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International Lending, Long-Term Credit Relationships, and Dynamic Contract Theory

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INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
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CONTENTS

1 INTRODUCTION

Recent theoretical work has attempted to explain the long-term credit relationships that often arise in modern international capital markets between large banks or groups of banks and developing countries. Realistic models of these relationships must allow for several special features: mutually beneficial relations between lenders and borrowers may require complex long-term credit agreements; legal enforcement of loan contracts is difficult or impossible; asymmetries of information restrict the effectiveness of other enforcement techniques; and competitive forces are too weak to prevent strategic behavior from influencing the organization of relationships. In surveying and criticizing this literature, I shall use the term "dynamic contract theory" to refer to models based on rationality in which credit relationships have some or all of these features. Dynamic contract theory furnishes significantly better explanations of behavior than perfectly competitive models in which parties can make complete, perfectly enforceable long-term contracts.

This study considers to what extent dynamic contract theory has been, or could be, used to explain several phenomena often observed in modern international capital markets—notably credit rationing, rescheduling of loan payments, the predominance of short- and medium-term credit over long-term credit, and restricted access of poor countries to commercial loan markets. Dynamic contract theory allows unified, relatively simple explanations of these phenomena and helps to identify several likely sources of inefficient capital allocation, either within a given relationship or across countries in market equilibrium. These, in turn, may suggest roles for intervention by institutions like the International Monetary Fund and the World Bank in order to improve market performance.

The study is organized as follows. Chapter 2 describes the features of international loan markets that make dynamic contract theory appropriate to model them. It then briefly discusses dynamic contract models in general terms and presents a scheme for classifying them that is helpful later on. Chapters 3 and 4 provide a critical survey of recent theoretical work on loan markets that is relevant to international lending. Chapter 3 discusses one-period models of loan agreements, and Chapter 4 discusses models of long-term credit relationships. Chapter 5 is the conclusion.

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2 DYNAMIC CONTRACT THEORY

Features of International Loan Markets

Several features of modern international capital markets are important in determining how best to model long-term credit relationships.

1. An efficient allocation of capital requires complex intertemporal decision making. Developing countries must base current investment plans on predictions of how much they can borrow in the future and on what terms.

2. The lender cannot directly control the borrower's fulfillment of loan contracts. Yet the borrower's failure to fulfill loan obligations imposes costs on the lender that cannot be fully shifted to the borrower. As we shall see, this implies that lenders can typically benefit by using instruments other than interest rates—usually credit limits—to control borrowers' use of funds. Thus, market equilibrium will be contractual, with the market cleared by complex loan agreements rather than prices alone.

3. Despite the need for loan agreements, legal enforcement of contracts is almost impossible in international capital markets, because there is no authority with sufficient power to override the sovereignty of nations and settle international contract disputes.

4. There is typically considerable uncertainty about a borrower's ability to meet future loan obligations. Nevertheless, it is generally not optimal to structure a loan agreement so that default or rescheduling will not occur under any foreseeable circumstance, because risk sharing is an important source of potential gain for both borrowers and lenders. In many cases, the probability of default or rescheduling could be reduced to zero only by not lending at all.

5. Finally, competitive forces are very weak in modern international capital markets. Borrowers are highly heterogeneous, and lenders, although less heterogeneous, are small in number.[1] Even in cases where the conditions for perfect competition prevail *ex ante*, loan agreements may create monopoly power over time. A lender with loans outstanding to a given borrower has a cost advantage over other lenders, because extending further loans raises the probability that the earlier ones will be repaid (see Hellwig, 1977). For this and other reasons, it is typical for a credit relationship to generate a significant surplus, at some or all times during its life, relative to the parties' next-best alternatives. Therefore, competition from outside the relationship cannot

[1] The small number of lenders is a crucial difference between modern capital markets and earlier international bond markets, because it makes renegotiation of loan agreements easier (see, e.g., Sachs, 1984).

compensate for the impossibility of enforcing contracts, and strategic behavior can exert considerable influence on the way relationships are organized.

Structure of Dynamic Contract Models

The institutional features of modern international capital markets suggest the structure of the dynamic contract models needed to describe them. These models are inherently dynamic and game-theoretic; they apply the standard notion of rational behavior in dynamic games to long-term relationships in which parties have opportunities to make beneficial agreements. (In the discussion that follows, however, game-theoretic technicalities are kept to a minimum. Readers who desire a fuller explanation of the underlying theoretical structure are referred to Crawford, 1985a, where the notion of rationality employed—perfect Bayesian Nash equilibrium—is defined and discussed at length.) Requiring this much rationality is clearly very strong, but it appears to be the only working hypothesis that has been used with success in this kind of analysis. Simple, realistic models based on rationality are flexible enough (some would argue, *too* flexible) to explain most observed behavior. And the range of behavior that is possible without rationality, even in models with simple, realistic structures, is so enormous that it is difficult to have confidence in any specific prediction not based on rationality. By assuming rationality, the theorist submits to a useful discipline: credit-market inefficiencies must be explained solely by realistic limitations on the ability of borrowers and lenders to make and enforce agreements or contracts.

Dynamic contract models can differ along several dimensions. Many of the possibilities are illustrated in Chapters 3 and 4, but I provide a classification scheme here, both as a guide to the discussion of specific models that follows and to illustrate possibilities that have not yet been explored in the literature. These are some dimensions that must be considered:

1. Competition from outside may be weak or strong on either side of a credit relationship and may vary in strength over its life.

2. Borrowers and lenders may share in many ways the surplus their relationship generates, and surplus sharing may interact with borrowing and lending decisions.

3. Borrowers and lenders may have perfect information, imperfect but symmetric information, or asymmetric information.

4. Relationships may differ with respect to what decisions can feasibly be covered by contract.

5. Finally, the parties may enforce a loan agreement in different ways. In general, parties' enforcement strategies relate their actions at each decision point to observable history, and those actions will have effects both within and outside the relationship. The three kinds of enforcement that are theoretically possible are discussed below. All three play important roles in the literature on credit markets, sometimes coexisting within the same model.

Enforcement Techniques

It is often possible for parties to forge a cooperative agreement in an enduring relationship by relating their current behavior to past history, not only because of the direct influence past actions may have on the costs and benefits of current actions, but also because past actions create expectations about future behavior. In applications, cooperation usually ceases forever if these expectations are violated. Because the agreement is implicit in the kinds of behavior that will terminate cooperation or elicit other sanctions, and need not be stated to be effective, it is called an *implicit contract* in the literature.

A useful distinction can be made between an implicit contract in which the behavior of the parties is influenced only by the anticipated responses of the parties themselves and one in which it is influenced in part by the anticipated responses of outsiders. I call the former an *internal* implicit contract and the latter an *external* implicit contract. A party (hereafter referred to as "he") who violates an internal implicit contract typically loses the opportunity to cooperate with his current partner; a party who violates an external implicit contract loses the opportunity to cooperate with some or all potential partners as well.

The theory of implicit contracts has been worked out primarily for a simple model known as the "repeated Prisoner's Dilemma," made up of a series of one-stage Prisoner's Dilemmas played between the same two parties. The parties can identify each other and observe and recall exactly what happened each time the game was played in the past. They may therefore use strategies that make their current actions depend in any desired way on past history.

To see how such strategies allow the parties to maintain cooperation, it is first necessary to understand the one-stage Prisoner's Dilemma. In the one-stage Prisoner's Dilemma, each party chooses between two actions, which I shall call responsible behavior (R) and cheating (C). An example is shown in the figure, in which the "payoffs" of the party who chooses between rows are listed first in each cell of the payoff matrix, and the payoffs of the party who chooses between columns are listed second. The game is designed so that the outcome is better for both parties if both behave responsibly (5,5) than if both cheat (2,2). It is nevertheless in a party's individual interest to cheat no matter what he expects his partner to do (because $6 > 5$ and $2 > 1$).

	R	C
R	5,5	1,6
C	6,1	2,2

The one-stage Prisoner's Dilemma is a simple example of the tension between individual incentives to cheat and the collective benefits of responsible behavior. As such, it can be viewed as a highly stylized model of a loan agree-

ment. Responsible behavior by the borrower, for example, might be taken to mean eschewing repudiation and avoiding actions that could impair his ability to repay. Responsible behavior by the lender might be taken to involve not cutting off credit or attempting to extort more than the agreed-upon loan payment in times when the borrower's need for continued credit makes him vulnerable to "holdups."

When the one-stage Prisoner's Dilemma completely describes the situation under study—when, in particular, parties cannot make binding contracts before they play the game—there is no incentive for responsible behavior: cheating is unassailably rational on the individual level, even though it leads to an outcome that is collectively irrational, i.e., inefficient. Fortunately, even though legal enforcement of loan contracts is typically impossible in international capital markets, a long-term credit relationship more closely resembles a repeated Prisoner's Dilemma than the one-stage version of the game, and repetition opens up a wide range of possibilities for implicit-contract enforcement of cooperative agreements.

1. *Internal Implicit Contracts.* Internal implicit contracts support cooperation with credible implicit threats to end or interrupt cooperation if cheating is detected (see Crawford, 1985a; Fudenberg and Maskin, 1986; and Kreps, 1984, for overviews of the theory). For such threats to be effective, continuation of the relationship must have value for both parties relative to their next-best alternatives.

To see how such threats can support cooperation, consider the repeated Prisoner's Dilemma when the time horizon is infinite and parties discount the future at constant, equal rates. (If the time horizon were finite, a standard argument shows that rationality would require cheating in every period. If both parties know that they are in the last period, and know that they both know, and so on, they must know that rationality requires cheating in that period. This implies, in turn, that there are no gains to behaving responsibly in the penultimate period, and so on by backward induction to the start of the relationship.) [2] Let each party adopt the strategy of behaving responsibly if and

[2] This result is contradicted by the observations of Axelrod (1984) and others that experiments run with a large but finite known horizon usually yield cooperation in the repeated Prisoner's Dilemma until very near the end of the horizon. The infinite-horizon model can be viewed as a convenient way to model this phenomenon. If an infinite horizon seems objectionable on first principles, it may help to interpret the parties' behavior as reflecting (entirely or in part) an exogenous probability that the repeated game will be terminated in any given period. On this interpretation, the horizon is only potentially infinite, and the infinite-horizon assumption may be taken to mean that, no matter how long the relationship lasts, parties assign a nonnegligible probability to its continuation for at least one more period. Kreps, Milgrom, Roberts, and Wilson (1982) give an alternative explanation for the occurrence of cooperation in the finitely repeated Prisoner's Dilemma. In their explanation, a party behaves responsibly to keep alive his partner's hope that he will continue to do so and thus discourage the partner from cheating.

only if both parties behaved responsibly in the previous period. Once a party cheats, no matter what his subsequent behavior, his partner will cheat in the next period. Given the parties' strategies, this implies that both parties will cheat in all future periods.

In the example above, a party will therefore behave responsibly if an infinite stream of payoffs of 5 is preferable to an initial payoff of 6 followed by payoffs of 2 forever. If a is the discount factor ($a < 1$), responsible behavior yields a discounted lifetime payoff of $5/(1 - a)$; and cheating yields $6 + 2a/(1 - a)$. Responsible behavior is thus weakly preferred if and only if $a \geq \frac{1}{4}$. As long as the discount factor is high enough for the value of continued cooperation to exceed the one-time gain from cheating, these strategies support cooperation in the repeated Prisoner's Dilemma. (There is, in fact, a range of supportable implicit agreements that favor one party or the other by permitting a party to reap the short-run benefits of cheating some of the time without ending the relationship.)

The strategies just described meet the normal standard of rationality in dynamic games (i.e., perfect Nash equilibrium): if a party ever cheated, he would cheat in all future periods no matter what his partner did, so it would be rational for his partner to punish him in keeping with his strategy. In theory, then, these strategies give credibility to threats to terminate the relationship in response to cheating, even though *both* parties would forgo the future potential benefits of cooperation if the threat were carried out.

Yet the realism of this way of supporting cooperation can be criticized on various grounds. Perhaps most important, it is not robust to "mistakes," which the theory assumes away but which are certainly important in practice. Axelrod (1984) presents experimental evidence that the tit-for-tat strategy (begin by behaving responsibly, and then behave responsibly if and only if your partner did so in the previous period) is a superior way to play the repeated Prisoner's Dilemma. Its punishments are severe enough to prevent cheating, but, unlike the strategies described above, "forgiving" enough to allow the relationship to recover after a mistake. Green and Porter (1984), Porter (1983), and Radner (1980, 1981) discuss strategies that perform well when there is some noise in the environment, so that cheating cannot be detected with certainty. These analyses confirm the intuition that when punishments are costly for the punisher as well as for the transgressor, it is advantageous to moderate their severity when they must actually be carried out.

2. *External Implicit Contracts.* External implicit contracts enforce cooperation by using the responses of parties outside the relationship to supplement the penalties for cheating in internal implicit contracts (see Bull, 1983; Crawford, 1985a; Cremer, 1986; Holmstrom, 1981; Kreps, 1984; and Wilson, 1985, for an overview; and Eaton, 1985, for an application to loan markets,

where intermediation is viewed as a device to ensure the costly enforcement of default penalties). For this kind of sanction to work, behavior within the relationship must be observable by parties outside it, and relationships with outside parties must be potentially valuable to the parties within the relationship.

Again, the repeated Prisoner's Dilemma provides a good illustration. Suppose that the economy consists of a large number of identical individuals, each of whom has many opportunities during his life to form relationships with other members of the population. Let each party adopt the strategy of behaving responsibly vis-à-vis another party if and only if that other party has never cheated in the past. When one party violates an agreement, he knows that he will never again find a partner who will behave responsibly with him. Because cheating is the only rational action in the one-stage Prisoner's Dilemma, and behaving responsibly can no longer yield any future benefits to someone who has already cheated, it would be rational for him to cheat again if he were lucky enough to form a relationship. This makes it rational for all other parties to cheat in relationships with him and ensures that such relationships will never form if they have any opportunity cost and if it is possible to find potential partners who have not yet cheated.

When parties have many potential opportunities to form beneficial relationships, these strategies support cooperation even when the immediate gain from cheating is high and parties discount the future significantly. When cheating is perfectly observable by all, external implicit contracts therefore support a wider range of agreements than internal implicit contracts.

3. *Explicit Contracts.* There is a third technique for enforcing cooperation, which I shall call "explicit contracting," for want of a better name. In explicit contracts, parties can base their current actions on past experience only to the extent that it *directly* influences the current costs and benefits of possible actions. Dependence on history that is informative but does not otherwise have a direct influence on the costs and benefits of parties' actions is not excluded, because new information directly influences expected costs and benefits. (By contrast, the implicit contracts discussed above support cooperation in the repeated Prisoner's Dilemma only by allowing parties to base their current decisions on history that does not influence the current payoffs, which are fixed throughout.)

A legally binding contract, which is the leading example of explicit-contract enforcement, provides a useful illustration, even though the sovereignty of nations makes it impossible to enforce such a contract in international capital markets. In the repeated Prisoner's Dilemma, such a contract between rational parties might simply stipulate responsible behavior for all time, specifying penalties for cheating that are high enough by themselves to make it unprofitable. In the numerical example discussed above, for instance, any

penalty greater than 1 for each instance of cheating would make it unprofitable.

More generally, explicit contracts work by changing the payoffs in the game in a way that creates incentives for parties to behave as desired. In the extreme case of perfectly, costlessly enforceable legal contracts, explicit contracting can duplicate the effects of a complete commitment about all future actions, except that it may be impossible to preclude renegotiations that both parties consent to.[3] Under more realistic assumptions, explicit contracts allow parties to make partial, but still useful, commitments by various devices, such as leaving reserves in foreign banks as "hostages" or choosing an investment policy that lowers the risk of default.

Explicit-contract analyses play an important role in the literature, partly because they allow the modeler to control the assumptions about the kinds of agreements parties can make and thus facilitate the analysis of the effects of realistic limitations on contracting. When no agreements are possible, the model is completely "noncooperative" in the conventional use of the term. As the set of allowable agreements is expanded to permit more complete stipulations about parties' choices, the model becomes more "cooperative." Note that the same standard of noncooperative rationality is maintained in each case: cooperative and noncooperative models are distinguished by their assumptions about parties' opportunities to make and enforce agreements, not by the principles that govern behavior in the agreements.

To the extent that implicit contracts succeed in supporting the desired agreements, the observable differences between implicit and explicit contracts are subtle. The problem lies in the importance of those portions of parties' strategies that specify what *would* happen if the agreement were violated. If violations do not occur, much of the structure of a working implicit agreement can remain invisible to outside observers. The kind of enforcement being used can only be inferred, within a fully specified model, from the kinds of commitment it allows parties to make.

When the short-run gains from cheating are large and parties discount the future, implicit-contract enforcement may be significantly less effective than a complete, legally binding explicit contract, if one can be made. Implicit contracts can penalize cheating only to the extent that future cooperation remains valuable, and this limits the range of supportable agreements. In environments like the one studied by Green and Porter (1984) and Porter (1983),

[3] Commitment not to renegotiate might actually be beneficial in some realistic circumstances (see, e.g., Hellwig, 1977, or Stiglitz and Weiss, 1983, which are discussed in Chapter 4). Whether such commitments can be enforced legally seems to be a delicate question: the modal response among lawyers I have asked is surprise at being asked the question, followed by the statement that it might be possible, in some cases, "with a good lawyer." In contrast, there seems to be no reason, at least in theory, why *implicit* contracts cannot preclude renegotiation.

where imperfect observability prevents parties from attaining the first-best outcome, the limitations may reduce efficiency as well as restrict the possible divisions of surplus. External implicit contracts tend to have a larger set of enforceable agreements than internal implicit contracts, because they punish cheating by ending cooperation not just with the cheater's current partner, but also with other potential partners.

3 ONE-PERIOD LOAN AGREEMENTS

The primary purpose of the models of one-period loan agreements discussed here is to explain the occurrence of credit rationing, defined broadly to include any method of allocating credit other than posting an interest rate for each identifiable class of borrowers and allowing each borrower to determine the size of his loan. Credit rationing may thus include nonlinear pricing of loans, the imposition of credit ceilings, and, in extreme cases, the complete cutoff of credit to some borrowers in some circumstances.

Credit rationing derives, ultimately, from the inability of lenders to exercise direct control over the fulfillment by borrowers of loan-contract obligations. In domestic capital markets, this inability follows from bankruptcy law. In international lending, the sovereignty of nations has the same effect. Because failures to fulfill loan obligations impose costs on the lender, this incompleteness of loan contracts creates externalities analogous to moral-hazard problems in insurance. When loan contracts are incomplete in other ways, the resulting externalities can lead in turn to more complex moral-hazard and adverse-selection problems, which are illustrated below. When, as is typical, the interest rate affects the borrower's incentive to fulfill his loan obligations, the lender can use additional instruments, such as credit limits, to deal more effectively with these problems.

It is useful to distinguish three kinds of failure to fulfill loan obligations: default, rescheduling, and repudiation. "Default," which technically means any failure to meet the terms of a formal loan agreement, will be used here to refer to an interruption of loan payments that is beyond the borrower's control. "Rescheduling" means a negotiated change in the timing, and perhaps the magnitude, of loan payments. "Repudiation" means a "voluntary" failure to meet loan obligations when it would be feasible (albeit costly) to meet them. Repudiation usually involves a complete, permanent failure to comply with the loan agreement, whereas default is normally temporary. (In models with only one repayment period, of course, repudiation and default are not very different, because it is impossible to distinguish between permanent and temporary interruptions.) In what follows, I shall use these definitions even when it requires a departure from the terminology used in the work being surveyed.

Bester (1985), Jaffee and Russell (1976), Keeton (1979), Stiglitz and Weiss (1981, n.d.), and Gale and Hellwig (1985) all study the use of credit rationing to control bankruptcy externalities in domestic loan markets. Because bankruptcy plays a role in domestic markets analogous to the role of default (or, in

these one-period models, repudiation) in international lending, these models contribute to an understanding of international as well as domestic credit relationships.

Jaffee and Russell (1976)

Jaffee and Russell (1976) study credit rationing in a two-period Fisherian model in which borrowing smooths intertemporal consumption. Repudiation imposes costs on the lender and yields corresponding benefits to the borrower equal to the contracted repayment that the borrower avoids. Repudiation is also assumed to impose costs on the borrower that are independent of the size of the unpaid loan balance.[1] It is therefore feasible for lenders to restrict loan size so that repudiation is never profitable to borrowers.

There are two types of borrowers in the market: "honest" ones, who repay even when repudiation is financially advantageous, and "dishonest" ones, who repudiate whenever repudiation is less costly than meeting their loan obligations. Borrowers know from the start whether or not they are honest, but lenders cannot distinguish among borrowers *ex ante*. There is no other uncertainty.[2]

In these circumstances, the profitability of restricting loan size by enough to make even dishonest borrowers repay depends on the proportion of such borrowers in a lender's clientele. Given the fixed cost of repudiation, a reduction in loan size lowers the amount that a borrower can gain by repudiation. Loan size can be reduced by raising the interest rate or rationing credit. These have different effects on profitability insofar as they have different effects on the proportion of honest borrowers in the lender's clientele. A monopolistic lender always finds it more profitable to restrict loan size by raising the interest rate charged all borrowers than by rationing credit, because raising the interest rate does not decrease the proportion of honest borrowers in his market. Thus, a monopolistic lender adjusts the interest rate to reflect the probability (if any) of repudiation, but does not use credit rationing to sort honest from dishonest borrowers.

By contrast, a competitive lender has an incentive to use credit limits to make it unprofitable for dishonest borrowers to repudiate. If the lender does

[1] These costs might be identified with the loss of the reputation for responsible behavior the borrower needs to secure future loans in an external-implicit-contract setting. On such an explanation, the relationship between repudiation costs and the size of unpaid balances could be inferred from what other agents can observe. Other rationales are, of course, possible.

[2] On an alternative interpretation, all borrowers are honest, but there is uncertainty about whether borrowers' future incomes will be large enough to make repayment feasible. Jaffee and Russell make some observations about the symmetric-information case where borrowers do not know, *ex ante*, whether they will be "lucky" or "unlucky"; Stiglitz and Weiss (1981), discussed below, consider the case where borrowers have more information about their future incomes than lenders have.

not screen out dishonest borrowers in this way, he may afford his competitors an opportunity to design contracts that attract his honest borrowers and leave him with a portfolio of low-quality loans. This adverse-selection effect makes possible competitive equilibria in which all lenders restrict credit below what borrowers would wish to borrow at the interest rate actually charged. There may also be competitive equilibria, however, in which credit is not rationed.

Stiglitz and Weiss (1981)

Stiglitz and Weiss (1981) develop a model of credit rationing in a competitive market where lenders face more complex adverse-selection and moral-hazard problems (see Keeton, 1979, for an earlier analysis based on similar considerations). In this model, unlike Jaffee and Russell's, borrowers who obtain credit choose among risky investment projects, and the costs of repudiation are sufficiently high that loan obligations are always met to the extent that investment returns make it feasible. Loan contracts are explicit, but because lenders cannot observe the riskiness of the investment projects chosen by borrowers, contracts cannot take account of it. This creates a default externality, because investment risk determines default risk, and most of the costs of default are borne by the lender.[3]

Because borrowers in default need not meet all of their interest obligations, they choose riskier investment projects than lenders would wish. But raising the interest rate to reflect the added risk only exacerbates this problem and may actually lower the expected return from the loan. Therefore, credit limits become a useful supplement to the interest rate in controlling the moral hazard arising from the borrower's choice of investment projects. Further, loan contracts with relatively high interest rates but relatively favorable credit limits are comparatively more attractive to riskier borrowers, so credit limits also have a role to play in controlling adverse selection.

Stiglitz and Weiss (1981) state conditions under which these circumstances can generate competitive equilibria involving credit rationing (see Hellwig, 1983, for some important qualifications to their conclusions). Credit rationing may involve nonlinear pricing of loans or, in some circumstances, complete denial of credit to some borrowers who are indistinguishable from other borrowers who receive loans. As noted in Stiglitz and Weiss (n.d.), these results also hold, in contrast to Jaffee and Russell's, for a monopolistic lender; the difference arises because Stiglitz and Weiss's lenders cannot control the choice of investment projects made by their borrowers.

Stiglitz and Weiss (1981) also observe that, starting from the equilibrium contract in their model, a lender may not wish to use collateral requirements

[3] These assumptions about borrowers' costs of default and repudiation can be rationalized in an external-implicit-contract framework if lenders' observations allow them to distinguish (involuntary) default from (voluntary) repudiation (see, e.g., Grossman and Van Huyck, 1985).

to sort borrowers, even when such requirements are feasible.[4] Bester (1985) shows that this observation is not valid for the Stiglitz and Weiss (1981) model when it is assumed, as is natural, that lenders can vary the other terms of their contracts. He shows that there are competitive equilibria in which lenders set interest rates and collateral requirements to sort borrowers perfectly, without rationing credit. Nevertheless, Bester also observes (and Stiglitz and Weiss, n.d., confirm) that these instruments may not suffice for perfect sorting in some circumstances.

Gale and Hellwig (1985)

Gale and Hellwig (1985) study one-period loan contracting in an environment like Stiglitz and Weiss's (1981) in most of its essentials. Unlike Stiglitz and Weiss, however, they assume that the lender can observe and control by contract the borrower's investment decision (and its riskiness). Furthermore, whereas Stiglitz and Weiss take it for granted that limited-liability loan contracts will be used to share risk, Gale and Hellwig leave the form of the contract unrestricted *a priori*. Their primary goals are to explain the role of the institution of bankruptcy in promoting efficient sharing of investment risk and to explain why loan contracts are the prevalent risk-sharing instruments in capital markets rather than, say, equity or insurance contracts.[5] They also consider how the underlying features of credit relationships interact to determine the level of borrowing and investment.

In the Gale and Hellwig model, a risk-averse borrower has sole access to risky investment projects. He can costlessly make complete, legally enforceable explicit contracts with a risk-neutral lender, allowing the lender to share the investment risk and thereby enabling the borrower to take advantage of more productive investment opportunities.[6] However, only the borrower can observe the realized return from his investment project.

In the absence of the bankruptcy institution (and, in the one-period model

[4] The possibilities for using collateral in international lending are limited. However, foreign investments and reserves in foreign banks may serve an analogous purpose.

[5] Bankruptcy occurs when the borrower fails to meet his loan obligations and allows the lender to observe and realize the borrower's investment return. In addition, bankruptcy imposes costs on the borrower, which might either be "real," as Gale and Hellwig assume, or derived from loss of reputation in an implicit-contract framework. This definition of bankruptcy is not fully appropriate as a characterization of default in models of international loan markets, in that default may not allow the lender to observe or capture any returns. However, to the extent that default is costly to the borrower as well as to the lender, he will still have an incentive to avoid it whenever possible. Thus, most of the conclusions that follow from Gale and Hellwig's characterization of bankruptcy will carry over to default as well.

[6] Parties' assumed ability to make loan agreements can also be rationalized by external-implicit-contract considerations. Thus, the analysis has something to say about international credit relationships, even though their legal contract-enforcement possibilities are limited.

being considered, future penalties for misrepresentation), the borrower's desire to keep interest payments as low as possible would lead to a complete contingent contract in which payments to the lender were independent of realized investment returns. If the contract specified different payments for different returns, the borrower would always have an incentive to report the outcome—normally, the worst possible—that resulted in the lowest payment. (The ability of the lender to check the plausibility of an entire history of such reports is one of the most important benefits of the long-term credit relationships discussed in Chapter 4.) A rational lender, foreseeing the implications of the borrower's incentives, would make only those loans for which even the worst possible outcome allowed him to realize a profit. Because this payment must also be feasible for the borrower, the incentive to misrepresent outcomes would preclude—or, at best, severely restrict—lending for all but the most productive risky investment opportunities. The resulting absence of lending need not be construed as credit rationing; because of the incentive problems, there is simply no interest rate that is consistent with both positive supply of and positive demand for credit.

Now suppose that the lender can force the borrower into bankruptcy if he fails to meet his obligations, which permits the lender to observe and realize the return from his investment. If bankruptcy has real costs for the borrower, he can never benefit from declaring bankruptcy when he could in fact meet his loan obligations. This makes feasible contracts in which the "normal" (i.e., nonbankruptcy) payment exceeds the lowest possible investment return. As in a standard loan contract, the normal payment must still be independent of the realized investment return, because of the incentive for misrepresentation generated by asymmetric information. Yet the institution of bankruptcy allows partial risk sharing and a higher level of productive investment. Because bankruptcy is costly for the borrower, loan contracts can yield some of the benefits that would follow if the borrower could post a bond that would be forfeited if he misrepresented his investment returns.

Gale and Hellwig also study the distortions in borrowing and investment that arise from the incentive problems in their model. Credit is rationed, in that the optimal loan contract cannot generally be duplicated by lending the borrower as much as he wishes at a given interest rate. As a result, the contract usually results in a lower level of investment than would be negotiated if the lender as well as the borrower could observe investment returns, thereby precluding misrepresentation and making possible complete contingent risk sharing. This follows because the parties' best response to the incentive problems involves allowing bankruptcy to occur in some circumstances, despite its real costs. Starting at the first-best investment level, reducing investment has a locally negligible effect on productivity but induces a first-order reduction in the probability of bankruptcy. The second-best compromise therefore involves underinvestment.

4 LONG-TERM CREDIT RELATIONSHIPS

Unlike the models discussed in Chapter 3, models of long-term credit relationships are potentially directly applicable to international lending, where legal enforcement of loan contracts is impossible, so that implicit-contract enforcement becomes essential.

Hellwig (1977)

Hellwig (1977) was the first to identify many of the crucial features of long-term credit relationships. He studied the problem faced by a single lender who has an opportunity to make legally enforceable explicit contracts with a borrower whose future income is uncertain. The lender is risk-neutral (or is able to pool risks perfectly, because he lends to a large group of homogeneous borrowers facing independent risks), and the borrower is risk-averse, so there are potential gains from loan contracts via risk sharing as well as consumption smoothing.

For tractability, Hellwig assumes that time is continuous and the horizon potentially infinite. Parties have symmetric information about the borrower's future income, which is assumed to take a once-for-all jump from a known low level to a known high level at an unknown future date. Except for the jump in income and the effect of past loan contracts, the model is stationary. In particular, the probability of an increase in income for a borrower whose income is still low is constant over time and independent of past history.

Hellwig's lender can make perfectly enforceable long-term loan commitments, guaranteeing future interest rates and that repayment of principal will not be required as long as interest obligations are met. He can also make commitments about the future limits he will impose on the borrower's total indebtedness to him (henceforth called "credit limits"), but he can neither forswear renegotiation of these commitments, in the event that renegotiation becomes mutually beneficial for him and the borrower, nor commit himself now to extend additional credit in the future. (Because the borrower generally faces higher interest rates than the lender, extending more credit now is not a perfect substitute for a commitment to lend in the future.) Finally, the loan contract cannot be made contingent on the borrower's consumption behavior or realized income.[1]

As in the one-period models discussed in Chapter 3, the lender cannot di-

[1] There may be implicit-contract counterparts to Hellwig's explicit-contract rationale for these restrictions, but they would be rather contrived. Still, Hellwig's model appears to yield insights into international lending. (Furthermore, it is easy to imagine implicit-contract justifications for Hellwig's assumption about bankruptcy, decribed below, along lines discussed in Chapter 2.)

rectly control the borrower's decision to declare bankruptcy. A bankrupt borrower avoids his loan obligations (the lender recovers nothing) but loses access to further credit. He also incurs additional costs that are assumed to depend in a plausible, general way on the amount of his indebtedness. The borrower will declare bankruptcy if the lender enforces a credit limit (i.e., cuts off new credit completely) at a time when the borrower's income cannot satisfy both his loan obligations and his desired consumption, given the relative benefits of maintaining consumption and avoiding bankruptcy. Thus, bankruptcy in Hellwig's model is formally analogous to repudiation in international lending but shares some of the characteristics of default as well, because it is caused mainly by the irreversible effects of past consumption decisions.

Because a borrower who is about to go bankrupt generally benefits from a relaxation of the credit limit, he will not object if the lender wishes to raise it. Thus, the lender must decide at each instant whether to extend additional credit and, if so, what interest rate to charge. (To simplify the problem further, Hellwig takes the interest schedule as exogenous. This appears to be innocuous for his purposes.) Both parties must therefore predicate their behavior on a rational prediction of what credit limit the lender will actually enforce when it becomes binding on the borrower.

In Hellwig's model, a rational lender must stop extending credit, driving the borrower into bankruptcy, before the borrower's debt burden becomes so large that even the highest possible level of income will not suffice to meet his loan obligations. A borrower whose income has not yet risen continues to borrow, steadily increasing his indebtedness until his income rises or he is forced into bankruptcy. If his income rises before he is driven into bankruptcy, the borrower makes no further gain from borrowing or lending under Hellwig's assumptions, so he simply pays off his obligations and passes into autarky.

Because there is a positive probability that the borrower's income will remain low beyond any given date, the only way to reduce the probability of bankruptcy to zero is not to lend at all. To realize the consumption-smoothing and risk-sharing benefits of the credit relationship, both parties must therefore accept some risk of incurring the costs of bankruptcy. This risk is heavily influenced by the borrower's consumption behavior, and the borrower's expectation that the lender will enforce a credit limit makes him choose a more conservative consumption plan than he would in the absence of that expectation, so as to reduce the risk of incurring his own bankruptcy costs. By enforcing a credit limit, the lender obtains some of the benefits he would realize if he could control by contract the borrower's consumption behavior and therefore his risk of bankruptcy.

Yet a lender who is unable to commit himself not to renegotiate his credit

limit may be unwilling to enforce the limit that would be best for him if he *could* commit himself, or even a limit that reduces the risk of bankruptcy by enough to make lending profitable.[2] The irreversible effects of the lender's loan commitments make his preferences concerning the enforcement of credit limits time-inconsistent. To see this, imagine that the lender plans initially to enforce the credit limit that maximizes his profit from his relationship with the borrower and that the borrower is unlucky in that his income does not rise in time to keep this credit limit from binding. At this point, the lender can no longer benefit from enforcing the initially announced credit limit because that limit cannot influence the borrower's past consumption behavior, and extending additional credit when bankruptcy is imminent raises above zero the probability that the borrower will eventually be able to repay his loans. Thus, the lender may find it optimal to propose a relaxation of the credit limit when it becomes binding (a proposal the borrower will accept), even though both parties would have been better off if the lender had been able to impose the limit irrevocably when he began extending credit. If the borrower's initial expectations correctly anticipate this time inconsistency, the announced credit limit does not even moderate the borrower's consumption behavior in the interim.

It remains to ask what credit limit a rational lender will actually enforce when the announced limit becomes binding. Hellwig proposes several criteria for enforceability. None of them corresponds to the standard notion of rationality for dynamic games (perfect Nash equilibrium), but this does not appear to affect his qualitative results.[3]

Hellwig finds that the lender's choice of credit limit is highly sensitive to the way he decides between cutting off credit and lending further when he is indifferent between these two options. (Both ways of breaking such ties are potentially consistent with rationality.)

If the lender always breaks ties in favor of additional lending,[4] he will en-

[2] It is interesting that even a long-term commitment to a credit limit does not help if parties cannot forswear renegotiation. (See also Stiglitz and Weiss, 1983, discussed below, and footnote 3 in Chapter 2.) This gives implicit-contract enforcement a significant advantage over an explicit contract, even when legal enforcement is possible.

[3] Such rationality requires the construction by both parties of a self-confirming conjecture about the lender's behavior—a conjecture with the property that a lender who cuts off credit can do no better by extending additional credit, and vice versa, given his own conjecture about when he would choose to cut off credit if he did not do so immediately. The lowest level of total indebtedness at which the lender cuts off credit on the basis of these conjectures is the credit limit referred to in the text. Even if the lender is allowed to commit himself to lines of credit that the borrower can use in the future, the definitions Hellwig favors (his "strong f-sophisticated" and "weak f-sophisticated" cutoff criteria) are both inconsistent with perfect Nash equilibrium.

[4] At the time the decision is made, additional lending is strictly better for the borrower, and no worse for the lender, than cutting off credit. "Always" refers to whenever the lender makes a choice in the mostly hypothetical conjecture of footnote 3.

force the lowest credit limit having the property that it is optimal for him to stop lending immediately, no matter what his conjecture about the next-lowest limit he would choose to enforce later if he failed to enforce one immediately. This is the highest credit limit consistent with common sense (or with perfect Nash equilibrium). If the lender finds that he has already lent so much that further lending is clearly unprofitable, then it is definitely time to cut off credit. Although the resulting credit limit is typically lower than the one defined at the start of this discussion (the one that would keep the borrower's obligations from exceeding his means at the highest possible level of income), it can be much higher than the limit the lender would choose if he could make a nonrenegotiable commitment at the start of the relationship. Further, it may exert so little control over the borrower's consumption behavior that bankruptcy risk will still render *all* lending unprofitable from the start.[5]

If, instead, the lender always breaks ties in favor of cutting off credit, the limit he will enforce may lie anywhere from zero to the limit that would be enforced under the previous tie-breaking assumption. The outcome is indeterminate, and no restrictions beyond those implied by common sense can be imposed on the lender's credit-rationing strategy.

One might argue in response that the lender will enforce that credit limit which maximizes his surplus, choosing among those consistent with rationality. (The one he would choose if he could commit not to renegotiate is always in this set.) However, an equally strong case can be made that the choice resides effectively with the borrower, because his consumption behavior necessarily precedes the lender's decision to enforce a particular credit limit.

A related issue is whether the lender can influence the outcome by announcing the credit limit he intends to enforce. When information is symmetric and parties are rational, the borrower cannot learn anything from such an announcement, except perhaps how the lender is thinking about the game (or, more precisely, how the lender would like the borrower to think he is thinking about the game). In a game with such a multiplicity of equilibria, however, the influence of such announcements should not be completely discounted, although it is difficult to evaluate their effectiveness.

Despite their paradoxical nature, these results seem to capture the essence of the lender's dilemma in the face of bankruptcy risk. When the risk seems unduly high, he wishes to avoid "throwing good money after bad," but additional lending increases the probability that his earlier loans will eventually be repaid. If the borrower expects the lender to extend further credit, however, the threat of eventual enforcement of a credit limit loses some of its ef-

[5] In this case, there is a sense in which the lender enforces a zero credit limit, but the situation is analogous to a market with no price consistent with positive demand and supply, as in Gale and Hellwig's (1985) analysis.

fectiveness in controlling the borrower's consumption behavior, and this in turn may raise the risk of bankruptcy and thus enhance the lender's incentive to relax the credit limit. The end result is that rationality may not narrow down the possibilities very much, and expectations consequently have great influence.[6]

Hellwig makes another point of particular interest for international lending. A lender with loans outstanding to a given borrower has a cost advantage over other potential lenders, because further loans raise the probability that earlier loans will be repaid. This competitive advantage is akin to the entry-deterring effect of sunk costs. As a result, the evolution of a long-term credit relationship creates monopoly power. Market competition is important in allocating capital when credit relationships are initiated, but its influence becomes weaker as the level of outstanding debt increases. There is therefore little reason to expect capital to be allocated efficiently across borrowers or for capital flows to be efficient within a given credit relationship.

Hellwig's (1977) model captures many important features of international credit relationships. It deserves closer scrutiny, and the issues he raises should be integrated into the literature on international lending. In particular, it would be of great interest to learn whether his paradoxical conclusions about the usefulness of credit limits in controlling default risk are valid for standard notions of rationality and with an endogenously determined interest-rate schedule. It would also be worthwhile to see whether his assumed limitations on explicit loan contracts can be derived from first principles using an implicit-contract model that realistically represents international credit relationships.

Eaton and Gersovitz (1981a, 1981b)

Eaton and Gersovitz (1981a, 1981b) develop a model of long-term credit relationships that resembles Hellwig's (1977) model in many ways but has complementary strengths and weaknesses from the standpoint of understanding international lending. As in Hellwig's model, credit relationships yield consumption-smoothing benefits (and risk-sharing benefits in part of their analysis); information is symmetric, except that an asymmetry may be required to explain the assumption that the parties cannot make contracts contingent on the borrower's realized future income; default or repudiation (not distinguished, and formally analogous to Hellwig's bankruptcy) has costs for the borrower and does not lead to any recovery by the lender; and credit limits are the lender's principal instrument for controlling default risk.

[6] These conclusions must be qualified, because Hellwig does not employ the standard notion of rationality, and his results appear to be sensitive to the continuous-time formulation. Discrete-time counterparts of Hellwig's model typically make definite predictions, which oscillate wildly, however, as period length approaches zero.

Eaton and Gersovitz's approach has two important advantages over Hellwig's. First, they determine the interest-rate schedule endogenously by allowing competition among lenders. Second, they derive the cost of repudiation to the borrower within the model, using an external-implicit-contract argument; a borrower who repudiates loses all future access to credit. Although such a rationale is easy to construct, Eaton and Gersovitz use it not just to account for repudiation costs but also to relate these costs to the underlying characteristics of the borrower. This approach yields interesting results about the role of market data in determining credit limits and the level of borrowing. By contrast, Hellwig makes general assumptions about bankruptcy costs in an explicit-contract framework and does not ask how changes in the environment affect credit limits.

Eaton and Gersovitz present two classes of tractable examples to illustrate the implications of their model. In one, the borrower's future income is certain but variable over time, so that loan agreements yield consumption-smoothing benefits but no risk-sharing benefits. Because there is no uncertainty, rational lenders always set credit limits to ensure that the threat of shutting the borrower out of the credit market forever is sufficient to deter repudiation.[7] It is shown that the equilibrium credit ceiling increases with the temporal variability of the borrower's income but is ambiguously related to its growth rate.

When the borrower's future income is uncertain, by contrast, the advantages of risk sharing imply, as in Hellwig's model, that it is no longer optimal to set credit limits low enough to reduce to zero the probability of repudiation. The comparative-static properties of the model, although ambiguous in general, suggest possible explanations for the fact that low-income countries—which tend to have highly specialized economies, fewer opportunities for risk pooling, and more political risk—also have restricted access to capital markets.

In two important respects, the Eaton-Gersovitz model is significantly less descriptive of international capital markets than Hellwig's (1977) model. First, when they assume that the borrower's future income is stochastic,

[7] With a single borrower and lender and a finite time horizon, it is not difficult to show that a rational lender must require that each loan "stand alone" (i.e., meet a profitability test in isolation); Eaton and Gersovitz's conclusion about credit limits then follows easily. In their model, however, there are many lenders and an infinite time horizon (a frequently useful, though more difficult, case to study), and it is therefore conceivable that cross-subsidization of loans will be profitable. However, Foley and Hellwig (1975) have extended the "stand alone" principle to this case as well, using an explicit-contract framework. They show that with many lenders each one can decide how much to lend only by making a rational prediction of the future responses of potential lenders as well as the response of the borrower. Loans whose profitability depends on repayment financed by anticipated future loans from other lenders at below-market rates (cross-subsidization) do not meet this test of rationality.

which is necessary for repudiation to have a positive probability in their framework, they also arbitrarily rule out saving by the borrower. (Neither model allows capital formation.) If the borrower does not save, however, credit limits cannot control the borrower's consumption behavior, which was their central role in Hellwig's analysis. Credit limits can affect default or repudiation risk only by influencing the repudiation decision itself, a serious oversimplification.

Second, Eaton and Gersovitz do not allow lenders to make long-term loan commitments. Loans must be repaid (or defaulted) in each period, before new loan commitments are made, so that additional lending cannot improve the quality of existing loans. This eliminates the monopoly-creating effect of long-term loan commitments identified by Hellwig and makes it less clear why international credit relationships should persist over time. Furthermore, it rules out time-consistency problems in the enforcement of credit limits, and these seem central to modern debt crises.[8]

Stiglitz and Weiss (1983)

In a two-period version of their 1981 model, Stiglitz and Weiss (1983) study the usefulness of rationing credit in response to a borrower's default history as a device for controlling default risk. (Wilson, 1985, provides an informative discussion of this paper.) Each borrower has exclusive access to a set of investment projects. On obtaining credit, he chooses a particular project whose riskiness is unobservable by the lender. This choice creates a moral-hazard problem like that studied in Stiglitz and Weiss (1981) or (for consumption rather than investment) in Hellwig (1977). All borrowers are identical, however, so there is no adverse-selection problem. (Eaton and Gersovitz, by contrast, assume away all moral-hazard and adverse-selection problems except those inherent in the repudiation decision itself.)

Although the lender cannot observe the borrower's investment choice in the Stiglitz-Weiss model, he can observe whether the borrower has defaulted on the first-period loan before he makes his second-period lending decision. Because borrowers who choose riskier investment projects are more likely to default, a borrower's default record contains information about his investment choice, and the lender's ability to respond to it in the second period allows him to influence the borrower's first-period choice.

Stiglitz and Weiss use external-implicit-contract arguments to justify their assumptions that borrowers can commit themselves never to repudiate their obligations and lenders can commit themselves to two-period loan contracts

[8] The other differences between the two models, such as discrete vs. continuous time and the form of income uncertainty, do not appear to be important. (See, however, Kletzer, 1984, who notes that Eaton and Gersovitz's discrete probability distribution for the borrower's income may make competitive equilibrium impossible in their model.)

in which the availability of credit and the interest rate in the second period are contingent on whether or not the borrower defaults in the first period. They rule out a commitment not to renegotiate interest rates—without explaining why a lender who can commit himself by reputation to cutting off credit in circumstances where both parties would prefer more lending cannot also preclude the renegotiation of the second-period interest rate.

Stiglitz and Weiss show that their model may produce competitive equilibria in which nondefaulters pay high interest rates in the first period and low rates in the second, while defaulters are either cut off from credit entirely in the second period or are charged a higher interest rate. In such equilibria, the risk of losing access to credit or paying a higher interest rate helps borrowers to internalize the cost of default, so that they choose less risky investment projects. There may also be competitive equilibria, however, in which some lenders do not punish first-period default.

The outcome for a particular borrower is highly sensitive to history and luck. After a run of bad luck, a borrower may face credit-market terms inferior to those faced by other borrowers who have unambiguously inferior investment projects. Lenders will go against their short-run best interests in order to maintain a reputational commitment that is useful in controlling default risk and possibly essential to survival in the market. As a result, bad luck may impoverish a borrower and then deny him the access to credit he needs to recover.

Recent Contributions

Several recent contributions adapt the Eaton-Gersovitz (1981a, 1981b) framework to make its predictions more realistic.

Glick and Kharas (1983) and Sachs (1984, Chap. 3) give a borrowing country's economy more internal structure, placing constraints on domestic fiscal policy that limit a country's ability to fulfill its loan obligations. These constraints yield more realistic predictions about the timing of reschedulings in the borrowing cycle.

Sachs (1984, Chap. 4), Sachs and Cohen (1984), and Glick and Kharas (1983) show how borrowers can use domestic investment policy to control default risk and ensure continued access to credit. Suppose an investment involves sunk costs, so that the borrower cannot costlessly withdraw capital after a loan is approved and use the proceeds for consumption. Then a multiperiod loan contract can call for partial completion of the investment before additional loan disbursements are made. Such a commitment would raise the borrower's ability to pay and thus reduce default risk. It could also lead to inefficiently high levels of investment, however, as a second-best response to default risk, an outcome that contrasts with Gale and Hellwig's (1985) conclusion that bankruptcy risk, in conjunction with the lender's inability to observe investment returns, may lead to underinvestment.

Sachs and Cohen (1984) employ a model with multiple debt maturities to study default-risk externalities that arise when new loans from one lender affect the quality of the borrower's existing debt to other lenders by making default more or less likely. In domestic capital markets, such externalities can be handled, to a certain extent, by seniority provisions and bond covenants, but there is no way to enforce such stipulations in international capital markets. They must therefore be enforced, if at all, by implicit contract; this favors shorter debt maturities because they allow quicker responses to cheating.[9] These shorter maturities, however, require parties to forego important diversification and planning benefits.

In closely related work, Kletzer (1984) extends the Eaton-Gersovitz model to study the effects of new loans on default risk, and the implications of new loans when lenders cannot observe total debt obligations. Because it is a borrower's total indebtedness that matters for default risk, Kletzer argues that unobservability makes it impossible to have competitive equilibria in which the interest rate on each loan depends on its size. An analogous argument was made by Arnott and Stiglitz (1983) for competitive insurance markets with moral-hazard problems, but Hellwig (1983) has shown that it is not correct; nonlinear pricing of loans can occur in competitive equilibrium, even with this kind of unobservability. Hellwig's conclusion for competitive insurance markets is almost surely valid for the analogous setting of credit markets with default risk.

Sachs and Cohen (1984) and Sachs (1984) discuss rescheduling, which has played only a limited role in the literature although it is much more common than default in modern international capital markets.[10] Rescheduling is presumably arranged when delayed repayment is better for both parties than default. It serves as a partial substitute for complete contingent contracting, which is prohibitively costly or impossible (presumably for implicit as well as explicit contracts). Because it tends to make loan payments more sensitive to the borrower's ability to pay, rescheduling, if anticipated, probably makes a loan agreement more efficient (see Shavell, 1984). It is worth noting, however, that a commitment *not* to renegotiate can be beneficial in models like those of Hellwig (1977) and Stiglitz and Weiss (1983).

[9] The benefits of shorter maturities are limited by the speed with which lenders can observe cheating and the extent to which they can retain the flexibility to punish it in the face of default risk (see, e.g., Guttentag and Herring, 1986).

[10] An exception is Hellwig (1977), who discusses extensively the announcement and subsequent renegotiation of credit limits. In his model, such renegotiation is equivalent to rescheduling. But Hellwig's credit-limit announcements are nonbinding, because they can be renegotiated and both parties will generally want to renegotiate them. Because they do not restrict parties' actions, and parties cannot learn anything from them in a model with symmetric information, announcements cannot alter the set of outcomes that are consistent with rationality in Hellwig's model. As noted, they might nevertheless help to determine which of the many outcomes defensible as rational will actually govern behavior.

Sachs and Cohen assume that bonds, unlike bank loans, are impossible to renegotiate because of the large number of bondholders whose consent would be required. They explain the modern transition from bond to bank lending in international capital markets by the increased benefits of renegotiation in response to debt crises. Although this explanation has some plausibility, most debt crises are surely unanticipated, and reschedulings may reduce the borrower's interest obligations, possibly by more than the parties would have agreed to *ex ante* in a complete contingent contract.

Sachs (1984) constructs an external-implicit-contract explanation of the predominance of rescheduling over default in international capital markets, basing it in part on the assumption that default has costs outside the relationship but rescheduling does not. Yet rescheduling and default are equally observable to outsiders, and both weaken the parties' ability to make long-term commitments that are helpful in controlling default risk. The role of rescheduling depends on whether default-risk moral hazard is more costly than the shared uncertainty that cannot be adequately dealt with by contingent contracts. If moral-hazard problems predominate, borrowers and lenders might both benefit from decreasing the frequency of reschedulings or making them more difficult, despite the resulting increase in the frequency of defaults.[11]

Sachs (1984) also considers the collective-action problems associated with lending by consortia. Individual lenders capture only some of the benefits of their attempts to prevent default, so there is a free-rider problem. And panics may occur in which lenders' expectations that other lenders will not extend additional credit are self-confirming, even though everyone would prefer an outcome in which all lenders extended further credit. This explanation has some plausibility, but the argument relies too heavily on current agnosticism about what governs behavior when there are multiple Nash equilibria. A more trustworthy dynamic model would have decisions made sequentially and milder multiple-equilibrium problems.

[11] Grossman and Van Huyck (1985) develop a model in which "excusable default," analogous to rescheduling, occurs in an external implicit contract when both parties observe that the borrower's ability to pay is low. In equilibrium, repudiation is punished, but excusable default is not; the latter can be viewed as a cheap way to make interest obligations contingent on ability to pay.

5 CONCLUSION

This study has provided an introduction to dynamic contract theory and a survey of dynamic contract models dealing with credit relationships. The models of long-term credit relationships discussed in Chapter 4, notably those of Hellwig (1977), Eaton and Gersovitz (1981a, 1981b), and Stiglitz and Weiss (1983), provide a framework in which to seek explanations for several phenomena that are observed in modern international capital markets but cannot occur in a perfectly competitive world—credit rationing, default and rescheduling, the predominance of short debt maturities, and poor countries' restricted access to credit. Some of the explanations of these phenomena indicate that capital is allocated inefficiently; they suggest that there are potential benefits from intervention by international institutions like the International Monetary Fund and the World Bank.[1]

We have a long way to go, however, before such models can be trusted to provide precise recommendations about beneficial intervention. The more applications-oriented work discussed in Chapter 4 (e.g., Glick and Kharas, 1983; Sachs, 1984; and Sachs and Cohen, 1984) adds realistic structure to the Eaton and Gersovitz (1981a, 1981b) model. That model seeks to explain how the characteristics of borrowers determine the availability of credit by showing how they affect the feasibility of using implicit-contract enforcement to uphold loan agreements. As such, it is a natural vehicle for applications. But comparisons with the models of Hellwig (1977) and Stiglitz and Weiss (1983) suggest that the Eaton and Gersovitz model ignores some features of international capital markets that seem essential to understanding how they function. A model that incorporated these features would provide a much sounder basis for applications.

In particular, applications-oriented models should allow lenders to make long-term loan commitments when they find it useful. They should confront borrowers with nontrivial consumption and investment decisions, so that the important moral-hazard problems identified by Hellwig (1977) are not assumed away. Adverse selection, studied by Stiglitz and Weiss (1981), may also prove important.

[1] Roles for intervention, analogous to those identified in the theory of labor arbitration in Crawford (1985b), are discussed in Crawford (1984); see also Sachs (1984). As Stiglitz and Weiss (n.d.) note, allocations that are efficient relative to the information available to a social planner in models like those discussed here typically involve credit rationing, so the occurrence of credit rationing is not *prima facie* evidence that intervention is potentially beneficial. However, these models usually do imply a potential role for intervention.

Furthermore, the bargaining process is far more complex, and surplus sharing more varied, than can be described by a bargaining model with all-or-nothing contract offers, but that is the model used in almost all of the work surveyed here. It would be useful to ascertain whether this caricature of the bargaining process distorts the models' predictions.

Implicit-contract enforcement of loan agreements is a tricky business in practice, but it is treated cavalierly in almost all of the work discussed in Chapter 4. Imperfect observability of behavior and limiting the cost of mistakes surely play a major role in determining the structure of international loan agreements, but the lessons of Axelrod (1984) and Green and Porter (1984), to name only two important contributions, have yet to take hold in the international-lending literature. Further, more justification should be given, either within the model or empirically, for currently *ad hoc* assumptions about the kinds of commitments that implicit contracts allow.

Finally, repudiation is not the only threat to the enforcement of international loan agreements: default and rescheduling are far more important empirically. The distinctive characteristics of default, rescheduling, and repudiation must be studied carefully in applications of implicit-contract theory to international capital markets.

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