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Chapter 2

Incentive-Compatible Sovereign Debt[1]

Abstract. In a model of sovereign borrowing and lending—a model with asymmetric information, costly state disclosure, and no court to enforce repayment—I show that a sovereign borrower optimally issues a contract that specifies (i) a fixed payment, or face value, in high income states, and (ii) a default if the sovereign's willingness-to-pay falls short of the face value, where (iii) default is partial rather than complete, and (iv) the default repayment depends on the power that creditors have to punish repudiation. The result explains why sovereign borrowers issue simple debt instruments instead of more contingent contracts. An increase in the costs of repudiation lowers the interest rate on sovereign debt through a commitment effect: higher costs of repudiation, both political an economic, commit the sovereign to repay the debt at face value in more states of the world; thus, reducing sovereign risk.

2.1   Introduction

This chapter analyses credit extension to a borrower in the absence of a court. Creditors can punish *repudiation* by the borrower, but they cannot seize any of the borrower's income. The borrower is also better informed as to her income. Creditors can get informed if the borrower agrees to a *public audit*, which is costly. The problem occurs naturally in sovereign borrowing. Sovereign debt contracts have been shown to be hard to enforce, not least because governments have private information, and are reluctant to subject to a public audit of their books by the International Monetary Fund (IMF), or fellow member states. In this chapter, I adopt a simple model of sovereign borrowing and lending to answer the following question: if a government seeks to finance an expenditure today, but receives income only in the future, *what is the optimal financial contract* the government can offer to international creditors?

In an Arrow-Debreu world, with complete contingent contracts, the question is easily answered: the optimal contract is either indeterminate or the optimal contract doesn't exist–depending on whether expected income exceeds the expenditure. The market for sovereign finance, by contrast, is plagued by at least two frictions. First, there is an enforcement friction: there is little collateral, and seizure of sovereign assets is complicated.[2] It follows that a sovereign borrower can repudiate any contract she has entered and repay zero to her creditors; this is known as the *willingness-to-pay problem*. Why a sovereign borrower ever chooses repayment over repudiation, in the absence of a court, is a central question of the sovereign debt literature. The sovereign pays for two reasons in this chapter. First, the sovereign pays because she is concerned with the economic costs of repudiation. In line with the literature on the willingness-to-pay problem, I assume that repudiation is economically costly.[3] Second, and novel to my

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[2]Domestic courts are subject to the laws of the sovereign and, therefore, cannot be used to force the sovereign to repay. As for outside courts, there are few assets located abroad, and those that are located abroad are often protected by sovereign immunity, cf. Sturzenegger and Zettelmeyer (cf. 2006).

[3]In a seminal contribution, Eaton and Gersovitz (1981) show that reputational concerns can

model, the sovereign pays because she is concerned with the political costs of repudiation: the sovereign is forced to resign if she repudiates.[4]

Aside from the enforcement friction, there is an information friction: the sovereign has private information about her income, or *ability-to-pay*. The sovereign can disclose her true ability-to-pay to the creditors, but this is costly: the government has to invite an outside auditor, like the IMF, and dislikes the increased scrutiny and interference that follow a public audit. Building on the enforcement friction and the information friction, I propose a new theory of sovereign debt to explain why sovereign borrowers issue simple debt instruments instead of more contingent contracts

The optimal contract specifies (i) a fixed payment, or *face value*, in unaudited states; (ii) a payment equal to the creditor punishment threat in audited states; and (iii) an audit if and only if the sovereign's willingness-to-pay falls short of the face value The intuition for the optimal contract is that it economises on costly auditing, which is what the costly state verification literature has emphasised (cf. Townsend, 1979; Gale and Hellwig, 1985). Compared to the familiar standard debt contract, there is still a fixed payment in high-income states, i.e., the optimal contract is still a *debt contract*. But the optimal contract specifies partial repayment for audited states, rather than full repayment (or *maximum recovery*); in addition, the usual budget constraint is replaced by a willingness-to-pay constraint.

It is natural to interpret a public audit as a *sovereign default* episode. Examples abound: Russia defaulted in 1998, Pakistan in 1999, Argentina in 2001. Indeed, default episodes are politically costly to governments who are likely to lose office,

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sustain positive repayment by the sovereign; other papers that show how positive repayment can be sustained, in the absence of a court, include Grossman and Van Huyck (1988), Bulow and Rogoff (1989a,b), Worrall (1990), Fernandez and Rosenthal (1990), Atkeson (1991), Cole and Kehoe (1998), Kletzer and Wright (2000), Sandleris (2008), Guembel and Sussman (2009), and Hellwig and Lorenzoni (2009). Eaton and Fernandez (1995) and Reinhart and Rogoff (2009) survey the literature.

[4]The political cost is best thought of as a punishment by the electorate for the economic hardship suffered. Indeed, governments are often forced to resign in the wake of a default, as Argentina's government was in 2001. See Blustein (2005) for a detailed account.

as Borensztein and Panizza (2009) document. Default episodes also involve a transfer of information: more information comes available through, e.g., IMF reports and increased press coverage.[5]

With the default interpretation, the characteristics of the optimal contract match some key facts of sovereign borrowing: first, the sovereign's default decision depends on her willingness-to-pay, rather than on her solvency;[6] second, default is partial rather than complete, and creditors get a haircut that depends on their power;[7] and third, countries issue plain bonds that promise a fixed payment.[8]

A further result is that an increase in the political cost of repudiation can increase welfare by alleviating the inefficiency due to the enforcement friction. High repudiation costs work as a commitment to repay in the absence of formal outside enforcement: the government is committed to repay the debt at face value in more states of the world.

In section 2.5, I extend the basic model to study the role of creditor coordination costs, along the lines of Bolton and Jeanne (2009). Clearly, creditor coordination is an important issue in sovereign debt renegotiations. If creditors cannot coordinate around a debt renegotiation, then such renegotiation breaks down, leading to a deadweight loss. Bolton and Jeanne (2007, 2009) take this observation to an extreme by assuming that sovereign debt can either be renegotiated at no cost, or not at all. I show that the debt contracts that are available to the sovereign *by as-*

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[5]The 2010 debt crisis in Greece serves as a case in point: details on its tax-collection system, and the size of its public sector entitlements, became widely known after the EU-IMF-ECB bailout. Greece, however, has not defaulted on its creditors at the time of writing. In light of the model in section 3.2, Greece has chosen to be audited, but has not yet made its repayment decision.

[6]Reinhart and Rogoff (2009) document a wide dispersion of debt-to-GDP levels at time of default, and argue that a sovereign's willingness-to-pay, rather than her ability-to-pay, determines the repayment decision.

[7]All creditors are not equal. As there is no court to enforce creditor priority, creditors can expect to be repaid according to the power they wield. The IMF, for example, is typically repaid in full, whereas private creditors receive a haircut.

[8]All parties involved understand that plain bonds are, implicitly, contingent on the state of the world. Still, the prevalence of plain bonds, instead of more explicitly contingent contracts, in sovereign borrowing is puzzling, as Borensztein and Mauro (2004) and Shleifer (2003) have argued.

sumption in Bolton and Jeanne (2007, 2009), can be derived as optimal contracts: non-renegotiable debt is the optimal contract if an audit and creditor coordination are both costly; renegotiable debt is optimal if an audit is costly, but subsequent creditor coordination is costless

This chapter is related to theories of debt in the corporate finance literature, in particular to the costly state verification models pioneered by Townsend (1979) and Gale and Hellwig (1985).[9] My approach is new in combining the well-known costly state verification approach with an ex-post repayment decision, i.e. with the willingness-to-pay problem. A second innovation is that the audit cost is political: the sovereign dislikes to disclose its true ability-to-pay. The political reluctance to disclose, the political cost of repudiation, and the economic cost of repudiation drive the optimal contract design.

Conceptually, this chapter is close to Gale and Hellwig (1989) who consider a model of sovereign borrowing with asymmetric information and a willingness-to-pay problem. But Gale and Hellwig (1989) study the outcome of the ex-post debt renegotiation; they are not concerned with the ex-ante optimal contract design as I am here.[10]

Finally, this chapter is related to Bolton and Jeanne (2007, 2009) who argue that the sovereign debt market–left to itself–produces equilibria in which the sovereign debt structure is excessively hard to restructure. In both papers the sovereign, by assumption, can issue two types of debt: debt that is renegotiable (r-debt), and debt that is not renegotiable (n-debt). If the government is truly unable to repay, renegotiable debt allows for an efficient renegotiation of

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[9]Other papers that study optimal contracting under *costly state verification* are Border and Sobel (1987); Mookherjee and Png (1989); Krasa and Villamil (1994, 2000); Hvide and Leite (2010). Other papers that show the optimality of debt under some form of enforceability include Diamond (1984), Innes (1990), and Hart and Moore (1998).

[10]Specifically, Gale and Hellwig (1989) model debt renegotiation under asymmetric information as a signalling game: first the borrower decides how much to repay, then the creditors choose whether to accept the payment or punish the borrower and seize some output. As creditors can always use their punishment technology, the initial contract does not matter in Gale and Hellwig (1989). By contrast, in this chapter creditors can only punish the sovereign debtor if there is a breach of contract and output cannot be seized.

the debt burden, while non-renegotiable debt leads to a dead-weight loss. Still, the sovereign may choose to issue non-renegotiable debt because it offers some commitment value: n-debt strengthens the sovereign's repayment incentives in Bolton and Jeanne (2007), and n-debt cannot be diluted by subsequent debt issues in Bolton and Jeanne (2009). In this chapter, both renegotiable debt and non-renegotiable debt emerge as optimal contracts, see section 2.5.

2.2 Model: A Simple Borrowing Problem

Consider a small open economy over two periods: the present ($t = 0$) and the future ($t = 1$). There is a single homogeneous good that can be consumed or invested. A sovereign government, or *sovereign*, seeks to finance a fixed government expenditure, $g > 0$, at time 0; the government expenditure benefits all residents in the economy equally.[11] As the sovereign has no funds at time 0, she seeks to raise the full amount from international creditors, in return for a promise to repay at date 1. A continuum of risk-neutral creditors provides funds at the prevailing opportunity cost of capital, normalised to 0. The sovereign seeks to borrow from a mass one subset of the creditors.

The sovereign's budget at date 1 is uncertain as of date 0. Budget uncertainty arises because future output is uncertain, as is the sovereign's ability to tax output, cut expenses, or generate income from other sources, e.g., from privatising state property, or undertaking structural reforms. The sovereign's budget, or *ability-to-pay*, is denoted by y, a random variable that takes values in an interval $T \subseteq \mathbb{R}_+$ and is distributed according to a cumulative distribution function $F(y)$.

Two frictions limit the efficiency of sovereign borrowing. The first friction arises from asymmetric information: while the sovereign observes y at no cost, outside creditors only observe y if the sovereign subjects to a public audit. If there is a public audit, the country comes under international public scrutiny, led by the

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[11]The government expenditure can be thought of as public consumption, as the expenditure does not raise future productivity of the economy. This assumption is not crucial for any of my results, but plausible in the context of sovereign borrowing, cf. also Bolton and Jeanne (2009).

IMF, and creditors learn about the sovereign's ability-to-pay. The public audit is costly to the sovereign: the sovereign faces interference with her policies and, as a result of increased transparency, possibly loses office.

The second friction arises from the lack of enforcement in the sovereign finance market: a sovereign borrower can repudiate any contract and repay 0. In line with the literature on the willingness-to-pay problem, I assume that repudiation is economically costly. This cost should be thought of as arising, either, from direct creditor sanctions, as in Sachs and Cohen (1982); or, from a loss of market access, as in Eaton and Gersovitz (1981).

The sovereign maximises the utility of the representative resident, and enjoys a private benefit from holding office. The utility of the sovereign is given by

$$U_S = \chi_g V + c + S(y, \hat{y}) \tag{2.2.1}$$

where the first two terms capture the utility of the representative resident: χ_g is an indicator that equals 1 if the expenditure is financed; V represents the utility value the residents derive from the expenditure at date 0; and c is consumption at date 1, i.e. income net of any repayment to creditors, or punishment for repudiation. The third term, $S(y, \hat{y}) \geq 0$, is a non-pecuniary private of holding office, which is enjoyed depending on the sovereign's announcement and repayment decision at date 1. The sovereign enjoys the biggest private benefit if she repays without a public audit; she enjoys a smaller private benefit if she repays after a public audit; finally, she enjoys no private benefit if she repudiates–repudiation is costly, and so is a public audit. This is represented by a step-function

$$S(y, \hat{y}) = B \chi_{\{no\,audit,\,repayment\}}(y, \hat{y}) + b \chi_{\{audit,\,repayment\}}(y, \hat{y})$$

where χ is an indicator function, $B > 0$, and $0 < b \leq B$.

In autarky, residents consume y as it comes available and the sovereign enjoys

her full private benefit from holding office; her expected utility at date 0 is

$$EU_S^{aut} = Ey + B \qquad (2.2.2)$$

I assume that financing the government expenditure is efficient, $g < V$, and that the sovereign's expected income exceeds the expenditure, $Ey > g$. These assumptions ensure, first, that the sovereign *wants to* finance the expenditure expenditure and, second, that the sovereign *is able to* finance the expenditure if information is symmetric and enforcement is complete–i.e. in a first-best world. The sovereign's first-best expected utility is given by

$$EU_S^{FB} = V + Ey - g + B \qquad (2.2.3)$$

Any contract that satisfies the budget constraint and, in expectation, pays out g to creditors implements the first-best allocation.

With asymmetric information and no formal outside enforcement–i.e. in a second-best world–the interaction between the sovereign and international creditors is as follows. At date 0, *the financing stage*, the sovereign seeks to finance the expenditure by offering a contract to creditors. The contract determines (i) the sovereign's contractual payment obligation in each state; and (ii) what states are to be audited. Formally, a *contract* is defined as an array (O_1, I_d), where $O_1 = O_1(y)$ gives the date 1 contractual obligation as a function of the budget, and $I_d = I_d(y)$ is an indicator that equals 1 if there is an audit, 0 otherwise. At date 1, *the repayment stage*, the sequence of actions is as follows:

1. Nature chooses the state y, sovereign observes y ;

2. **Announcement:** Sovereign announces her ability-to-pay $\hat{y}$,

    (a) if $I_d(\hat{y}) = 1$, then creditors observe y, and the contractual obligation is $O_1(y)$;

    (b) if $I_d(\hat{y}) = 0$, then the contractual obligation is $O_1(\hat{y})$.

3. **Payment:** Sovereign makes a repayment decision $r \in \{0,1\}$,

   (a) $r = 1$: she pays O_1, i.e. honours the contract, and the games ends, or

   (b) $r = 0$: she pays 0, i.e. repudiates, and creditors charge a punishment.

The contractual obligation of the sovereign is fully determined by her announcement at the repayment stage. If the sovereign announces a state for which the contract specifies an audit, then creditors observe the budget and the contractual obligation is set at $O_1(y)$. If instead the sovereign announces a state that remains unaudited, then based on the announcement the contractual obligation is set at $O_1(\hat{y})$. Finally, the sovereign makes her payment decision: she can either repudiate the contractual obligation she entered, or honour it. An outside arbitrator, with the same information as creditors, certifies whether the sovereign has honoured or repudiated her contractual obligation.[12] If the sovereign honours the contract, then investors have no further claim against her. If, instead, the sovereign repudiates the contract, there is a proportional output loss, γy, as in Sachs and Cohen (1982) and Bolton and Jeanne (2009). Creditors do not recover any payment if the sovereign repudiates; thus, the output loss represents a deadweight loss.[13] Note that the sovereign's repayment decision depends on the true budget, y, as well as on the contractual obligation, $O_1(\hat{y})$. The sovereign's payoff is summarised in the following table:

To conclude the section, consider the different entries in table 2.2.1. All entries but the lower-left (no audit, repayment), correspond to a sovereign default

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[12]The IMF plays an important role in sovereign default episodes and subsequent debt renegotiations. For example, an IMF program is prerequisite to a renegotiation of any Paris club debt (i.e. debt owed to creditor nations). Furthermore, IMF data form the basis for debt renegotiations with the private sector; sometimes, the IMF even provides an explicit seal of approval for a proposed debt restructuring by sending *comfort letters* to creditors, cf. Díaz-Cassou, Erce, and Vázquez-Zamora (2008). While the IMF performs the role of an auditor, the IMF crucially cannot enforce payments or seize assets.

[13]The output loss is best thought of as arising from a loss of market access: as long as no settlement is reached with outside investors, the country is shut out off international markets (Bolton and Jeanne, 2009); the parameter $\gamma \leq 1$ captures the power of creditors to punish the sovereign for repudiation.

	Repayment	Repudiation
Audit	$y - O_1(y)$	$y - \gamma y$
No Audit	$y - O_1(\hat{y}) + B_1$	$y - \gamma y$

Table 2.2.1: Sovereign's Payoff Matrix

episode; and all default episodes are politically costly to the sovereign. Still, not all default episodes are equal. If there is a public audit and the sovereign subsequently repays, the outcome resembles a successful debt workout, or an excusable default as in Grossman and Van Huyck (1988). If the sovereign repudiates, there is an output loss of γy, but creditors do not recover any payment.[14]

2.3 Optimal contract

2.3.1 With repayment commitment

The optimal contract depends on whether the sovereign can commit to a future repayment strategy at the financing stage. As a benchmark, I derive the optimal contract assuming that the sovereign can commit, at date 0, to a future repayment strategy, at date 1. In the following, let y be the true state, while $\hat{y}$ denotes the announced state. Under commitment, the sovereign chooses *full-repayment*, i.e. a repayment strategy given by

$$r(y,\hat{y}) = \begin{cases} 1 & \text{if} \quad O_1(y) \leq y \quad \text{and} \quad I_d(\hat{y}) = 1, \\ 1 & \text{if} \quad O_1(\hat{y}) \leq y \quad \text{and} \quad I_d(\hat{y}) = 0, \\ 0 & \text{if} \quad \text{otherwise} \end{cases}$$

With full repayment, the sovereign pays any contractual obligation that respects the budget constraint. The remaining problem is to derive the optimal contract under a full-repayment commitment; a problem that is equivalent to a special case

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[14]Outright repudiation is rarely observed. An example is the refusal of Russia's Bolshevik government to repay Tsarist debts after the revolution in 1918.

of Gale and Hellwig (1985), who consider a model of credit extension without any enforcement friction.

If there is an optimal contract, it takes the form of a *standard debt contract*. Three features define standard debt: (i) a fixed payment, or face value; (ii) an audit if and only if the sovereign's ability-to-pay falls short of debt's face value; and (iii) maximum recovery in case of an audit.[15] Formally, a contract (O_1, I_d) is said to be a *standard debt contract* if and only if

1. for some D, we have $O_1(y) = D$ if $I_d(y) = 0$;

2. $I_d(y) = 1$ if and only if $y < D$; and

3. $O_1(y) = y$ if $I_d(y) = 1$;
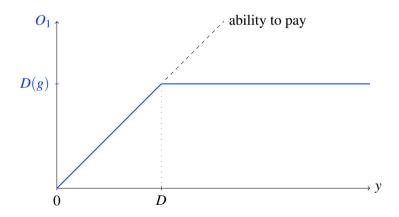
also see figure 2.3.1.

Figure 2.3.1: Payment of standard debt contract as a function of income.

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[15]As there is only a private cost of disclosure, maximum recovery implies that all income is transferred to creditors in case of disclosure. By contrast, the pecuniary costs of state observation in Gale and Hellwig (1985) imply that creditors recover only part of firm income in case of disclosure.

2.3.2   Without repayment commitment

Without the ability to commit, the sovereign makes her repayment decision after the contractual obligation is set. To see which contractual obligations are repaid, and which are repudiated, consider the repayment stage at time 1. The optimal repayment strategy, $r(y, \hat{y})$, follows from comparing the sovereign's utility in case of repayment with her utility in case of repudiation; it is given by

$$
r(y, \hat{y}) = \begin{cases}
1 & \text{if} \quad O_1(y) \leq \min\{\gamma y + b, y\} \quad \text{and} \quad I_d(\hat{y}) = 1, \\
1 & \text{if} \quad O_1(\hat{y}) \leq \min\{\gamma y + B, y\} \quad \text{and} \quad I_d(\hat{y}) = 0, \\
0 & \text{if} \qquad \text{otherwise}
\end{cases}
\tag{2.3.1}
$$

The maximum contractual obligation that is repaid under the optimal repayment strategy, by definition, is the sovereign's *willingness-to-pay*; it depends both on the true state and the announced state, and is increasing in the costs of repudiation– the economic cost γ, and the political cost B.

Repudiation leads to a deadweight loss, as creditors do not recover any payment if the sovereign repudiates. Contracts that are repaid almost surely at the repayment stage are called repudiation-proof. Formally, a contract, (O_1, I_d), is said to be *repudiation proof* if and only if:

$$
\mathbb{P}\left(\{y \in T \mid \hat{y}(y) \text{ is such that } r(y, \hat{y}(y)) = 0\}\right) = 0
$$

were $\hat{y}(y)$ is the sovereign's chosen announcement in state y under the given contract. Repudiation proofness is necessary for optimality, as the following proposition shows.

Proposition 2.3.1. *An optimal contract must be repudiation-proof.*

Proof. Consider an optimal contract, (O_1, I_d) and suppose it is not repudiation-

proof. Then consider a new contract, $(\tilde{O}_1, \tilde{I}_d)$, given by

$$
\tilde{O}_1(y) = \begin{cases} \min\{\gamma y + b, y\} & \text{for } \{y \in T \mid \hat{y}(y) \text{ such that } I_d = 1 \text{ and } r = 0\} \\ \min\{\gamma y + B, y\} & \text{for } \{y \in T \mid \hat{y}(y) \text{ such that } I_d = 0 \text{ and } r = 0\} \\ O_1(y) & \text{for } \{y \in T \mid \hat{y}(y) \text{ such that } r = 1\} \end{cases}
$$

and $\tilde{I}_d \equiv I_d$. Note that the new contract is repudiation-proof by construction, and leaves the sovereign with identical announcement incentives. It follows that, under the new contract, the sovereign receives the same payoff in all states, while creditors receive a higher expected payment, which contradicts the optimality of the initial contract. □

The proposition is intuitive: an optimal contract avoids the deadweight loss of repudiation by respecting the sovereign's willingness-to-pay constraints. Note that the standard debt contract is, in general, not repudiation-proof.[16]

At the announcement stage, the sovereign can lie about her income; she will if lying leads to a lower repayment. I check that the the contract, (O_1, I_d), is carried out as specified. If the announcement is such that the contract calls for an audit (i.e. $I_d(\hat{y}) = 1$), then creditors observe the true state, and the contractual obligation is set at $O_1(y)$; thus, I need only check that the sovereign has no incentive to falsely claim that her income is $\hat{y}$, with $I_d(\hat{y}) = 0$.

Let $W(y, \hat{y})$ denote the sovereign's date 1 payoff if her true income is y, while she announces $\hat{y}$ for which $I_d(\hat{y}) = 0$, so

$$
W(y, \hat{y}) := y - O_1(\hat{y}) + B
$$

If the sovereign reveals the true state y, her date 1 utility is

$$
y - O_1(y) + S(y, y)
$$

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[16]Under standard debt, the contractual obligation exceeds the sovereign's willingness-to-pay with positive probability, except for $\gamma = 1$.

A contract then is said to satisfy *truthful state revelation* if and only if: for any states y and $\hat{y}$ such that $I_d(\hat{y}) = 0$, we have $W(y, \hat{y}) \leq y - O_1(y) + S(y, y)$. Announcing a false state is unprofitable if a contract satisfies truthful state revelation; the structure imposed is given in the following lemma.

Proposition 2.3.2. *A contract (O_1, I_d) satisfies truthful state revelation if and only if there is a constant D such that (i) $O_1(y) = D$, whenever $I_d(y) = 0$; and (ii) for any y and $\hat{y}$ such that $I_d(\hat{y}) = 0$, $I_d(y) = 1$, we have $O_1(y) \leq O_1(\hat{y}) - (B - b)$.*

Proof. If (i) and (ii) hold, the sovereign cannot do better than truthfully reveal her income at the announcement stage. To see that (i) and (ii) are necessary, suppose $O_1(y)$ is not constant for unaudited states; then, the sovereign has an incentive to announce the unaudited state that results in the lowest repayment, contradicting truthful state revelation. Likewise, suppose condition (ii) is violated; then, there exists y and $\hat{y}$ with $I_d(\hat{y}) = 0$ and $I_d(y) = 1$, such that $O_1(y) > O_1(\hat{y}) - (B - b)$. This implies that the sovereign strictly prefers to announces $\hat{y}$ instead of y, again a contradiction. $\qquad\square$

Condition (i) of the lemma ensures that the sovereign has no gain from announcing a different state if the actual realisation remains unaudited. Condition (ii) of the lemma ensures that the sovereign has no gain from announcing an unaudited state if the actual realisation calls for an audit. She may be tempted to do so to avert the loss of private benefit that is associated with an audit, i.e., to avert the loss of $(B - b)$.

An optimal contract, (O_1, I_d), solves

$$\max_{(O_1, I_d)} E\left(y + S(y, \hat{y})\right) - g$$

such that

$$E O_1(y) \geq g \qquad\qquad (2.3.2)$$

and

$$O_1(y) \leq \min\{\gamma y + B, y\} \quad \text{for } y \in \{x | I_d(x) = 0\} \qquad (2.3.3)$$

$$O_1(y) \leq \min\{\gamma y + b, y\} \quad \text{for } y \in \{x | I_d(x) = 1\} \qquad (2.3.4)$$

and there is a constant D such that

$$O_1(y) = D \quad \text{for } y \in \{x | I_d(x) = 0\} \qquad (2.3.5)$$

$$O_1(y) \leq D - (B - b) \quad \text{for } y \in \{x | I_d(x) = 1\} \qquad (2.3.6)$$

An optimal contract maximises the sovereign's expected utility subject to the investor participation constraint and four incentive constraints: two repudiation proofness constraints, and two truthful revelation constraints. It is easy to show that the participation constraint of the investor must bind at an optimum, or $EO_1 = g$.[17] The maximisation problem reveals that the sovereign wishes to finance the government expenditure, while maximising the private benefit of holding office. To characterise the solution, I introduce a new type of contract: the sovereign debt contract. A contract is said to be a *sovereign debt contract* if and only if

(i)   for some D, we have $O_1(y) = D$ if $I_d(y) = 0$;

(ii) $I_d(y) = 1$ if and only if $D > \min\{\gamma y + B, y\}$; and

(iii) $O_1(y) = \gamma y + b$ if $I_d(y) = 1$.

The sovereign debt contract specifies: (i) a fixed payment, or face value; (ii) disclosure if and only if the willingness-to-pay falls short of the face value; and (iii) a payment equal to the remaining creditor punishment threat in case of disclosure, also see figure 2.3.2.[18] Sovereign debt contracts are repudiation-proof, they satisfy truthful state revelation, and they are uniquely characterised by their face value. The following proposition shows that an optimal contract must be a

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[17] If the participation constraint does not bind, then $P_1(y)$ can be decreased such that the participation constraint of the investor, and truthful state revelation, remain satisfied. The resulting increase in expected utility for the sovereign, contradicts optimality.

[18] In the graph shown, the political cost of auditing equals the political cost of repudiation, its upper bound.

sovereign debt contract.

Proposition 2.3.3. *Let (O_1, I_d) be an optimal contract, then (O_1, I_d) is a sovereign* debt contract.

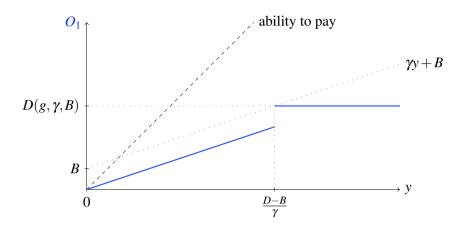*Proof.* See the Appendix. □

Figure 2.3.2: Payment of sovereign debt contract as a function of income

Intuitively, the sovereign debt contract is optimal because it (i) economises on the costs of auditing, and (ii) is never repudiated. While costly audits serve to establish the sovereign's ability-to-pay, repudiation leads to a pure deadweight loss. The sovereign debt contract is repaid at face value in high income states, where the sovereign's willingness-to-pay is also high; in low income states, where the sovereign's willingness-to-pay is also low, the sovereign debt contract specifies a public audit and an output-contingent payment.

Compared to standard debt, the fixed repayment feature is retained in the sovereign debt contract. The audit decision differs; in particular, there is an audit whenever the willingness-to-pay of the sovereign falls below a threshold. Finally, the sovereign debt contract does not specify maximum recovery for states that are audited. Rather, the amount that is recovered in audit states equals the punishment

that creditors can inflict. For the boundary case, $\gamma = 1$, the sovereign debt contract coincides with standard debt. The intuition is that the willingness-to-pay problem poses no constraint if repudiation leads to a loss of the full budget. For the more plausible cases, with $\gamma < 1$, the payment of the sovereign debt contract is discontinuous at the audit threshold, i.e., at $y = \frac{D-B}{\gamma}$. The payment discontinuity ensures that the sovereign reveals her budget truthfully in all states.

The primitives of the contracting problem are (i) the private benefits of holding office, B and b (ii) the proportion of output that is lost if the sovereign repudiates, γ (iii) the government expenditure need g, and (iv) the distribution and support of income y, i.e. $F(y)$ and $T \subseteq \mathbb{R}_+$. To gain intuition for the existence problem, consider the contracting problem under symmetric information. With symmetric information, the only remaining friction is the willingness-to-pay problem and the scope for inefficiency is extreme: either the expenditure can be financed and the first-best is achieved, or there is no contract with which the expenditure can be financed. To see this, note that with symmetric information there is no need for costly auditing, and the sovereign can pledge a maximum of $\gamma y + B$ in each state, as long as the budget constraint is satisfied. Expected pledgeable income therefore equals

$$E\left(\min\{\gamma y + B, y\}\right) \tag{2.3.7}$$

If pledgeable income exceeds the expenditure (g), then the first-best can be achieved and the optimal contract is indeterminate; if the expenditure exceeds pledgeable income, then no contract allows the sovereign to finance the expenditure. The example shows that the primitives of the problem can be such that the sovereign is not able to finance the expenditure with any contract. In particular this is the case if creditors have little power to punish repudiation ($\gamma \ll 1$), or if the government expenditure is high ($g \gg 0$).

2.4   Sovereign Debt Contract

An individual investor who holds a sovereign debt contract, (O_1, I_d), expects a repayment of

$$EO_1 = \gamma \int_0^{D-B/\gamma} yf(y)dy + D \int_{D-B/\gamma}^{\infty} f(y)dy \qquad (2.4.1)$$

Simple comparative statics show that

Proposition 2.4.1. *The expected repayment of a sovereign debt contract with a given face value D, is increasing in creditor power, γ, and in the private benefit of holding office, B.*

The proposition is intuitive. An increase in the economic cost of repudiation, γ, increases the sovereign's willingness-to-pay in all states. An increase in political cost of repudiation, B, also increases the sovereign's willingness-to-pay, but only in unaudited states.[19]

Consider the primary market for sovereign debt, i.e. the market at the date of issuance. The main question at date 0 is whether the sovereign can finance g. She can't if creditors have too little power or if the government expenditure is too high (cf. section 2.3.2). Proposition 2.4.1 then implies that an increase in B may lift the sovereign out of autarky; likewise, an increase in γ can leave the sovereign debtor better off. . For the primary market, the model predicts that the sovereign should find it easier to raise funds from powerful creditors, meaning that the sovereign pays a lower interest rate on a loan of given size. After the date of issuance, sovereign debt contracts trade in a secondary market, where their *market value* equals expected creditor repayment.[20]

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[19]In disclosed states, the political audit cost is sunk and only the threat of creditor punishment deters the sovereign from repudiation.

[20]Formally, there is no secondary market in my model, as investors are homogeneous. Trade can easily be introduced, however, by assuming exogenous liquidity shocks. That the market value equals expected repayment follows from investor risk neutrality. It follows from investors' participation constraint that the market value at date 0 equals g.

Different events may move the secondary market price, or implied interest rate, of the sovereign debt contracts. Suppose, for example, that the government announces an audit at time 1, cf. timing of events in section 3.2. Then creditors will observe the state of the economy as information on the economy comes available. This may not be immediate. By contrast any market response will be immediate. As soon as the government announces the audit, the market value drops to

$$E(O_1|I_d = 1) = \gamma \int_0^{D-B/\gamma} yf(y)dy$$

where $f(y)$ is the probability density function. When creditors learn about y, the market value converges to γy.[21]

Another event of interest is a change of government before the repayment stage. Within the framework of the model, there are two channels through which a change in government can effect the market value of outstanding debt:

1. a change in the private benefit B (willingness-to-pay channel) ; or

2. a change in the distribution, F, and support ,T, of ability-to-pay y (competence channel) .

Suppose a new government takes office that is understood to be more competent than its predecessor as to collecting taxes, undertaking structural reforms, and privatising state property. Then the probability of a high income state increases and so does the market value of outstanding debt.[22] The opposite happens if a new government takes charge that is perceived to be less competent than its predecessor. Likewise, suppose a government takes over that is known to be highly committed to avoid a public audit (high B), then the market will view this favourably and the market value of outstanding debt increases. A new government that is per-

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[21]Learning about y can, for example, be modelled as a narrowing of the support of y.

[22]Any market response must run through expectations of investors, as there is not yet a realisation of y.

ceived as less committed to pay the debt at face value (low *B*) leads to a decline in the market value of outstanding debt.

Finally, one may consider the impact of changes in γ and *B* in the secondary market. If changes take place before date 1, then the effect is given by proposition 2.4.1. Hence the market value of the sovereign debt contract increases with an increase in either γ or B.[23]

2.5 Alternative Repayment Game

I consider an alternative repayment game, in which a debt crisis is followed by a debt renegotiation, as in Bolton and Jeanne (2009). In the original formulation, there is no need to renegotiate the initial contract, as the contract specifies the course of action in each contingency. The alternative view, explored here, is that the contract cannot be explicitly conditioned on the state of the world, even if creditors observe that state. The repayment game, at time $t = 1$, is as follows:

1. Nature chooses the state *y*, sovereign observes *y* ;

2. **Announcement:** Sovereign announces her ability-to-pay $\hat{y}$,

    (a) if $I_d(\hat{y}) = 1$, investor observes *y*, and a debt renegotiation starts;

    (b) if $I_d(\hat{y}) = 0$, then contractual obligation is $O_1(\hat{y})$.

3. In case of a debt renegotiation, coordinated creditors make a repayment offer η. Otherwise, the contract binds both parties to $O_1(\hat{y})$.

4. **Payment:** Sovereign makes a repayment decision $r \in \{0, 1\}$,

    (a) she pays and the game ends ($r = 1$), or

    (b) she repudiates and creditors charge a punishment ($r = 0$).

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[23]Note that both an increase in γ and an increase in *B* destroy truthful state revelation of the contract that was initially issued: the sovereign pays *D* even in states where the contract calls for an audit. Indeed, this is the reason why the market value increases.

If the sovereign announces a state that is not audited, then the contractual obligation, $O_1(\hat{y})$, is binding for all parties. If instead there is an audit, then creditors make a repayment offer η for which they are willing to swap the initial contract and lift repudiation sanctions; but, creditors can only make the offer if they manage to coordinate. Formally, there is a coordination cost c_R, incurred by creditors if they make an offer η. As the renegotiation surplus equals γy, creditors cannot be coordinated if the income realisation is too low, or $\gamma y < c_R$. In such states, no renegotiation takes place, creditors receive 0, and the sovereign suffers the economic and political cost of repudiation. If creditors can coordinate, i.e., $\gamma y \geq c_R$, then the creditor offer follows from solving the repayment game backwards along the public audit branch. Because the sovereign accepts any offer $\eta \leq \gamma y$, creditors set their offer at $\eta = \gamma y$, and receive a net payment of $\gamma y - c_R$.

I assume that creditors can either coordinate at no cost ($c_R = 0$); or creditors cannot coordinate at all ($c_R = \infty$). These assumptions are made to capture, in a stylised way, the difference between debt that is held by a handful of banks that find it easy to coordinate; and debt that is held by dispersed bondholders that cannot be coordinated, also see Bolton and Jeanne (2009).

If creditors can coordinate at no cost, then introducing the debt renegotiation is equivalent to setting the contractual obligation in audited states equal to $O_1(y) = \gamma y$ in the original specification of the model; thus, the contracting problem becomes a special case of section 2.3.2: the set of admissible contracts is restricted.[24] By proposition 2.3.3, the optimal contract is a sovereign debt contract; furthermore, a sovereign debt contract is admissible as it satisfies $O_1(y) = \gamma y$ for audited states. It follows that proposition 2.3.3 applies, so that

Proposition 2.5.1. *For $c_R = 0$ and $\gamma = 1$, the optimal contract is standard debt contract; for $c_R = 0$ and $\gamma < 1$ the optimal contract is a sovereign debt contract.*

Proof. Let $c_R = 0$ and $\gamma = 1$ and assume that an optimal contract exists. Then, by proposition 2.3.3, the optimal contract is a sovereign debt contract. As $\gamma = 1$, the

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[24]Stage 3 can be collapsed into Stage 2a of the original repayment game, by setting $O_1(y) = \gamma y$ for audited states (cf. section 3.2).

sovereign debt contract coincides with the standard debt contract; If $c_R = 0$ and $\gamma < 1$, and there exists an optimal contract, then the optimal contract is a sovereign debt contract by proposition 2.3.3. $\qquad\square$

Proposition 2.5.1 shows that the optimal contract is a sovereign debt contract. The conditions for the existence of an optimal contract are the same as in section 2.3.2, i.e. g cannot be too big, and γ cannot be too small. Proposition 2.5.1 also shows that renegotiable debt, as in Bolton and Jeanne (2009), is optimal if creditor coordination is costless ($c_R = 0$), and if creditor punishment is maximal ($\gamma = 1$).

If creditors cannot coordinate at all, then no renegotiation can take place and an audit leads to the same payoff as repudiation: creditors receive 0; the sovereign incurs a loss of γy, and loses her private benefit B. In an optimal contract, the payment to creditors in undisclosed states must compensate for the zero payment to creditors in all other states.[25] Furthermore, the contract must specify a constant contractual obligation across states. Any other contract leaves the sovereign with an incentive to announce the state with the lowest contractual obligation and cannot satisfy truthful revelation. Let D denote the constant contractual obligation, or face value, of the optimal contract. Then expected payment is given by

$$EO_1 = D \int\limits_{\{y|D<\min\{\gamma y+B,y\}\}} f(y)dy$$

The sovereign only pays the debt at face value in states where her willingness-to-pay exceeds the debt's face value D. If creditor punishment is maximal, or $\gamma = 1$, then the willingness-to-pay of the sovereign equals her ability-to-pay. It follows that expected repayment is given by

$$EO_1 = D \int\limits_{D}^{\infty} f(y)dy$$

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[25]Note that this implies that the conditions for existence of an optimal contract are more stringent than before.

and the optimal contract corresponds to non-renegotiable debt as in Bolton and Jeanne (2009). If creditor punishment is less than maximal, or $\gamma < 1$, then the willingness-to-pay of the sovereign is smaller than her ability-to-pay and repayment is a political decision; expected repayment is

$$EO_1 = D \int\limits_{\frac{D-B}{\gamma}}^{\infty} f(y)dy$$

which corresponds to non-renegotiable debt à la Bolton and Jeanne (2009), but with a repudiation threshold that depends on creditor power, and on the private benefit of holding office. The following proposition summarises the discussion above.

Proposition 2.5.2. *For $c_R = \infty$ and $\gamma = 1$, the optimal contract corresponds to non-renegotiable debt; for $c_R = \infty$ and $\gamma < 1$ the optimal contract is a non-renegotiable debt contract with a repudiation threshold of $\frac{D-B}{\gamma}$.*

Proof. Omitted □

2.6 Conclusion

In this chapter, I analyse the problem of credit extension to a a sovereign borrower given that (i) there is no court, (ii) the sovereign knows better than creditors what her repayment capacity is, and (iii) disclosure of that information is politically costly. Recent events in Greece show the relevance of these issues: creditors did not have accurate information on the state of government finances and sovereign debt contracts proved difficult to enforce. In this setting, positive repayment is sustained by an economic and political penalty associated with repudiation; and by a political penalty associated with disclosure. These three penalties drive the optimal contract design.

I show that the sovereign borrower optimally issues a contract for which (i) the repayment profile is flat in high income states; (ii) there's a state contingent

payment that depends on creditor power in low income states; and (iii) there is an audit (or disclosure) if the willingness-to-pay falls short of the *face value* of the contract.

The intuition for the optimal contract is that it saves on costly auditing, which is what the corporate finance literature has emphasised. The optimal contract itself, however, is different from what the corporate finance literature has found: it is still a debt contract, but the default decision and the repayment in case of default differ from standard debt due to the willingness-to-pay problem.

The optimal contract I derive explains some of the salient facts of sovereign borrowing. First, a sovereign's ability-to-pay is not the relevant constraint when it comes to repayment. It is the willingness-to-pay that determines repayment, and the willingness-to-pay depends jointly on the budget, creditor power, and the private benefit of holding office. Second, the payment to creditors depends on their power to punish repudiation. The most powerful creditor is the International Monetary Fund (IMF); historically, the IMF takes priority over all other creditors. The upshot is that, even if rates on IMF loans are lower than on other loans, IMF lending is not concessionary. Third, the sovereign chooses to issue plain bonds. A priori, this is puzzling, as Shleifer (2003) and others have argued. Why don't sovereign borrowers issue contracts that condition on future income? Such contracts are not optimal, because the auditing requirements would be prohibitively costly.

The current work can be extended and complemented in several directions. Empirically, the cross-sectional implications of the model should be taken to the data. In particular, do shifts in political power or ultimate holdings of sovereign debt lead to the secondary price responses that the model predicts? The theory can be extended to develop a fully dynamic model of sovereign debt; a model that endogenizes the cost of repudiation and allows the study of repayment and refinancing decisions in one framework.

References

ATKESON, A. (1991): "International Lending with Moral Hazard and Risk of Repudiation," *Econometrica*, 59(4), 1069–1089.

——— (2005): *And the Money Kept Rolling In (and Out)*. Public Affairs, New York.

BOLTON, P., AND O. JEANNE (2007): "Structuring and Restructuring Sovereign Debt: The Role of a Bankruptcy Regime," *Journal of Political Economy*, 115(6), 901–924.

——— (2009): "Structuring and Restructuring Sovereign Debt: The Role of a Seniority," *Review of Economic Studies*, 76, 879–902.

BORDER, K. C., AND J. SOBEL (1987): "Samurai Accountant: A Theory of Auditing and Plunder," *Review of Economic Studies*, 54, 525–540.

BORENSZTEIN, E., AND P. MAURO (2004): "The case for GDP-indexed bonds," *Economic Policy*, 19(38), 165–216.

BORENSZTEIN, E., AND U. PANIZZA (2009): "The Costs of Sovereign Default," IMF Staff Papers 56, International Monetary Fund.

——— (1989a): "A Constant Recontracting Model of Sovereign Debt," *Journal of Political Economy*, 97(1), 155–78.

——— (1989b): "Sovereign Debt: Is to Forgive to Forget?," *American Economic Review*, 79(1), 43–50.

COLE, H. L., AND P. J. KEHOE (1998): "Models of Sovereign Debt: Partial versus General Reputations.," *International Economic Review*, 39(1), 55 – 70.

DIAMOND, D. W. (1984): "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, 51, 393–414.

DÍAZ-CASSOU, J., A. ERCE, AND J. J. VÁZQUEZ-ZAMORA (2008): "The Role of the IMF in Recent Sovereign Debt Restructurings: Implications for the Policy of Lending into Arrears.," Occasional Paper 805, Bank of Spain.

EATON, J., AND R. FERNANDEZ (1995): "Sovereign Debt," NBER Working Papers 5131, National Bureau of Economic Research.

EATON, J., AND M. GERSOVITZ (1981): "Debt with Potential Repudiation: Theoretical and Empirical Analysis," *Review of Economic Studies*, 48(2), 289–309.

FERNANDEZ, R., AND R. W. ROSENTHAL (1990): "Strategic Models of Sovereign-Debt Renegotiations," *Review of Economic Studies*, 57(3), 331–349.

GALE, D., AND M. HELLWIG (1985): "Incentive-Compatible Debt Contracts: The One-Period Problem," *Review of Economic Studies*, 52, 647–663.

——— (1989): "Repudiation and Renegotiation: The Case of Sovereign Debt," *International Economic Review*, 30(1), 3–25.

GROSSMAN, H. I., AND J. B. VAN HUYCK (1988): "Sovereign Debt as a Contingent Claim: Excusable Default, Repudiation, and Reputation," *American Economic Review*, 78(5), 1088–97.

GUEMBEL, A., AND O. SUSSMAN (2009): "Sovereign Debt without Default Penalties," *Review of Economic Studies*, 76(4), 1297–1320.

HART, O., AND J. MOORE (1998): "Default and Renegotiation: A Dynamic Model of Debt," *the Quarterly Journal of Economics*, 113, 1–41.

HELLWIG, C., AND G. LORENZONI (2009): "Bubbles and Self-Enforcing Debt," *Econometrica*, 77(4), 1137–1164.

HVIDE, H. K., AND T. E. LEITE (2010): "Optimal Debt Contracts under Costly Enforcement," *Economic Theory*, 44(1), 149–165.

INNES, R. D. (1990): "Limited Liability and Incentive Contracting with Ex-ante Action Choices," *Journal of Economic Theory*, 52, 45–67.

KLETZER, K. M., AND B. D. WRIGHT (2000): "Sovereign Debt as Intertemporal Barter," *American Economic Review*, 90(3), 621–639.

KRASA, S., AND A. P. VILLAMIL (1994): "Optimal Multilateral Contracts," *Economic Theory*, 4(2), 167–187.

——— (2000): "Optimal Contratcs when Enforcement is a Decision Variable," *Econometrica*, 68, 119–134.

MOOKHERJEE, D., AND I. PNG (1989): "Optimal Auditing, Insurance and Redistribution," *Quarterly Journal of Economics*, 104, 399–415.

REINHART, C. M., AND K. S. ROGOFF (2009): *This Time is Different: Eight Centuries of Financial Folly*. Princeton University Press, Princeton and Oxford.

SACHS, J., AND D. COHEN (1982): "LDC Borrowing with Default Risk," Working Paper 925, NBER.

SANDLERIS, G. (2008): "Sovereign Defaults: Information, Investment and Credit," *Journal of International Economics*, 76(2), 267–275.

SHLEIFER, A. (2003): "Will the Sovereign Debt Market Survive?," *American Economic Review Papers and Proceedings*, 93(2), 85–90.

STURZENEGGER, F., AND J. ZETTELMEYER (2006): *Debt Defaults and Lessons from a Decade of Crises*. MIT Press, Cambridge.

TOWNSEND, R. M. (1979): "Optimal Contracts and Competitive Markets with Costly State Verification," *Journal of Economic Theory*, 21, 265–293.

WORRALL, T. (1990): "Debt with potential repudiation," *European Economic Review*, 34(5), 1099–1109.