a negative slope, the signs of the partial derivatives of the haircut with respect the parameters require a regular behavior in the peakedness[17] of the distribution function.

$$\frac{\frac{\partial f(\theta^*(h,\mathbf{x}))}{\partial \theta^*(h,\mathbf{x})}}{f(\theta^*(h,\mathbf{x}))} \leq \frac{\frac{\partial^2 \theta^*(h,\mathbf{x})}{\partial h \partial x_i}\gamma + \frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i}\left(\frac{\partial \theta^*(h,\mathbf{x})}{\partial h}\xi + 1\right)}{\frac{\partial \theta^*(h,\mathbf{x})}{\partial x_i}\frac{\partial \theta^*(h,\mathbf{x})}{\partial h}\gamma} \tag{C.17}$$

Appendix C.9. Cross derivatives

In this Appendix, I demonstrate Lemma 5 on the cross-partial derivatives of $\theta^*(h, \mathbf{x})$. Let $\mathbf{x}$ denote the vector of model, with element $x_i = \{\delta, \nu, m, \xi\}$.

[17]This property is not equivalent to the kurtosis, which also consider the tails of the distribution.

Through the derivation, I use Assumption 1, Lemma 3, and the parameter restrictions $m > 0$, $\xi > 0$ and $\delta \in [0, 1]$.

For the cross-derivative with respect to h and m:

$$\frac{\partial^2 \theta^*(h, \mathbf{x})}{\partial h \partial m} = \frac{1}{\xi} \frac{(1-\delta)\nu}{(1-h-\delta\nu)^2} \geq 0 \tag{C.18}$$

Equality holds in the limiting case $\delta = 1$.

For the cross-derivative with respect to h and ν:

$$\frac{\partial^2 \theta(h, \mathbf{x})}{\partial h \partial \nu} = \frac{1}{\xi} \frac{m(1-\delta)(1-h-\delta\nu)^2 - 2(1-h-\delta\nu)(-\delta)m(1-\delta)\nu}{(1-h-\delta\nu)^4}$$

Which simplifies to:

$$\frac{\partial^2 \theta(h, \mathbf{x})}{\partial h \partial \nu} = \frac{m(1-\delta)(1-h-\delta\nu)}{\xi} \left(\frac{1-h+\delta\nu}{(1-h-\delta\nu)^4} \right) \geq 0 \tag{C.19}$$

The equality to zero holds when $\delta = 1$ in Equation (C.19). I also used $\delta \in [0, 1]$ and Lemma 3 above. For the cross-derivative with respect to h and δ:

$$\frac{\partial^2 \theta(h, \mathbf{x})}{\partial h \partial \delta} = \frac{1}{\xi} \frac{-m\nu(1-h-\delta\nu)^2 - 2(1-h-\delta\nu)(-\nu)m(1-\delta)\nu}{(1-h-\delta\nu)^4}$$

which simplifies to

$$\frac{\partial^2 \theta(h, \mathbf{x})}{\partial h \partial \delta} = \frac{m\nu(1-h-\delta\nu)}{\xi} \left(\frac{\nu - (1-h) + (1-\delta)\nu}{(1-h-\delta\nu)^4} \right) > 0 \tag{C.20}$$

The positive sign in Equation (C.20) follows from $m > 0$, $\delta \in [0, 1]$ Lemma 3 and Assumption 1.

Finally, for the cross-derivative with respect to h and ξ:

$$\frac{\partial^2 \theta(h, \mathbf{x})}{\partial h \partial \xi} = -\frac{1}{\xi^2} \left(-1 + \frac{m(1-\delta)\nu}{(1-h-\delta\nu)^2} \right)$$

or equivalently,

$$\frac{\partial^2 \theta(h, \mathbf{x})}{\partial h \partial \xi} = -\frac{1}{\xi^2} \left(\frac{-(1-h-\delta\nu)^2 + m(1-\delta)\nu}{(1-h-\delta\nu)^2} \right) \leq 0$$

Appendix D. Alternative Specification with Market Haircut as Dependent Variable

	(1)	(2)	(3)	(4)	(5)
bondexchange	0.0248	-0.285***	-0.259**	-0.152	-0.176**
	(0.0757)	(0.0864)	(0.115)	(0.149)	(0.0847)
lsize		0.0398**	0.0285	0.0700*	0.0609***
		(0.0168)	(0.0346)	(0.0386)	(0.0193)
lgdp		-0.0863***	-0.0557	-0.0652	-0.194**
		(0.0237)	(0.0352)	(0.221)	(0.0843)
case		0.00477	-0.00477	0.0113	0.00660
		(0.00910)	(0.0156)	(0.0159)	(0.00834)
fedfunds		0.00227	-0.00168	-0.00786	0.00399
		(0.00575)	(0.00950)	(0.00849)	(0.00634)
year		0.0248***	0.0181***	0.0133	0.0299***
		(0.00428)	(0.00699)	(0.0150)	(0.00594)
debt			0.288	-0.0879	
			(0.202)	(0.538)	
ca			0.00359	0.00681	
			(0.00570)	(0.0132)	
deficit			-0.0113**	-0.0172*	
			(0.00444)	(0.00961)	
_cons	0.468***	-48.41***	-35.13**	-25.58	-57.73***
	(0.0329)	(8.593)	(13.98)	(28.16)	(11.42)
FE				Yes	Yes
N	185	166	75	75	166
adj. R^2	0.0061	0.4595	0.2767	0.250	0.493

Table D.7: **Model estimates for the logarithm of the haircut.** The dependent variable is the markethaircut haircut, as defined in Cruces and Trebesch (2013). Independent variables include: *bondexchange*, a dummy equal to one if the restructured debt is in bonds and zero if it is bank debt; *lsize*, the logarithm of restructured debt (in USD millions); *lgdp*, the logarithm of GDP (in USD millions); *case*, the number of restructuring cases in the same country; *fedfunds*, the U.S. federal funds rate; *year*, the start year of the restructuring; *ldebt*, the ratio of public debt to GDP; *reserves*, the ratio of reserves to GDP; and *ca*, the current account balance as a percentage of GDP. Standard errors in parentheses. *FE* indicates country fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix E. Nash bargaining haircut

In this section, I introduce the proposed framework into a Nash generalized bargaining process, to obtain the haircut as the allocation that maximizes the Nash product in Equation (E.1). The function $\omega(h)$ represents the net outcome of the restructuring—success versus failure— to be distributed among agents. The government and bondholders have bargaining powers α and $1-\alpha$ respectively, which determine their share of the total product.

$$\omega(h) = (E[\theta(1+\xi) - [(1-h)\ell + \nu(1-\ell)] - \theta])^{\alpha}(E[1-h-m-\delta\nu])^{1-\alpha} \quad \text{(E.1)}$$

Note that if an investor i does not participate, this does not alter the outcome of the agreement. His individual outside option is therefore to receive $\nu\delta$, instead of zero as in the case where the proposal fails.

Appendix E.1. General case

In this setting, the haircut is obtained as the allocation that maximizes the generalized Nash product $\omega(h)$ of the expected utilities over θ.

$$h = argmax\{\omega(h)\}$$

Let θ^e denote the expected value of the random variable θ. Taking the derivative of Equation (E.1) with respect to h and solving for h yields:

$$\begin{aligned} &\alpha\ell(\xi\theta^e - (1-h)\ell - \nu(1-\ell))^{\alpha-1}(1-h-m-\delta\nu)^{1-\alpha} = \\ &\qquad (1-\alpha)(\xi\theta^e - \nu - \ell(1-h-\nu))^{\alpha}(1-h-m-\delta\nu)^{-\alpha} \end{aligned} \quad \text{(E.2)}$$

Since in a successful proposal the participation rate satisfies $\ell = 1$, we obtain:

$$h_{nb} = \alpha(1-m-\delta\nu) - (1-\alpha)(\xi\theta^e - 1) \quad \text{(E.3)}$$

We can also derive the corresponding equilibrium value of α for a given haircut h:

$$\alpha_{nb} = \frac{\xi\theta^e - \nu - \ell(1-h-\nu)}{(\ell(-m-\delta\nu) + \xi\theta^e - \nu - \ell(-\nu))} \quad \text{(E.4)}$$

With $\ell = 1$, this expression simplifies to:

$$\alpha_{nb} = \frac{\xi\theta^e - (1-h)}{\xi\theta^e - (m+\delta\nu)} \quad \text{(E.5)}$$

Appendix E.2. Coordination case

In a Nash bargaining framework with a coordination feature, the agreement succeeds only within the region $[\theta^*, \hat{\theta}]$. Therefore, I replace the simple expectation, with the truncated expectation in the payment capacity. This modification introduces an additional dependency of $\omega(h)$ on h through $\theta^*(h)$. I denote the truncated expectation as $\mathring{\theta}(\theta^*(h))$, and take once again the first derivative of Equation (E.1), now accounting for these new dependencies.

$$\alpha\big(\xi\,\mathring{\theta}(\theta^*(h))-(1-h)\ell-\nu(1-\ell)\big)^{\alpha-1}\big(1-h-m-\delta\nu\big)^{1-\alpha}\left(\xi\frac{\partial\,\mathring{\theta}(h)}{\partial\theta^*(h)}\frac{\partial\theta^*(h)}{\partial h}+\ell\right)$$

$$-(1-\alpha)\big(\xi\,\mathring{\theta}(\theta^*(h))-(1-h)\ell-\nu(1-\ell)\big)^{\alpha}\big(1-h-m-\delta\nu\big)^{-\alpha}=0$$

After some rearrangement, and substituting the equilibrium $\ell = 1$, we obtain Equation (E.6), from which it is possible to derive a new expression for $\alpha = \alpha_{nb,co}$ that incorporates the coordination aspect of the problem, as shown in Equation (E.7).

$$\alpha\big(1-h-m-\delta\nu\big)\left(\xi\frac{\partial\,\mathring{\theta}(h)}{\partial\theta^*(h)}\frac{\partial\theta^*(h)}{\partial h}+1\right)-(1-\alpha)\big(\xi\,\mathring{\theta}(\theta^*(h))-(1-h)\big)=0 \tag{E.6}$$

$$\alpha_{nb,co}=\frac{\xi\,\mathring{\theta}(\theta^*(h))-(1-h)}{\xi\,\mathring{\theta}(\theta^*(h))+\big(1-h-m-\delta\nu\big)\xi\frac{\partial\,\mathring{\theta}(h)}{\partial\theta^*(h)}\frac{\partial\theta^*(h)}{\partial h}-\delta\nu} \tag{E.7}$$

Appendix E.3. Slopes of the haircuts under Nash bargaining model

In this section, I demonstrate Lemma 4, which analyzes the first derivatives with respect to α for both functions h_{nb} and h_{co} obtained in Appendix E. This analysis allows us to characterize the comparative behavior of the haircuts across the bargaining power space, α.

In the general case, we can directly differentiate Equation (14) with respect to α. Using Lemmas 1 and 3, it follows that h_{nb} is a linearly increasing function of α.

$$\frac{\partial h_{nb}}{\partial\alpha}=-m-\delta\nu+\xi\theta^e>0$$

In the coordination case, we must instead use implicit differentiation on Equation (17) to obtain $\frac{dh_{nb,co}}{d\alpha}$. As in Appendix C.5, I denote $\gamma = 1 - h - \delta\nu - m$ to simplify notation. The resulting derivative is:

$$\frac{dh_{nb,co}}{d\alpha} = -\frac{\gamma\left(\xi \frac{\partial \mathring{\theta}(h)}{\partial\theta^*(h)} \frac{\partial\theta^*(h)}{\partial h}\right) + \xi\, \mathring{\theta}(\theta^*(h)) - (1-h)}{\gamma\xi\alpha\left(\frac{\partial^2 \mathring{\theta}(h)}{\partial\theta^*(h)}\left(\frac{\partial\theta^*(h)}{\partial h}\right)^2 + \frac{\partial \mathring{\theta}(h)}{\partial\theta^*(h)}\frac{\partial^2\theta^*(h)}{\partial h}\right) - \left(\xi \frac{\partial \mathring{\theta}(\theta^*(h))}{\partial\theta^*(h)}\frac{\partial\theta^*(h)}{\partial h} + 1\right)} \tag{E.8}$$

Equation (E.8) defines an inverse function in α with a unique discontinuity where the denominator equals zero. Let $\alpha_0 \in \mathbb{R}$ denote that critical point. The slope of $h_{nb,co}$ within the economically relevant interval $\alpha \in [0,1]$ depends critically on the position of α_0.

The numerator in Equation (E.8) is always positive. First, $\gamma > 0$ for Lemma 3; second, the bracketed terms is non-negative by the definition of the truncated mean and Corollary 2; and third, $\xi\, \mathring{\theta}(\theta^*(h)) > 1 - h$, follows from Lemma 1, given $\ell = 1$ in a successful restructuring.

Because the derivative never equals zero, the haircut function does not attain an interior maximum or minimum for any value of α. Hence, a discontinuity at α_0 within $[0,1]$ can only produce two possible configurations.

First, the haircut converges to $+\infty$ when α approaches to $\alpha_0 \in [0,1]$. In this case, we would have $\frac{dh_{nb,co}}{d\alpha} > 0$ when $\alpha < \alpha_0$ and $\frac{dh_{nb,co}}{d\alpha} < 0$ when $\alpha > \alpha_0$. Second, the haircut converges to $-\infty$ when α approaches $\alpha_0 \in [0,1]$. Thus we need the opposite $\frac{dh_{nb,co}}{d\alpha} < 0$ when $\alpha < \alpha_0$ and $\frac{dh_{nb,co}}{d\alpha} > 0$ for $\alpha > \alpha_0$.

To rule out both cases, we analyze the denominator of (E.8) at the limits of α in the interval $[0,1]$.

When $\alpha = 0$, the first term cancels and the slope is positive since both the second term and the numerator are always positive.

$$\frac{dh_{nb,co}}{d\alpha} > 0$$

When $\alpha = 1$, we must evaluate the entire denominator. Note, however, that $\alpha = 1$ implies $h_{nb,co} = 1 - m - \delta\nu$, and therefore $\gamma = 1 - h - \delta\nu - m = 0$.[18]

[18] Although Lemma 3 simplifies this case for the coordinating haircut, we can consider a small ϵ distance from this point and say that the limit of γ is 0, since ϵ converges to zero which is sufficient to prove the theorem above.

Thus, the first term cancels again, and the slope of $h_{nb,co}$ at $\alpha = 1$ remains positive.

Therefore, both potential discontinuity scenarios ($\alpha_0 \in [0, 1]$) can be excluded. Consequently, we demonstrate that $h_{nb,co}$ is an increasing function of α over the entire interval $[0, 1]$.

Appendix E.4. Comparison of haircuts inside Nash bargaining model

In this section, I demonstrate Proposition 5. The proof follows directly from the definitions of the limits of $h_{nb,co}$, h_{nb} and the properties of the truncated mean, and Lemma 4.

Using Equation (E.3) and Equation (E.6) we obtain:

$$h_{nb}(\alpha = 0) = max\{0, 1 - \xi\theta^e\} \qquad h_{nb,co}(\alpha = 0) = max\{0, 1 - \xi \mathring{\theta}\}$$

. For all cases where $1 - \xi\theta^e > 0$, since $\theta^e \leq \mathring{\theta}$, it follows that:

$$h_{nb}(\alpha = 0) > h_{nb,co}(\alpha = 0)$$

As before, we have $h_{nb}(\alpha = 1) = 1 - m - \delta\nu$. In the coordination case, note that by Corollary 2 and the properties of truncated mean, Equation (17) yields a unique value of h for the coordinating Nash bargaining haircut, such that

$$h_{nb,co}(\alpha = 1) = 1 - m - \delta\nu$$

Finally, by Lemma 4, the intersection between the two haircut functions is unique, and occurs precisely at $\alpha = 1$. Consequently,

$$h_{nb,co} \leq h_{nb}, \quad \forall\alpha \in [0, 1]$$

Moreover, given the respective slopes and the boundary values at $\alpha = 0$ and $\alpha = 1$, we can confirm that the difference between the two haircut functions decreases monotonically over the interval $\alpha \in [0, 1]$.

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