Interaction between Modes of Credit Contract Enforcement

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Abstract

Beneficial economic activity relies on voluntarily undertaken and fulfilled contracts, yet in many situations it is not obvious that successful market economies will spontaneously emerge. Conflicting motivations between parties can prevent mutually beneficial exchange; in such cases, the framework of incentives must be altered to enable a cooperative outcome. In this paper I examine different theoretical resolutions to the ex-post dilemma game inherent in credit lending contracts, building on Avinash Dixit’s 2003 paper “On Modes of Economic Governance.” Dixit describes two organizations that can establish a cooperative equilibrium between economic agents with conflicting interests: one that detects and conveys information about cheating and another that inflicts punishment on cheaters. Terming these players Info and Enfo, respectively, Dixit leaves to future research the question of interaction between governance structures. In an attempt to address this challenge, I create a credit-lending model in which Info- and Enfo-types coexist. This approach motivates an evaluation of different modes of credit contract enforcement and is relevant to questions surrounding extralegal lending, debtor’s prison and the subprime mortgage crisis.
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1 Introduction

Beneficial economic activity relies on voluntarily undertaken and fulfilled contracts, yet in many situations it is not obvious that successful market economies will spontaneously emerge. Conflicting motivations between parties can lead to moral hazard, adverse selection and coordination problems that prevent mutually beneficial exchange; in such cases, the framework of incentives must be altered to ensure that rational agents achieve the cooperative outcome.

I examine the problem of economic governance from the perspective of the ex-post dilemma game inherent to credit lending contracts. A lender extends credit, but what prevents the borrower from simply skipping out on his interest payments? Without some framework to motivate repayment, a borrower will strictly prefer to cheat the lender. Knowing this, the lender will never make loans and the credit market dissolves.

Default can be a significant problem, as the current subprime mortgage crisis illustrates, yet the fact that it is the exception and not the rule indicates the presence of some mechanism that makes repayment an appealing strategy. In highly developed financial systems, lending is regulated with a complex set of legal rules to incentivize borrower repayment. Information on credit transactions is recorded and publicly available, allowing credit rating agencies to track borrower history, and the state punishes defaulters by giving lenders the right to seize property in the case of nonpayment. Lively credit markets are not restricted to developed, highly structured environments, however, and exist even in economies without formal governance. Microfinance, for example, makes use of social networks and peer pressure to expand the scope of feasible lending. The challenge of this paper will be to develop a theoretical model of the mechanisms that enforce credit contracts in diverse situations.
2 Background and Literature Review

Economic analysis traditionally assumes that the state provides a framework of incentives exogenous to the market, shaped by laws and formal governance. Under the general heading of New Institutional Economics, however, research has begun to question how these institutions emerge in the first place. Game theoretical approaches to the development of the institutional structure itself attempt to show how rules of behavior spontaneously emerge from anarchy. Skaperdas (2005) presents an overview of theoretical models of stateless societies, building on the foundational work of Hirshleifer (1989, 1996) and Grossman (1995). Bates, Greif and Singh (2002) and Konrad and Skaperdas (2005) describe an environment of insecure property rights in which formal governance may emerge as a means of controlling the use of violence and protecting property.

The interaction between formal and informal structures is an important question within New Institutional Economics. On the one hand, the field of Law and Economics, shaped by the work of Landes (1971), Posner (2002), Cooter and Rubinfeld (1989) and Shavell (2004), focuses on the impact of state law on economic decision-making and efficiency. On the other hand, the study of non-governmental, extralegal solutions to problems of property rights and contract enforcement, dubbed “Lawlessness and Economics” by Avinash Dixit, examines situations where the state is absent or ineffective (Dixit 2004).

This overlap between “Law and Economics” and “Lawlessness and Economics” has significant implications in the field of development economics. Research gives increasing weight to the idea that designing formal institutions capable of fostering growth requires an understanding not only of incentives within the official structure, but also how these incentives
interact with the complex set of informal economic institutions already in existence. A Pakistani official interviewed for *The New Yorker* explains that “it’s very difficult to approach a police officer or minister” but “very easy to approach the Taliban,” and as a result many have come to prefer the informal, Taliban-run *jirga* courts over the official system (Coll 2008). Murrell (1996) and De Soto (2001) give more detailed empirical accounts of the choice between formality and informality.

Loan agreements are an interesting lens through which to examine the workings of and interaction between different governance structures, as they are an example of contracting that spans formal and informal boundaries. A classic one-sided prisoner’s dilemma, credit contracts present a conflict between ex-ante and ex-post incentives. In brief, stylized terms, a borrower seeks access to a lender’s assets in order to undertake an investment with a payoff that exceeds the investment amount. In a one-shot game, the borrower will ex-ante agree to share the surplus with the lender in exchange for the use of his funds, but without any enforcement mechanism, the borrower’s optimal strategy ex-post is to keep the entire payoff for himself. Anticipating this, the lender will refuse to give loans and the market breaks down.

2.1 Self-governing solutions versus third-party enforcement

Several resolutions to the ex-ante/ex-post dilemma game have been proposed. The literature can be divided into those that deal with self-governing solutions between the two economic agents (borrower and lender, buyer and seller) and those that introduce a third player who alters the structure of the game.
If the same borrower and lender play the game repeatedly, a self-governing equilibrium is possible under a grim-trigger strategy: the lender agrees to lend as long as the borrower always repays, but if the borrower ever cheats, the lender will never lend to him again. As long as the borrower values a continued income stream more than a one-time payoff from cheating (as long as his discount factor is sufficiently low), he will prefer to behave honestly. Yet theory (Dixit 2003; Ellison 1994; Kandori 1992) argues that if the same players do not meet repeatedly and information transmission is difficult, a self-governing equilibrium becomes less feasible. Greif (1993, 1994), for example, presents a well-known analysis of the Maghribi traders, who used group governance to overcome the commitment problem of long-distance trade, but were consequently limited to a small economic sphere.

Under conditions where self-governance is not possible, third-party enforcers may emerge to facilitate market function. Gambetta (1993) argues that the Sicilian mafia, rather than being a predatory organization, profits from its ability to make unstable transactions possible. “I know that he wants to cheat me,” a cattle breeder says of his potential trading partner, “thus we need, say, Peppe [that is, a third party] to make us agree. And we both pay Peppe a percentage of the deal” (p. 15). Milgrom, North and Weingast (1990) offer a model in which the medieval Law Merchant serves as a third party who enters the game to motivate honest trade. The large, anonymous populations at medieval trade fairs made self-enforcement between buyers and sellers impossible, but the Law Merchant resolved the commitment problem by transmitting information about traders’ past behavior.
2.2 Modes of economic governance and foundation of thesis

In his 2003 paper “On Modes of Economic Governance,” Avinash Dixit examines two different modes of for-profit private governance that can succeed in enforcing contracts between agents playing a repeated dilemma game. One organization detects and conveys information about cheating, while the other inflicts punishment on behalf of cheated customers. Dixit terms these players Info and Enfo, respectively. In their most abstract form, Info and Enfo represent the two theoretical approaches to resolving a prisoners’ dilemma game: reputation and punishment. Info maintains cooperation by offering an incentive high enough to encourage repayment over the course of repeated interaction, while Enfo ensures honesty by imposing a punishment severe enough to discourage cheating even in a one-shot game.

The analogy in the lending game is direct and useful, since Info and Enfo have real-world counterparts. Info closely resembles a credit-rating bureau, for example, while Enfo can be thought of as any organization that motivates borrower repayment through the threat of force, like a collection agency, mafia-type organization or the state. Dixit examines Info and Enfo individually, assuming each operates within a structure of contestable monopoly, and leaves to future research issues of competition between different modes of private enforcement and a comparison of informal and formal governance.

This is what my thesis examines. Contestable monopoly conflicts with the reality of credit lending, where credit bureaus exist simultaneously with collection agencies. Credit card companies, for example, sell the rights to their uncollected debts to third-party collection agencies. PricewaterhouseCoopers estimates that $51.4 billion of debt were recovered by these third-party collection agencies in the United States in 2005 (PricewaterhouseCoopers 2006).
Why do collection agencies exist alongside credit-rating bureaus? Banks rely on both credit bureaus and the state-enforced right to seize collateral, suggesting that in some situations Info and Enfo may in fact be complements and not substitutes. Building from aspects of Dixit’s model of private governance, I create a credit-lending model in which Info- and Enfo-types coexist and apply the model to situations of competition and collaboration, hoping to gain insight into the advantages of different modes of contract enforcement.

3 Model

The foundation of my credit-lending game is a basic fixed-investment model of the type presented by Tirole (2006). Borrowers require a loan in order to undertake an investment of amount $I$ that yields a payoff $R$ with probability $p$ and a payoff of 0 with probability $(1 – p)$. The investment $I$ is consumed over the course of the project. Probability of success $p$ is distributed uniformly across borrowers but remains constant between each period for a given borrower. A borrower’s probability of success can be considered a measure of his type and is private information known with certainty only by the borrower. Lenders offer a loan contract $[R_l, R_b]$ where $R_l$ represents the lender’s return, $R_b$ represents the borrower’s return, and

$$R_l^E + R_b^E = R . \tag{1}$$

The model departs from the standard fixed-investment approach in its approach to the borrower’s ex-post incentive compatibility constraint; lenders must hire a third-party enforcer, either Enfo or Info, to make their loan agreements sustainable. Portraying the game in prisoner’s dilemma form (Figure 1), it can be seen that in the absence of third-party enforcement, the market will break down.
Ex-ante, the borrower has the option to repay, earning a payoff $R_b$, or cheat, earning a payoff of $R$. Because $R > R_b$, the borrower’s dominant strategy is to cheat. Knowing this, the lender faces a choice between lending, being cheated and earning a payoff of 0 or not lending, not being cheated and retaining the loan amount $I$. The unique solution to the un-enforced lending game, then, will be [Don’t Repay, Don’t Lend].

I will show that the cooperative outcome can be achieved by introducing a third party enforcer. There are two different for-profit governance structures, Info and Enfo (described in detail in sections 3.1 and 3.2). Each lender chooses to hire either Info or Enfo to enforce his credit contracts, and each borrower chooses whether to appeal to an Info- or Enfo-enforced lender for a loan. Info charges the lender a fee $\phi$ per borrower and Enfo charges a fee $\epsilon$ per borrower.
Assumption: zero profits among lenders

In all cases I assume that lenders make zero profits, motivated by the observation that there are few barriers to entry into the credit business. Anyone with access to capital is a potential lender; difficulty arises primarily in convincing borrowers to repay. As one financier in post-Civil War America complained in the face of intensified competition: “The question is no longer, How large a profit can I get but, How small a profit shall I accept?” (Olegario 144). Even in the market for illegal loans, often assumed to be under the control of organized crime, lenders do not seem to make monopolistic rents. Peter Reuter’s study of loansharking in New York suggests that small-scale, illegal lenders are numerous and evidence of collusion is scarce. “Loansharking is a business in which it is extremely difficult to restrict entry of newcomers,” he points out (Reuter 107).

Assumption: constant marginal cost and Bertrand competition

I assume marginal costs are constant and Info’s marginal costs are greater than Enfo’s, reasoning that the costs of gathering and communicating information exceed the costs of credibly threatening punishment.

The fee each enforcer charges is determined by Bertrand competition. As Info’s marginal cost exceeds Enfo’s marginal cost, it will always be possible for Enfo to undercut Info’s fee by a small amount. Therefore Info’s fee exceeds Enfo’s fee:

$$\phi > \varepsilon.$$ 

In sum, there are four categories of player: Info, Enfo, the lender and the borrower. Given the assumption of zero profits among lenders and $\phi > \varepsilon$, it is possible to solve the game for
equilibrium where borrowers who vary in type (probability of success, \( p \)) choose to either a) contract with a lender who has hired Enfo; b) contract with a lender who has hired Info; or c) not borrow at all. Section 3.1 describes the game between a borrower and an Enfo-type lender and section 3.2 describes the game between a borrower and an Info-type lender. Sections 3.3 and 3.4 solve for the equilibrium conditions when borrowers self-select among their optimal strategies given the options of Info enforcement, Enfo enforcement or opting out of the game.

3.1 Enfo game

Enfo specializes in the use of force, threatening punishment in the case of cheating severe enough that the borrower prefers to repay. Enfo observes whether the borrower pays or not and imposes a punishment of amount \( C \) in the event of nonpayment, but does not expend the effort to distinguish between honest failure, which happens to a borrower with probability \((1 - p)\), and cheating. \( C \) can be thought of as collateral. A proportion \( \beta \) of the collateral is transferred to the lender in cases where punishment is imposed. Figure 2 describes the stages of the game.

Figure 2: Lending Game under Enfo
3.1.1 Borrower incentives

In order to prevent the borrower from cheating, the lender must offer the borrower a return high enough to satisfy both his participation and incentive compatibility constraints. The borrower’s expected utility from an Enfo-enforced contract, \( U^\text{Enfo}_b \), is expressed as

\[
U^\text{Enfo}_b = pR^E_b - (1 - p)C,
\]

where \( R^E_b \) is the borrower’s return under Enfo. For the borrower to apply for credit from a lender who uses Enfo-style enforcement, his expected utility must be such that

\[
pr^E_b - (1 - p)C \geq U^\text{Info}_b.
\]

I will later find an equilibrium in which any borrower playing Enfo has been excluded from the Info game, so his reservation utility is zero. The participation constraint will therefore be

\[
pr^E_b - (1 - p)C \geq 0.
\]

To meet the incentive compatibility constraint and ensure the borrower who chooses an Enfo contract does not cheat, \( R^E_b \) and \( C \) must be such that

\[
R^E_b \geq R - C.
\]

Noting from (1) that \( R^E_b = R - R^E_i \) by definition, it follows that \( C \geq R^E_i \). Assuming a competitive market, a lender that offers a borrower a contract with an identical \( R^E_i \) but lower \( C \) (keeping \( R^E_i \) and \( C \) such that the lender still breaks even with this contract on average) will win the borrower’s business, since the borrower maximizes his expected utility by pledging the minimum amount of collateral necessary in order to credibly meet his incentive compatibility constraint. Therefore
in the marketplace.

Note that if Enfo could distinguish between honest failure and cheating, no punishment would be observed because no borrower would ever cheat. The fact that punishment does occur on the path of play fits with evidence of strong-arm enforcement in reality. Consider the example of India, where many banks make use of thugs-for-hire called goondas to retrieve nonperforming loans. The expansion of lending to lower-income segments of the population has been accompanied by a rise in defaults and a simultaneous increase in collection-related violence, suggesting a situation akin to the model where low-\( p \) borrowers incur Enfo’s punishment with greater frequency (Katz 2008).

### 3.1.2 Lender’s break-even condition

The lender must demand a return high enough that he breaks even on average and recoups the loan amount plus Enfo’s fee, \( I + \varepsilon \). The Enfo-type lender does not know the borrower’s type, but he has some belief that the average probability of project success in the population is \( \overline{p} \) (to be determined endogenously). His break-even constraint is therefore:

\[
\overline{p} R_{i}^{E} + (1 - \overline{p}) \beta C = I + \varepsilon .
\]

Using (1) and rearranging for minimum borrower return, we get:

\[
R_{b}^{E} = R - \frac{(I + \varepsilon)}{p} + \frac{(1 - \overline{p})}{p} \beta C .
\]

Remembering that \( C = R_{i}^{E} \), the lender’s return can be written as
\[ R_i^E = \frac{I + \varepsilon}{p + \beta(1 - p)}. \] (4)

To see the intuition behind this equation, recall that parameter \( \beta \) measures transferability of wealth. When \( \beta = 0 \), Enfo is a pure leg-breaking type enforcer and the damage imposed on the borrower is of no direct value to the lender, serving only as a threat to motivate repayment. When \( \beta = 1 \), in contrast, the borrower’s collateral insulates the lender in the case of project failure. Leg-breaking lenders bear the full cost of failure and demand \( R_i^E = \frac{I + \varepsilon}{p} \), while collateral-seizing lenders demand a lower \( R_i^E = I + \varepsilon \). Higher interest rates should be observed in cases where collateral transfer is difficult.

Returning to (2) and simplifying with (1) and (3), the borrower’s expected per-period utility under Enfo can be written as:

\[ U_b^{Enfo} = p(R - R_i^E) - (1 - p)R_i^E, \]

Which with equation (4) simplifies to

\[ U_b^{Enfo} = pR - \frac{I + \varepsilon}{p + \beta(1 - p)}. \]

This says that the borrower captures all of the surplus not taken by Enfo, since the lender earns no profits. Note that for some low-\( p \) types, expected utility is less than zero and the borrower would be better off not playing at all.
3.2 Info game

Info functions as a reporting mechanism, able to detect cheaters and communicate their status to his customers over the course of repeated interactions. As Figure 4 shows, the lender hires Info to investigate a borrower before making a loan. If the borrower’s history is known, Info reveals whether or not the borrower has ever cheated. The lender then decides whether or not to extend credit and specifies the contract. If an investment is made but the borrower does not fulfill the contract, Info investigates cases of nonpayment and distinguishes between cases of cheating and honest failure.

I will show that certain types of borrowers will cheat Info in equilibrium, given their probability of success $p$. To simplify the algebra, I assume that when Info investigates nonpayment he learns in general whether a borrower is of the honest or cheater type, although he does not learn $p$; he learns whether a borrower is of the kind who will cheat when his project
succeeds, even if in this case his project has failed and he therefore has not had the opportunity to cheat. By giving Info a limited ability to uncover type the model departs from a pure game of Bayesian updating, but this assumption both preserves the key insights in a simpler form and mirrors the actual behavior of credit bureaus and banks.¹

Figure 4: Lending Game under Info

3.2.1 Borrower incentives

The borrower is prevented from cheating by a grim-trigger strategy. If Info reveals to the lender that a borrower has ever cheated, the lender will not offer a contract, knowing that because the borrower has no reputation to lose his dominant strategy will be to cheat. How motivating this threat is depends on the borrower’s patience, type, and reservation utility. Let

\[ U_b^{\text{Info}} = pR_s^I \]

¹ Info-type organizations do make an effort to assess a borrower’s honesty based on factors other than past behavior. Lacking sophisticated records of payment history and asset worth, for example, early credit-reporting agencies focused on a borrower’s “character” as a measure of creditworthiness. In an attempt to approximate a borrower’s type, lending institutions would evaluate his honesty, punctuality, thrift, energy, focus and community involvement (Olegario 82). Even as record-keeping and technology have improved, lending institutions continue to assess a borrower’s character. As part of my research into bank lending, I interviewed financial advisors at Key Bank and Citigroup. Both of my contacts described a loan-approval process based on an applicant’s payment history (captured in the model by whether the borrower has cheated or not) and also on his perceived “honesty” or “responsibility” (an assessment of whether or not a borrower is trustworthy or not) (Bean, Pinkham).
represent the borrower’s expected utility under Info. The borrower’s expected utility under Info is a function of his probability of success, which is constant across periods, and the return an Info-type lender offers him. Unlike Enfo, Info distinguishes failure from cheating and imposes no punishment in the event of honest failure. This distinction highlights the essential tradeoff between Info- and Enfo-type lenders from the borrower’s perspective. Info lenders charge a higher rate for two reasons. First, they indirectly pass on Info’s higher fee and second, because their pool of borrowers contains cheaters and lower-$p$ types (as will be shown), Info-enforced lenders have a lower expected repayment rate compared to Enfo-enforced lenders. Enfo-type lenders, however, impose punishment in cases of honest failure, reducing the borrower’s expected utility (see equation 2).

The borrower’s incentive to repay is influenced by his utility from an Enfo-enforced contract; he will remain honest only if his ex-post payoff to cheating and borrowing from an Enfo-type lender forever after is less than his ex-post payoff to honoring the Info-enforced contract and borrowing from an Info-enforced lender forever after. Because this is a repeated game, introduce a discount factor $\delta$ that represents the probability that the borrower will survive into the next period of the game. Players who die are replaced in the next period by a borrower of identical $p$, keeping the number and distribution of borrowers stable. Let

$$V^\text{Enfo}_b = \frac{U^\text{Enfo}_b}{1 - \delta}$$

express the borrower’s discounted value of borrowing from an Enfo-type lender in all periods, and

$$V^\text{Info}_b = \frac{U^\text{Info}_b}{1 - \delta}$$
similarly describe the value of a stream of Info-enforced contracts. The borrower’s honesty constraint for an Info contract is therefore expressed as

\[ R + \delta V^E_b \leq R^l_b + \delta V^l_b. \]

The borrower repays only if his one-shot payoff to cheating, \( R \), plus his discounted utility from a subsequent lifetime of Enfo-enforced loans, \( \delta V^E_b \), is less than the value of continued access to Info-enforced loans.

### 3.2.2 Lender’s break-even condition

Unlike Enfo, the Info-enforced lender has no recourse to collateral and must always bear the full loss of his lending outlay \((I + \phi)\) in cases of project failure. His method of motivating repayment is the grim-trigger threat of refusing to lend to a cheater in the future. The Info lender cannot detect a borrower’s type, but knows that his pool of borrowers has some average per-period rate of repayment \( p = \bar{p} \), where \( \bar{p} \) is to be determined endogenously.

Recall that \( \phi \) represents Info’s fee. In order for the lender to stay in business,

\[
\bar{p}(R^l) - (I + \phi) \geq 0.
\]

Again assuming perfect competition among lenders, the market will set the lender’s return such that

\[
R^l = \frac{I + \phi}{\bar{p}}
\]

and the lender breaks even on average. Unable to learn the borrowers’ type, the lender loses money on borrowers with \( p < \bar{p} \) while profiting from those with \( p > \bar{p} \).

Using definition (1), it is easy to write the borrowers return from an Info-type contract:
\[ R^I_b = R - \frac{I + \phi}{p}. \] (5)

Remembering that \( U^\text{Info}_b = pR^I_b \), the borrower’s utility is expressed as

\[ U^\text{Info}_b = p \left( R - \frac{I + \phi}{p} \right), \]

a function of his type, \( p \), and the lender’s fee as a function of the expected repayment rate across all Info-contract borrowers. Returning to \( V^\text{Info}_b \) and \( V^\text{Info}_b \), and substituting in for borrower utility,

\[ V^\text{Info}_b = \frac{pR - I + \varepsilon}{p + \beta(1 - p)} \quad 1 - \delta \] (6)

and

\[ V^\text{Info}_b = \frac{p \left( R - \frac{I + \phi}{p} \right)}{1 - \delta}. \] (7)

**Lender**

<table>
<thead>
<tr>
<th></th>
<th>Lend</th>
<th>Don’t Lend</th>
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<tbody>
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<td>( \frac{\delta}{1 - \delta} )</td>
<td>( \frac{\delta}{1 - \delta} )</td>
</tr>
<tr>
<td>( R^I_b + \delta V^I_b )</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Don’t Repay</td>
<td>0</td>
<td>( \frac{\delta}{1 - \delta} )</td>
</tr>
<tr>
<td>( R + \delta V^E_b )</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
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**Figure 5: Strategies and Payoffs under Info**
3.3 Borrower self-selection

Potential borrowers in the Info-enforced game fall into two broad categories based on their utility under Enfo-type enforcement: those with a reservation utility of zero because their $p$ is so low that they have negative expected utility under Enfo and those with $p$ high enough that their reservation utility is greater than zero. Higher-$p$ types do better under both Info- and Enfo-style enforcement.

3.3.1 Borrowers with negative utility under an Enfo-type contract

Borrowers with $V^E_b < 0$ have a reservation utility of zero and will cheat Info and drop out if $R \geq R^I_b + \delta V^I_b$. Using equations (5) and (7), this can be written as

$$R \geq R - \frac{I + \phi}{p} + \left(\frac{\delta}{1 - \delta}\right) p \left(\frac{R - I + \phi}{p}\right),$$

which simplifies to

$$p < \left(\frac{1 - \delta}{\delta}\right) \frac{I + \phi}{R - (I + \phi)}$$

(see Appendix A for algebra).

3.3.2 Borrowers with positive utility under an Enfo-type contract

Borrowers with $V^E_b > 0$ cheat the Info lender and go on to play the credit game under Enfo if $R + \delta V^E_b \geq R^I_b + \delta V^I_b$. Using equations (5), (6) and (7), this can be written as
\[ R + \frac{\delta}{1-\delta} \left( pR - \frac{I + \varepsilon}{p + \beta(1 - p)} \right) \geq R - \frac{I + \phi}{p} + \left( \frac{\delta}{1-\delta} \right) \left[ p \left( R - \frac{I + \phi}{p} \right) \right], \]

which simplifies to

\[ p > \left( \frac{I + \varepsilon}{I + \phi} \right) \frac{\bar{p}}{p + \beta(1 - p)} - \left( \frac{1 - \delta}{\delta} \right) \]

(see Appendix B for algebra).

We therefore have two critical \( p \) cutoffs. Define \( p^0 \) as the lower cutoff such that

\[ p^0 = \left( \frac{1 - \delta}{\delta} \right) \frac{I + \phi}{pR - (I + \phi)} \]

(8)

and \( p^* \) as the upper cutoff such that

\[ p^* = \left( \frac{I + \varepsilon}{I + \phi} \right) \frac{\bar{p}}{p + \beta(1 - p)} - \left( \frac{1 - \delta}{\delta} \right). \]

(9)

Borrowers with \( p < p^0 \) receive negative utility from an Enfo-enforced contract but have such a low probability of success that the discounted value of an income stream from Info-enforced contracts is insufficient to prevent them from cheating in the event that their investment does pay off and yield \( R \). Borrowers with \( p > p^* \), in contrast, cheat because their probability of success is so high that they prefer the Enfo lender—he offers a lower interest rate and these high-\( p \) borrowers only rarely incur the punishment \( C \) in the case of failure. Figure 6 illustrates these divisions.
Claim: All borrowers filter through Info’s pool

Although types with \( p > p^* \) may actually derive higher expected utility under Enfo enforcement as opposed to Info enforcement, all players will begin by filtering through the Info’s pool of borrowers. As mentioned in section 3.1.1, there are no Enfo players who have not been excluded from the Info game in equilibrium. All Enfo’s players have chosen to first cheat Info, before becoming Enfo’s customers for the rest of their lifespan.

To see this, first consider a borrower with \( p = 1 \). His projects always succeed and so he has the highest potential utility of all borrowers. His utility from borrowing from only Enfo-type lenders is

\[
V_b^{Enfo} = \frac{R - \frac{I + \varepsilon}{p + \beta(1 - p)}}{\frac{1}{1 - \delta}}.
\]

His utility from playing Info first, succeeding with certainty and then going on to play Enfo is

\[
p^* = \left(1 - \frac{\delta}{\delta} \right) \frac{I + \phi}{pR - (I + \phi)} \quad \text{and} \quad p^0 = \left(1 - \frac{\delta}{\delta} \right) \frac{1 + \phi}{pR - (I + \phi)}.
\]

Figure 6: Distribution of Borrower Strategies as a Function of \( p \)
\[ V_{b}^{\text{Cheat}} = R + \frac{\delta}{1 - \delta} \left( R - \frac{I + \varepsilon}{p + \beta(1 - p)} \right). \]

No matter how high the borrower’s utility from an Enfo-type contract,
\[ R > R - \frac{I + \varepsilon}{p + \beta(1 - p)} \]
and the borrower will prefer to cheat Info once before playing Enfo. Therefore \( p^* < 1 \).

Finally, consider the borrower with type \( p = 0 \). Because his expected utility under Enfo enforcement is negative, this borrower faces a choice between entering into an Info-enforced contract and dropping out of the lending game. His expected utility from either strategy is 0, so he is indifferent between the two. As long as \( pR \geq 0 \), a borrower has nothing to lose by entering a credit contract with an Info lender and hoping for a positive outcome.

### 3.4 Beliefs

What determines \( \overline{p} \), the Enfo lender’s expected repayment rate, and \( \underline{p} \), the Info lender’s expected repayment rate? As Figure 6 illustrates, the bounds of Enfo and Info’s pools of borrowers, \( p^* \) and \( p^0 \), are functions of \( \overline{p} \) and \( \underline{p} \). Info- and Enfo-type lenders, however, form their expectation of \( \overline{p} \) and \( \underline{p} \) based on \( p^* \) and \( p^0 \).

Assuming a uniform distribution of \( p \) across borrowers, it is easy to see that
\[ \overline{p} = \frac{1 + p^*}{2}, \tag{10} \]
since Enfo’s pool is made up of borrowers evenly distributed from \( p = 1 \) to \( p = p^* \). 

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Expressing $\bar{p}$ in terms of $p^*$ and $p^0$ is slightly more complex. Recall the assumption that Info will investigate cases of nonpayment and uncover broadly whether the borrower is an “honest” or “cheater” type. From the perspective of the Info-enforced lender, a “cheater” type has $p < p^0$ or $p > p^*$. Although $p$ is private information and Info cannot observe $p$ directly, I assume he can distinguish between honest and cheater types after investigating nonpayment and will ration cheaters from the game after one round. Nonpayment from those with $p^0 \leq p \leq p^*$ is not cause for exclusion from the game, because Info knows that these are honest types who will repay when their projects are successful. Relaxing this assumption complicates the math but does not change the intuition of the model.

After each period, then, Info eliminates all cheater types with $p < p^0$ and $p > p^*$ from his pool. Normalizing the population of borrowers to 1, Info is left with a proportion $p^* - p^0$ of honest types.

A proportion $1 - \delta$ of the population, however, dies and is replaced each period. Newborn borrowers have never played the Info-enforced game and consequently have no history. Info cannot tell if they are cheaters or not. This means that Info’s pool receives a fresh influx of $\delta p^0$ and $\delta(1 - p^*)$ proportion of unidentifiable cheaters each period. Figure 7 illustrates this process.
Info therefore begins each period with a proportion of the total borrower population equal to
\[ (p^* - p^0) + (1 - \delta)p^0 + (1 - \delta)(1 - p^*), \]
which simplifies to
\[ (1 - \delta) + \delta(p^* - p^0). \]
This equation has an intuitive interpretation, indicating that the higher the value of \( \delta \)—the faster borrowers recycle into the lending game under Info—the larger Info’s pool of borrowers and the lower the proportion of honest types with \( p^0 \leq p \leq p^* \).

Info expects that the honest types will succeed and repay with probability
\[ \frac{p^0 + p^*}{2} \]
and the remainder of his borrowers will either cheat or fail. Therefore his expected repayment rate is equal to the average success rate of the honest types multiplied by the proportion of honest types in his pool of borrowers, or

\[
-\bar{p} = \frac{(p^* - p^0) \left( \frac{p^0 + p^*}{2} \right)}{(1 - \delta) + \delta (p^* - p^0)}.
\] (11)

If \( \delta = 1 \), for example, borrowers never cycle back in to Info’s pool once they have been eliminated and the Info-enforced lender expects a repayment rate of

\[
-\bar{p} = \frac{p^0 + p^*}{2},
\]

the average across the uniform distribution of borrowers with \( p^0 \leq p \leq p^* \).

If \( \delta = 0 \),

\[
-\bar{p} = \frac{(p^* - p^0)(p^0 + p^*)}{2}.
\]

Every borrower dies and is replaced each period, so every borrower is new to Info and the proportion of honest types in his pool is equal to the proportion of honest types in the population as a whole.

The value of \( p^* \) is critical to determining equilibrium in the game. Although there is no simple mathematical solution, Figure 8 shows the interaction between terms that settle of a value of \( p^* \) as a function of the variable parameters within the model. A description of steps A, B and C gives the intuition behind the determination of the equilibrium.
Figure 8: Determination of $p^*$

**Step A:**

Equation (8) describes $p^0(p)$ and can be combined with (11), which expresses

$$p(p^0, p^*) ,$$

to yield $p^0(p^*)$.

Recall that $p^0$ describes the point at which borrowers with $U^\text{Enfo}_h < 0$ choose to cheat and drop out rather than play Info’s lending game honestly. Equation (8) can be considered a function of $p$ because $p$ determines the interest rate charged by an Info lender. The higher the interest rate, the more likely a borrower is to prefer cheating over repayment and the higher $p^0$.

Equation (11) describes $p(p^0, p^*)$ because the Info lender’s expected repayment rate depends on the proportion of cheater-strategy borrowers with $p < p^0$ and $p > p^*$. The more borrowers who fall outside of the range $p^0 \leq p \leq p^*$, where the honest strategy dominates, the lower $p$. 
It is possible to think of \( p^0(p^*) \), then, because \( p^* \) influences the rate of cheating in Info’s pool; the rate of cheating determines \( \bar{p} \); \( \bar{p} \) in turn determines the incentive of borrowers with \( U_{Enfo}^b < 0 \) to cheat or play honest, and this decision sets the cutoff value \( p^0 \).

**Step B:**

Equation (9) expresses \( p^*(\bar{p}, \bar{p}) \), yielding \( p^*(p^0) \) when combined with (11) and (10), which express \( \bar{p}(p^0, p^*) \) and \( \bar{p}(p^*) \), respectively. The intuition behind (11) is described above and the value of Enfo’s expected repayment rate \( \bar{p} \) is simply the average across the range of borrowers with a success rate between \( p^* \) and 1.

Recall that \( p^* \) describes the point above which a borrower with \( U_{Enfo}^b > 0 \) prefers to cheat Info and play Enfo’s lending game. This borrower’s incentives depend both on the interest rate offered by an Info-type lender and the interest rate offered by an Enfo-type lender, and are therefore determined by both \( \bar{p} \) and \( \bar{p} \) in equation (9). A lower \( \bar{p} \), for example, translates into a higher Info-type interest rate and causes more borrowers to default and play Enfo, tending to lower \( p^* \). The reduction in \( p^* \) translates into a lower \( \bar{p} \) in equation (10), which tends to raise the Enfo-lender’s interest rate and reduce the incentive for borrowers in Info’s pool to cheat. These two contrary effects move against one another until a new equilibrium \( p^* \) is reached.

The situation is slightly more complicated than in Step A because the value of \( p^0 \) both directly influences \( \bar{p} \) and indirectly influences \( \bar{p} \) by affecting the borrower’s decision to cheat, but ultimately \( p^*(p^0) \). Using reasoning similar to that of Step A, then, \( p^*(p^0) \) because \( p^0 \) influences the rate of cheating in Info’s pool; the rate of cheating determines \( \bar{p} \); \( \bar{p} \),
in conjunction with $\bar{p}$, determines the incentive for borrowers to cheat and play Enfo, and this decision determines the cutoff value $p^*$.

Step C:

Equilibrium in the game, therefore, depends on the feedback between $p^0$ and $p^*$. Solving the simultaneous equations $p^0(p^*)$ and $p^*(p^0)$ describes equilibrium in the game as a function of parameters in the model. The value of one cutoff point influences the value of the other, but both cutoffs are ultimately shaped by the parameters $\beta, \delta, \phi$ and $\varepsilon$.

4 Applications

In this section I illustrate the implications of the model in various applications. Section 4.1 develops the intuition of the model with a simple comparison of real-world Info- and Enfo-type enforcement. Sections 4.2 and 4.3 test the model’s equilibrium predictions by examining the credit-lending game under different parameter values.

4.1 Loan sharks and salary lenders

Perhaps the most direct application for a model of endogenously determined credit contract enforcement is to credit markets that exist outside strict government purview. A borrower seeking an informal loan has recourse to two types of non-bank lender: the salary lender (also called a payday lender) and the loan shark. Consider Figure 6 a distribution of
borrowers who are seeking an extralegal loan, perhaps because they have been denied formal credit or obtain higher utility from an informal loan.

*Salary lender stylized facts:*

- Extremely high interest rates
- No collateral

*Loan shark stylized facts:*

- Lower interest rates
- Emphasis on collateral

### 4.1.1 Salary lenders as Info-type lenders

Salary lenders offer small, short-term loans to borrowers who either do not qualify for bank credit or prefer the convenience of a less formal contract. These payday loans are generally between $100 and $500, with standard fees on a two-week loan averaging around $20 per $100 borrowed (Flannery and Somolyk 2005). The federal government does not regulate these non-bank loans and underwriting practices vary from vendor to vendor but salary lenders generally place very little emphasis on collateral, lacking recourse to the state’s seizure powers, and require only a recent bank statement and pay stub to indicate a steady source of income (Flannery and Somolyk 2005; Huckstep 2007; Haller and Alviti 1977).

Annually adjusted rates are extremely high—often running in excess of 500% APR—and have attracted accusations of predatory lending practices (Huckstep 2007). The model suggests, however, that high interest rates need not reflect exorbitant lender profits or unfair business practices. Instead, the salary lender has a pool of borrowers with lower $p$, high rates of cheating and no requirement—or no capacity—to pledge collateral. He relies on Info-type grim-trigger enforcement and therefore must charge a high rate to cover losses in the case of failure.

Competition among salary lenders is intense, and Flannery and Somolyk (2005) report that “low
profitability has driven many mainstream financial institutions from the market for small short-term credit.” Rather than an example of predatory lending, the model suggests that payday lending is an Info-type situation where a low \( p \) translates into a lower \( R^I_b \) (see equation 5).

### 4.1.2 Loan sharks as Enfo-type lenders

A loan shark, in contrast, can be considered an extralegal lender that relies on Enfo-type enforcement. “The incentive to repay money lent by a loanshark,” Reuter concludes from research into criminal lending in New York, “is the fear of possible violence initiated by the lender if payment is not made” (Reuter 105). For simplicity, consider the loan shark a pure leg-breaking type (\( \beta = 0 \)) who threatens to impose a damage \( C \) in the event of nonpayment.

Although loan sharks are famous in the popular imagination for extortionate interest rates, evidence is scarce that this is in fact the case. “The illegal lending of money…is not a matter that requires much skill, time, or organization, and numerous individuals engage in it on a part-time basis,” Reuter observes, concluding that monopolistic control in the market is unlikely (108). As the model suggests, types with a high probability of project success may prefer to borrow from a loan shark as opposed to a salary lender, since they receive a better return and rarely face unjustified punishment. As a Russian shop owner under the protection of a local crime syndicate explains, “I know that they always charge an interest rate that is lower than the bank’s. The main difference is, however, that they want the money back right on time” (Varese 113).
4.2 Info versus Enfo: social optimum and debtor’s prison

Legal policies in relation to credit contracts provide an interesting lens through which to view the tradeoffs between Info- and Enfo-type enforcement. Prior to the 1830’s, imprisonment for debt was a common legal sanction in England and America; as the General Court of Massachusetts argued in 1725, the threat of prison was necessary to discourage “vicious and improvident persons” from cheating their creditors (Coleman 41). In short, debtor’s prison can be seen as a way to mitigate moral hazard and enforce loan contracts through Enfo-type punishment. The model motivates an understanding of the forces behind the history of debtor’s prison in England and America.

4.2.1 Info, Enfo and social efficiency

A foundational tenet of Law and Economics is that legal policy should seek to optimize social welfare. Comparing Info- and Enfo-type enforcement suggests that there should be a clear legal preference for Info-type enforcement from the perspective of social efficiency. To see this, consider an Enfo regime with $\beta < 1$. Recall from section 3.1 that

$$U_b^{Enfo} = pR^E_h - (1 - p)C.$$ 

The lender’s surplus, similarly, can be described as his expected return from lending less the investment outlay $I$ and the fee $\varepsilon$:

$$U_i^{Enfo} = p(R - R^E_h) + (1 - p)\beta C - (I + \varepsilon).$$

The maximum possible surplus to be gained from investment is $pR$. Adding $U_b^{Enfo} + U_i^{Enfo}$, we find a total surplus under Enfo equal to
\[ pR - (1 - p)(1 - \beta)C - (I + \epsilon) . \]

Surplus generated by investment is reduced by the amount of \( I \) and \( \epsilon \) because these represent true costs to lending, given the assumption that \( I \) is destroyed during investment and enforcers to charge a fee commensurate with their marginal costs. The lower \( \beta \), the transferability of wealth, and the higher \( C \), the punishment in case of failure, the greater the lost surplus from an Enfo regime. Imprisonment for debt is far from a socially optimal method of contract enforcement, as it is both of little use to the state (low \( \beta \)) and socially costly both in the sense that it is extremely damaging to the debtor (high \( C \)) and directly costly to the state in terms of maintaining the justice system (high \( \epsilon \)). As the 18th century essayist Samuel Johnson observes, “the confinement…of any man in the sloth and darkness of a prison, is a loss to the nation, and no gain to the creditor” (Idler no. 22).

Under an Info regime, in contrast, section 3.2 demonstrates that

\[ U^\text{Info}_b = pR^I_b \]

and

\[ U^\text{Info}_i = p(R - R^I_i) - (I + \phi) . \]

Adding \( U^\text{Info}_b + U^\text{Info}_i \) yields the social surplus equal to

\[ pR - (I + \phi) . \]

As long as \( (I + \phi) < (1 - p)(1 - \beta)C + (I + \epsilon) \), Info can be considered the socially optimal system of enforcement.

The theories of Hayek (1945) and Coase (1960) suggest that in the absence of interference legal institutions tend toward the efficient solution; state policy regarding credit contract enforcement, therefore, might be expected to favor Info over Enfo, given the low \( \beta \), high
and high $\varepsilon$ associated with debtor’s prison. What factors kept society at a seemingly sub-optimal equilibrium?

4.2.2 Technology, mobility and the abolition of debtor’s prison

The problem with an Info-type system is the fragility of its existence. Because the Info lender bears the full cost of borrower failure, he must demand a higher return and it may not be possible to prevent the borrower from cheating, given Info’s inability to impose direct punishment. For much of history, low $\delta$ and high $\phi$ would have made an equilibrium with Info impossible.

Prior to the industrial revolution, borrowers were more impatient; disease and poor living conditions conspired to keep probability of survival $\delta$ low. A high discount rate makes it harder for an Info lender to satisfy the borrower’s incentive compatibility constraint, since the borrower places little value on a steady income stream (see equation 7).

The parameter $\delta$ enters the model not only as a measure of lifespan but also as a measure of the rate at which cheaters cycle into Info’s pool of borrowers. In pre-industrial America, this rate was likely to be very high. As Olegario points out, “the country’s high immigration rate, its recent settlement, and the high geographical mobility of its population,” combined to discourage “stable information networks from forming” (Olegario 6).

High rates of immigration and geographic movement, combined with technological constraints, would have made Info-type services prohibitively costly and further restricted Info’s ability to exist. Prior to the advent of record-keeping and transparency in borrower credit history,
investigating an anonymous borrower’s past behavior or monitoring project outcomes was virtually impossible, a condition captured in the model by a high value of $\phi$.

High values of $\delta$ and $\phi$ limit Info’s pool of borrowers by increasing $p^0$ and decreasing $p^*$. Past a certain point, there is no window with $p^0 < p^*$ and Info cannot exist. Thus Enfo is the only suitable method of credit contract enforcement in mobile, short-lived and technologically limited populations. To see this in the model, recall that

$$p^0 = \left(1 - \frac{\delta}{\phi} + I + \phi\right) \frac{I}{pR - (I + \phi)} \quad \text{(equation 8)}$$

and

$$p^* = \left(\frac{I + \varepsilon}{I + \phi}\right) \frac{\bar{p}}{p + \beta(1 - p)} - \left(1 - \frac{\delta}{\phi}\right) \quad \text{(equation 9)}.$$ 

Claim: An increase in Info’s fee restricts his pool of borrowers

First consider the effect of $\phi$ in equation (8). An increase in Info’s costs has two effects, acting on $p^0$ directly through $\phi$ and indirectly through $\bar{p}$. It is easy to see that the direct effect of an increase in $\phi$ will be to reduce $p^0$. Higher cost of enforcement, however, has the added effect of making it hard for the Info-type lender to break even. As a result, lenders must demand a greater return and borrowers are more likely to cheat, reducing the Info lender’s expected repayment rate $\bar{p}$. This further compounds the increase in $p^0$ by reducing the size of the denominator in equation (8). Thus the higher $\phi$, the higher $p^0$.

Next consider the effect of $\phi$ in equation (9); here, an increase in cost acts directly on $p^*$ through $\phi$ and indirectly through $\bar{p}$ and $\bar{p}$. The direct effect of an increase in $\phi$ and the indirect
effect from the resulting decrease in $\bar{p}$ both tend to decrease $p^*$. A fall in $p^*$ tends to reduce $\bar{p}$ (see equation 10), but as section 3.4 shows, this happens in reaction to the fall in $p^*$ and does not alter the direction of the change in $p^*$. Thus the higher $\phi$, the lower $p^*$.

Claim: A decrease in the survival rate restricts Info’s pool of borrowers

Like Info’s fee, the survival rate acts on (8) and (9) directly through $\delta$ and indirectly through $\bar{p}$. A lower $\delta$ translates into a lower expected repayment rate $\bar{p}$ among borrowers in Info’s pool, since more borrowers playing a cheater strategy will cycle through each period. Figure 9 illustrates the shift in $\bar{p}$ as a function of the death rate, $(1 - \delta)$. (For a discussion of the intuition behind the endpoints in Figure 9, see section 3.4). A lower value of $\bar{p}$ increases $p^0$ and decreases $p^*$, since the Info-type lender must demand a higher return in order to break even and more borrowers at the margins of Info’s pool will opt for the cheater strategy.

$$\bar{p} = \frac{p^0 + p^*}{2}$$

$$(1 - \delta) = 0$$

$$(1 - \delta) = 1$$

Figure 9: Info’s Expected Repayment Rate as a Function of the Death Rate
To see this more explicitly in the model, again consider equation (8). Lowering \( \bar{p} \) by lowering \( \delta \) will increase \( p^0 \) because a fall in \( \bar{p} \) increases the \( \frac{I + \phi}{pR - (I + \phi)} \) term, while lowering \( \delta \) increases the \( \left( \frac{1 - \delta}{\delta} \right) \) term. As the product of two larger terms, \( p^0 \) rises. Similarly, equation (9) indicates that a reduction in \( \bar{p} \) driven by a fall in \( \delta \) will decrease \( p^* \) by lowering the \( \frac{I + \varepsilon}{I + \phi} \frac{\bar{p}}{p + \beta(1 - p)} \) term and increasing the \( \left( \frac{1 - \delta}{\delta} \right) \) term. Subtracting a larger term from a smaller term yields a decreased \( p^* \). As before, a reduction in \( \bar{p} \) does occur as a result of the fall in \( p^* \), but this shift occurs in adjustment to the new equilibrium and does not change the overall direction of the shift. Thus a lower \( \delta \) (higher death rate, greater geographic mobility) leads to a higher \( p^0 \) and lower \( p^* \), limiting Info’s window of existence.

By the mid-19th century, however, more stable populations and improvements in information-transmission technologies made Info-type enforcement feasible and debtor’s prisons were largely abolished in both the States and in England. “As we look back upon the absurdity, impolicy, and cruelty of imprisonment for debt,” the Judge John Dillon exclaimed in a lecture at Yale in 1894, “we wonder what influences had stupefied the conscience and intelligence of mankind that laws so atrocious were so long endured” (Dillon 1984). The model suggests that such atrocious laws were for a time the best and only solution available to the commitment problem inherent in the credit lending game.
4.3 Info and Enfo collaboration: rational default and the subprime mortgage crisis

The emergence of Info-type lending allowed the state to place less emphasis on forceful punishment as a method of contract enforcement, but did not eliminate Enfo’s role. As shown earlier, $p^*$ is always less than 1, giving Enfo-style enforcement room to exist. In this section I will examine the conditions under which Info and Enfo might collaborate and suggest that the breakdown in the equilibrium under this collaboration has implications for the issue of rational default in the subprime mortgage crisis that began in the summer of 2007.

4.3.1 Incentive to hire both Info and Enfo

The first step in applying the model to the recent upswing in rational default is to define the formal subprime lending market. This is not a straightforward choice between Info and Enfo-type enforcement, because legal lenders use both the Info services of ratings bureaus and the Enfo services of the state, which allow them to put a lien on a defaulter’s property. In the model, Info-type lenders have an incentive to hire Enfo in addition, if Enfo can reduce the level of cheating in the pool of borrowers, increasing the expected repayment rate. The formal lender can be thought of as an Info-type lender who pays for access to the state’s Enfo-style protection (through taxes, complying with regulation, etc).

To see this, consider an informal, pure Info-type lender earning a break-even return

$$R_{\text{Informal}} = \frac{I + \phi}{p^*},$$
where $p^I$ is the informal lender’s expected repayment rate. This lender has the option of hiring the state’s Enfo services and becoming formal. By combining Info and Enfo, the lender can both prevent cheating on the path of play and prevent deadweight loss from unjust punishment by using Info’s ability to detect cases of honest failure. By hiring the state as an enforcer and becoming formal, the lender has an expected repayment rate $p^F$ and earns a break-even return

$$R_t^{\text{Formal}} = \frac{I + \phi + \epsilon}{p^F}.$$ 

Note that although the formal lender has hired Enfo, the parameter $C$ does not factor in to the formal subprime lender’s return because in equilibrium $C$ is high enough to deter cheating and no punishment occurs in cases of honest failure.\(^2\)

Because $p^F > p^I$, the lender has an incentive to formalize as long as

$$\frac{I + \phi + \epsilon}{p^F} > \frac{I + \phi}{p^I},$$

or up to the point where

$$\frac{\epsilon}{I + \phi} = \frac{p^F - p^I}{p^I}.$$ 

As long as the additional cost in terms of fees is less than the benefit from an increased repayment rate, the lender will prefer to operate formally.

\(^2\) The advantage to formality from the lender’s perspective is the reduction in cheating, not in an increased ability to seize collateral. Seizures of property like foreclosures occur when the equilibrium breaks down; I assume the lender does not anticipate these events and incorporate them into his interest rate.
4.3.2 Borrower incentives under a mixed Info/Enfo regime

Let $U^{\text{Formal}}$ and $U^{\text{Informal}}$ denote per-period utility from borrowing in the formal and informal sectors, respectively. The borrower plays the honest strategy in the formal market if the value of cheating, being punished and borrowing in the informal market is less than the discounted value of remaining honest in the formal market across all periods:

$$R - C + \left(\frac{\delta}{1 - \delta}\right)U^{\text{Informal}} \leq R_b^{\text{Formal}} + \left(\frac{\delta}{1 - \delta}\right)U^{\text{Formal}}.$$  

Since the borrower is not punished for honest failure, his expected utility in the formal market is expressed as

$$U^{\text{Formal}} = pR_b^{\text{Formal}}.$$  

Assume that the borrower’s informal sector utility is zero for simplicity. Simplifying the borrower’s incentive compatibility constraint, we find the borrower plays honest as long as:

$$R_i^{\text{Formal}} \leq \left(\frac{\delta p R + (1 - \delta) C}{1 - \delta(1 - p)}\right)$$  \hspace{1cm} (12)

(see Appendix C for algebra). As expected, the higher $C$, the easier it is to maintain borrower honesty. By combining Info and Enfo abilities, the formal lender is able to motivate repayment while avoiding the social inefficiency of unjust punishment.
The solid lines in Figure 9 illustrate that if $C < C^*$, it is not possible to satisfy both the lender’s break-even condition and the borrower’s incentive compatibility constraint. For the borrower to repay, $C$ and $R_i^{Formal}$ must be on or below the honesty constraint line. For the lender to recoup his operating costs on average, $R_i^{Formal}$ must be on or above the solid break-even condition line. If $C < C^*$, there is no contract that satisfies both conditions and the borrower will prefer default over repayment, given the interest rate the lender must charge to break even. The dashed line shows that the critical value $C^*$ is higher for borrowers with lower values of $p$.

**4.3.3 Rational default and the subprime crisis**

Though not a comprehensive model of the subprime market, the framework presented here does provide insight into both the market’s development and unraveling with respect to...
strategic default. Subprime mortgage lending is generally described as extending high-interest credit to high-risk borrowers. Borrowers who default on a mortgage run the risk of having their homes foreclosed; the magnitude of $C$ in the subprime market, then, can be thought of as the value of the borrower’s house.

Between 1994 and 2006, the value of subprime loans outstanding rose from $35 billion to $600 billion (Bernanke March 14th, Inside Mortgage Finance 2007). Much of this expansion came from enlarging the pool of mortgages to include those who had previously been denied credit because of their high risk: in the model, these are borrowers at the lower end of the $p$ distribution.

Although legal reforms in the 1980’s created a regulatory environment favorable to high-cost lending,³ the market did not explode until the mid-1990’s when financial innovations made it less costly for lenders to assess and price risk (Bernanke May 17th). Computerized loan applications and automated underwriting reduced the fixed costs associated with screening applicants, effectively lowering Info’s marginal cost $\phi$. As argued in section 4.2.2, a reduction in $\phi$ will shift $p^0$ down and allow lenders to extend credit to less creditworthy borrowers. The average FICO score of a mortgage borrower did in fact decline during the 1990’s (Temkin, Johnson and Levy 2002).

Most salient to the issue of rational default is the fact that rising home prices allowed the credit pool to further expand to low-$p$ borrowers. “For a number of years,” Federal Reserve Chairman Ben Bernanke points out, “rapid increases in house prices effectively insulated lenders

³ The Depository Institutions Deregulation and Monetary Control Act of 1980 and Mortgage Transaction Parity Act of 1982 increased the lender’s willingness to extend credit by largely eliminating state interest rate caps, enabling lenders to extend credit to riskier types and allowing the use of variable rates³ (Chomsisengphet and Pennington-Cross 2006). From the borrower’s perspective, the Tax Reform Act of 1986 increased the attractiveness of mortgage loans by making interest paid on mortgages tax deductible (Temkin, Johnson and Levy 2002).
and investors from the effects of weaker underwriting” (Bernanke March 14th). Note from equation (12) that as $p$ falls, the critical value $C^*$ rises; this is equivalent to shifting the borrower’s honesty constraint line downward in Figure 9. Rising home prices therefore allowed lenders to extend credit to lower-$p$ types by increasing the magnitude of punishment in the case of default.

The model specifies, however, that if home prices decline these borrowers will begin to default. A body of empirical and anecdotal evidence supports the link between rational default and declining real estate prices. A study conducted by the Federal Reserve Bank of Boston argues that house price appreciation is the primary driver of default rates, citing data which indicates that borrowers whose homes decline in value by twenty percent are fourteen times more likely to default than those with homes that increase by twenty percent (Gerardi, Shapiro et al. 2007). Wachovia’s CEO Ken Thompson described those walking away from their mortgages as “people that have otherwise had the capacity to pay, but have basically just decided not to, because they feel like they’ve lost equity, value in their properties” (Christie 2008).

5 Conclusion

In this paper I have attempted to contribute to an understanding of credit contract enforcement, building on Avinash Dixit’s modes of information-based and punishment-based private governance. I show that third-party intermediaries can resolve the problem of ex-post honesty in the lending game and extend Dixit’s analysis by investigating the dynamics of a game with Info and Enfo as simultaneous players. The framework presented here allows for a comparison of the advantages to Info- and Enfo-type enforcement. Enfo expends less effort on
detection than Info and can consequently offer a lower fee, but because he blindly imposes punishment in cases of honest failure only high-\(p\) types find Enfo-enforced contracts profitable. Info distinguishes cheating from honest failure but passes the cost of this extra effort on to the lender in the form of a higher fee. This higher fee and the presence of cheaters in Info’s pool causes the interest rate on Info-type contracts to exceed those of Enfo-type contracts. From the perspective of social efficiency, however, Info-type enforcement may be optimal. The costs and benefits to these two modes of governance motivate an understanding of extralegal lending, debtor’s prison and the problem of rational default among subprime mortgage borrowers.

Several questions for future research emerge from this analysis. The issue of efficiency deserves closer attention, because although Enfo lending results in a deadweight loss, Info-type lenders may extend credit to borrowers with \(pR < I\), reducing overall surplus. Although I argue in section 4.2.1 that Info lending is likely to be more efficient, my cursory analysis needs to be developed. The approach to formal lending—or more generally, cases in which Info and Enfo collaborate—introduced in section 4.3 is also worthy of further consideration.

Considering Info and Enfo as strategic players would add an interesting element to the game. Info might double-cross the lender and agree not to report a borrower’s cheating in exchange for a bribe, for example, and Enfo could perhaps collude with lenders to extort money from borrowers. These complications would allow for an examination of industry structure beyond Bertrand competition and could yield insights into corruption, mafia-type extortion and predatory lending. Dixit (2004) provides an interesting analysis of Info and Enfo’s honesty constraints, and Milgrom, North and Weingast (1990) discuss Info-type agents as strategic players.
Endogenizing $\phi$ and $\epsilon$ could also add meaningful complexity to the model. This might be done by adding considerations of fixed costs and relaxing the assumption of constant marginal costs. Enfo, for example, may have negligible marginal cost but need to incur a substantial up-front cost to develop a credible reputation as an enforcer (for an insightful discussion of this point, see Konrad and Skaperdas [1997]). It would also be interesting to consider long-term parameter changes and possible routes of path dependency. Info-type enforcement, for example, could become a more stable equilibrium over time as institutions become more efficient at procession information. Alternately, the state’s Enfo-type enforcement could become more effective as lending fosters economic growth and leads to increased tax revenues. This paper has managed to address only a small portion of a rich and interesting area of research.
6 Appendix

A. Low-\( p \) types cheat when:

i. \( V^E_b < 0 \)

These borrowers will cheat Info and drop out if \( R \geq R^I_b + \delta V^I_b \).

\[
R \geq R - \frac{I + \phi}{p} + \left( \frac{\delta}{1-\delta} \right) \left[ p \left( R - \frac{I + \phi}{p} \right) \right],
\]

which becomes

\[
\frac{I + \phi}{p} \geq \left( \frac{\delta}{1-\delta} \right) \left[ p \left( R - \frac{I + \phi}{p} \right) \right]
\]

\[
\left( \frac{1-\delta}{\delta} \right) \frac{I + \phi}{p} \geq p \left( R - \frac{I + \phi}{p} \right)
\]

\[
p < \left( \frac{1-\delta}{\delta} \right) \frac{I + \phi}{pR - (I + \phi)}
\]

\[
p < \left( \frac{1-\delta}{\delta} \right) \frac{I + \phi}{pR - (I + \phi)}.
\]

B. High-\( p \) types cheat when:

ii. \( V^E_b > 0 \)

These borrowers cheat Info and go on to play Enfo if \( R + \delta V^E_b \geq R^I_b + \delta V^I_b \).

\[
R + \frac{\delta}{1-\delta} \left( pR - \frac{I + \varepsilon}{p + \beta(1-p)} \right) \geq R - \frac{I + \phi}{p} + \left( \frac{\delta}{1-\delta} \right) \left[ p \left( R - \frac{I + \phi}{p} \right) \right]
\]

\[
\left( \frac{\delta}{1-\delta} \right) \frac{I + \phi}{pR - \left( \frac{\delta}{1-\delta} \right) \frac{I + \varepsilon}{p + \beta(1-p)}} \geq - \frac{I + \phi}{p} + \left( \frac{\delta}{1-\delta} \right) \frac{I + \phi}{pR - \left( \frac{\delta}{1-\delta} \right) \frac{I + \phi}{p}}
\]

\[
p \frac{I + \phi}{p} \geq \frac{I + \varepsilon}{p + \beta(1-p)} - \frac{I + \phi}{p} \left( \frac{1-\delta}{\delta} \right)
\]
\[
p \geq \frac{I + \varepsilon}{p + \beta(1 - p)} - \frac{I + \phi}{p}\left(\frac{1 - \delta}{\delta}\right)
\]

\[
p > \frac{(I + \varepsilon) - p}{p + \beta(1 - p)} - \left(\frac{1 - \delta}{\delta}\right).
\]

C.

Solve for the formal, subprime lending constraint in terms of \( C \).

\[
R - C + \left(\frac{\delta}{1 - \delta}\right)U_{\text{Informal}} \leq R_{b}^{\text{Formal}} + \left(\frac{\delta}{1 - \delta}\right)U_{\text{Formal}}
\]

Assume that the borrower’s reservation utility is zero for simplicity.

\[
R - C \leq R_{b}^{\text{Formal}} + \left(\frac{\delta}{1 - \delta}\right)(pR_{b}^{\text{Formal}})
\]

\[
R - R_{b}^{\text{Formal}} \leq \left(\frac{\delta}{1 - \delta}\right)(pR_{b}^{\text{Formal}}) + C
\]

Using definition (1),

\[
R_{l}^{\text{Formal}} \leq \left(\frac{\delta}{1 - \delta}\right)\left[p(R - R_{l}^{\text{Formal}})\right] + C
\]

\[
R_{l}^{\text{Formal}} \leq \left(\frac{\delta p}{1 - \delta}\right)R - \left(\frac{\delta p}{1 - \delta}\right)R_{l}^{\text{Formal}} + C
\]

\[
R_{l}^{\text{Formal}} \left(1 + \frac{\delta p}{1 - \delta}\right) \leq \left(\frac{\delta p}{1 - \delta}\right)R + C
\]

\[
R_{l}^{\text{Formal}} \frac{1 - \delta(1 - p)}{1 - \delta} \leq \left(\frac{\delta pR + (1 - \delta)C}{1 - \delta}\right)
\]

\[
R_{l}^{\text{Formal}} \frac{1 - \delta(1 - p)}{1 - \delta} \leq \left(\frac{\delta pR + (1 - \delta)C}{1 - \delta}\right)
\]

\[
R_{l}^{\text{Formal}} \leq \left(\frac{\delta pR + (1 - \delta)C}{1 - \delta(1 - p)}\right).
\]
7 References


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