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Sovereign Debt Restructurings: Delays in Renegotiations and Risk Averse Creditors*

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Abstract

Foreign creditors' business cycles influence both the process and the outcome of sovereign debt restructurings. We compile two datasets on creditor committees and chairs and on creditor business and financial cycles at the restructurings, and find that when creditors experience high GDP growth, restructurings are delayed and settled with smaller haircuts. To rationalize these stylized facts, we develop a theoretical model of sovereign debt with multi-round renegotiations between a risk averse sovereign debtor and a risk averse creditor. The quantitative analysis of the model shows that high creditor income results in both longer delays in renegotiations and smaller haircuts. Our theoretical predictions are supported by data.

JEL Classification Codes: F34, F41, H63

Key words: Sovereign Debt; Sovereign Default; Sovereign Debt Restructuring; Delays in Negotiations; Risk Averse Creditor.

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1 Introduction

Foreign creditors' business cycles influence both the process and the outcome of sovereign debt restructurings. We compile two new datasets on creditor committees and chairs and on creditor business and financial cycles at the debt restructurings with private external creditors. Our datasets show that when foreign creditors experience high GDP growth, restructurings are delayed and settled with smaller net present value (NPV) haircuts and face value reductions. To rationalize these stylized facts, we develop a theoretical model of defaultable debt that explicitly embeds multi-round debt renegotiations between a risk averse sovereign debtor and a risk averse creditor. The quantitative analysis of the model shows that when creditor income is high, restructurings are delayed and settled with smaller haircuts. Our theoretical predictions are supported by data: a calibration exercise for the Argentine default and restructuring in 2001–05.

First, the paper presents two new datasets on (a) the creditor committee and chairs and (b) the creditor business and financial cycles at the time of debt restructurings with private external creditors (179 episodes over 1978–2010). On the first data, we compile a dataset on the creditor committees—normally comprised of groups of 5–20 representative creditors (mostly banks)—and appointed chairs—often the debtors' largest creditor or creditor who had chaired the last debt negotiation—based on multiple of different sources (e.g., Trebesch 2011). Our dataset shows a new stylized fact: formal creditor committees are formed in 131 restructuring episodes (73% of total episodes) and chairs are appointed by the debtors in 121 episodes (68% of total episodes).

On the second data, we also code two new datasets on business and financial cycles of both creditor chairs and committee members built on our dataset on the creditor chairs and Trebesch (2011) on the creditor committee members, respectively at the same sample of sovereign debt restructurings over 1978–2010. These datasets are comprised of three series; (a) real GDP growth rates; (b) risk premium on bank lending; and (c) bank interest spreads. All three series are measured as both average during and levels at the end of restructurings separately relying on duration data in Asonuma and Trebesch (2016).

Our datasets on business and financial cycles of both creditor chairs and committee members show three additional stylized facts: When creditors experience high GDP growth, restructurings: (i) are protracted i.e., have longer delays, (ii) result in lower haircuts, and (iii) have lower face value reductions. We confirm these findings through both cross-sectional and panel regressions using 111 post-default restructuring episodes.

These empirical facts unveil a new dimension of sovereign defaults and debt restructurings which the literature has not fully explored yet. In particular, two new questions emerge: Why are restructurings delayed when the creditors experience high GDP growth? And why are agreed haircuts low when the creditors have high GDP growth? These questions challenge the current understanding in the literature that the creditors' negotiation stance remains unchanged during debt restructurings. To our knowledge, we are the first to shed light on the influence of the creditors' business and financial cycles—reflecting changes in the creditors' negotiation stance—on the process and the outcome of debt restructurings.

To achieve this goal, we develop a theoretical model of sovereign debt with endogenous defaults and multi-round debt renegotiations with a risk averse sovereign debtor and its risk averse creditor.[1] The basic structure of the model follows closely the recent quantitative analysis of sovereign debt—built on the classic setup of Eaton and Gersovitz (1981)—for instance, Aguiar and Gopinath (2006), Arellano (2008), and Tomz and Wright (2007). We assume a small open economy model with a risk averse creditor and access to the segmented international capital market (reasonable debtor country size) as in Aguiar et al. (2016) and Lizarazo (2013). In our model, the creditor's surplus at the renegotiations is endogenously determined. This differs from *no creditor's surplus* at the renegotiations in a small open economy model with the risk averse creditor and *zero debtor country size* (Borri and Verdelhan 2011)—there is no feedback effect of defaults and restructurings on the creditor's consumption.

What differentiates our model from standard models with multi-round renegotiations is the incorporation of multi-round bargaining between a risk averse sovereign debtor and a risk averse creditor. We explicitly depart from the conventional assumption of risk-neutral creditors without income uncertainty who face a fixed outside option, as in Benjamin and Wright (2013) and Bi (2008). At each period, both the sovereign and the creditor face stochastic income processes. After observing the income processes, the sovereign chooses to repay the debt in full or to default. When a default occurs, the debtor and the creditor negotiate over the unpaid debt via multi-round bargaining. At the renegotiations, one party chooses whether to propose an offer with haircuts (recovery rates) or to pass its option. The other party decides whether to accept the proposal or to reject the offer. If the offer with haircuts is proposed and accepted, then the sovereign resumes access to the segmented international capital market in the next period and the creditor receives the recovered debt payments. Otherwise, both parties continue to renegotiate the debt in arrears.

The key feature in our model is that the risk averse creditor decides whether to complete the exchange with the proposed haircuts or postpone the settlement by comparing the utility value from receipt of the recovered debt payments to his outside options, i.e., utility value from postponing the settlement. What determines the creditor's choice is the state-dependent consumption-smoothing motive through the recovered debt payments. The creditor negotiation stance in our model differs substantially from that in models with risk-neutral creditors where they are keen only on the recovery rates, but not on the timing of settlement. This is because under risk neutrality the creditors' surplus depends only on the debtor's repayment capacity i.e., its income process, but not on the creditors' state (Benjamin and Wright 2013; Bi 2008).

With this novelty, the model provides deeper understanding on the role of the risk averse creditor both on the process and the outcome of the restructurings: high creditor income results in both longer delays in renegotiations and smaller haircuts. When the creditor has high income,

[1]We focus on the situations where creditors have long-term relationships with sovereign debtors, as in the London Club restructuring and Brady bond restructuring eras (late-1970s, 1980s, and 1990s). Creditors were constantly allocating a large portion of wealth to domestic investment opportunities and a fixed and (relatively) limited portion to sovereign countries.

he is less eager to recoup losses on the defaulted debt for his consumption-smoothing purpose (i.e., has low marginal utility of consumption from recovered debt payments) in the current round of negotiations. Moreover, an outside option for the creditor, defined as the utility value associated with the expected recovery rates in the future period, remains high since his high income is anticipated to persist. As a result, the creditor requests only recovery rates in the current round which are high enough to be comparable to the high expected recovery rates in the next round. This makes it difficult to reach an agreement with the debtor, who suffers the costs of default in the current period resulting in delays. Otherwise, the debtor with recovered repayment capacity—in line with Benjamin and Wright (2013) and Bi (2008)—has no option but to accept high recovery rates (small haircuts) if it prefers to settle the deal in the current period expecting to avoid further output costs and financial exclusion.

An additional insight of the model is that the sovereign is more willing to default ex-ante due to its lower default costs—driven by both a quick settlement and high haircuts—, ceteris paribus, when the creditor income is low. Our mechanism of willingness to default through renegotiations differs from an increase in borrowing costs driven by time-varying risk aversion (Borri and Verdelhan 2011).

Our theoretical predictions that debt restructurings are delayed and settled with low haircuts when the creditor income is high are supported by data. The quantitative exercise applied to the Argentine default and restructuring in 2001–05 replicates moment statistics that match with the data. The model predicts (i) positive correlations between creditor income and duration/recovery rates, (ii) further delays driven by high creditor income, and (iii) low likelihood of debt settlement and low haircuts at high creditor income—all are novel contributions of our model—as observed in the data.

Literature Review Our paper is similar to theoretical work on sovereign debt restructurings that models the outcome of default and debt renegotiation as a bargaining game between a sovereign debtor and its creditors.[2] In particular, our paper is closely related to Benjamin and Wright (2013), Bi (2008), and Bai and Zhang (2012) which embed a multi-round bargaining game to analyze delays in renegotiations.[3] Both Benjamin and Wright (2013) and Bi (2008) explain that delays can be beneficial for both parties in that they allow the debtor to recover from a crisis first and make more resources available to settle the renegotiation. In contrast,

[2]See Bulow and Rogoff (1989), Kovrijnykh and Szentes (2007), Yue (2010), Arellano et al. (2013, 2017), D'Erasmo (2011), Hatchondo et al. (2014), Asonuma and Trebesch (2016), Pitchford and Wright (2012), Fernandez and Martin (2014), Sunder-Plassmann (2018), Asonuma (2016), and Asonuma and Joo (2018). See also survey by Aguiar and Amador (2014) and Aguiar et al. (2016).

[3]Arellano et al. (2017) focus on simultaneous restructurings of multiple risk averse sovereign debtors negotiating with common risk averse creditors. They model a one-round bargaining game between multiple sovereign debtors and the creditors. An outside option of the creditors negotiating with one sovereign varies endogenously through payment returns on the other sovereign's debt, in particular whether the other sovereign is paying or defaulting/negotiating with the creditors. In contrast, our model assumes a multi-round bargaining game between a "single" sovereign debtor and the risk averse creditor, and an outside option of the creditor, which is the utility value associated with expected recovery rates in the future periods. Our modeling approach is consistent with the observed stylized fact on longer delays in renegotiations at high creditors' GDP growth.

Bai and Zhang (2012) show that delays arise due to information asymmetry between the debtor and its creditors. This paper contributes to the literature by explaining an additional channel of delays driven by the creditor's state-dependent consumption-smoothing motive.

The second stream of literature studies sovereign debt and risk averse creditors. Among previous studies, Aguiar et al. (2016), Borri and Verdelhan (2011), and Lizarazo (2013) show that the creditors' risk aversion allows the model to generate spreads larger than default probabilities, as observed in emerging market countries.[4] Arellano et al. (2017) analyze contagion in a model in which multiple borrowers trade with common risk averse lenders. Our paper fills a gap in the literature by exploring how the risk averse creditor's state-dependent consumption-smoothing motive influences both the process and the outcome of debt restructurings.

The paper also contributes to empirical literature on sovereign debt restructurings.[5] On private external debt restructurings, Benjamin and Wright (2013) first document a new perspective on the relationship between restructuring delays and haircuts, and Asonuma and Trebesch (2016) show that preemptive restructurings have much shorter duration (delays) and lower haircuts. Cruces and Trebesch (2013) show that restructurings involving higher haircuts are associated with significantly higher subsequent bond yield spreads and longer periods of capital market exclusion. The current paper differs from the existing literature in that we find new stylized facts on the creditor committees and chairs, and on the creditors business and financial cycles in private external debt restructurings.

[4]See Broner et al. (2013), Pouzo and Presno (2016), Gu (2016), and Tourre (2017).

[5]See Sturzenegger and Zettlemeyer (2006, 2008), Reinhart and Rogoff (2009, 2011), Panizza et al. (2009), Kaminsky and Vega-Garcia (2016), Das et al. (2012), and Gelos et al. (2011). See also Diaz-Cassou et al. (2008), Finger and Mecagni (2007), Duggar (2013), and Erce (2013) for recent country case studies.

2 Data, and Empirical Findings

2.1 New Data on Creditor Committees, Chairs, and Representatives

A restructuring episode is triggered by a default on debt payments or the announcement of a debt restructuring. The debtor embarks on some forms of negotiation with its creditors either bilaterally or with the assistance of advisors. The negotiation can take months or even years and both parties review the debtor's macroeconomic situation, proposed adjustments, and financing. The creditors assess the debtor's repayment capacity over the medium term and evaluate their expected recovery rates (haircuts) on the defaulted debt in the form of total portfolio returns. During negotiations, the debtor usually proposes indicative scenarios and the creditors express their views. At the end, the debtor presents a final restructuring proposal, i.e., an exchange offer, to the creditors. The creditors decide to accept or reject the offer.

In this regard, Ecuador's debt buyback in 2008–09 is a representative episode in which the creditors' business and financial cycles—as well as political stance of the debtor government (Levy-Yeyati 2011)—played a critical role in their negotiations (Buchheit and Gulati 2009; Porzecanski 2010). In November 2008, President Correa announced that upcoming coupon payments totaling US$31 million on the 2012 bonds would be skipped. A formal default on the foreign debt was declared in December 2008. In April 2009, Ecuador launched a cash buyback offer to repurchase two series of defaulted bonds. The buyback was successfully completed in June 2009. In fact, Ecuador's debt buyback took place amidst the global financial crisis and creditors who were suffering losses from the crisis, had little appetite for holding the distressed bonds. As a consequence, Ecuador succeeded in a quick settlement with the creditors (a duration of 7 months relative to an average of 48 months) despite its post-default restructuring strategy, which resulted in large creditor losses (a haircut of 68%).

Focusing specifically on creditors, at the start of negotiation, a "creditor committee chair" is appointed by the debtor to organize a "creditor committee"—alternatively called a bank advisory committee. Following conventional practice rather than its preference, the debtor often selects its largest creditor or the same creditor who chaired the last debt negotiation (Lomax 1986; Rieffel 2003; Das et al. 2012). Once selected, the creditor committee chair(s) invites other creditors (mostly banks) to participate on the committee. The selection of members is governed by nationality as well as exposure—banks from every major creditor country have at least one seat at the table. Generally, each creditor on the committee is responsible for obtaining cooperation from a specific group of small creditors not represented on the committee. The creditor committee and its chair(s) play a crucial role—by no means a symbolic one—in the restructuring process. The committee has the decision power over the terms of the restructuring, i.e., whether to accept, alter, and reject the debtor's proposed offer to creditors, and the timing of the launch of exchanges. The chair(s) is often instrumental in reaching an agreement over these matters, typically in consultation with the creditor committee's legal and financial advisors (Buchheit 2009, DeSieno 2016).

The literature on sovereign debt restructurings provide further empirical support of the aforementioned statements. Sturzenegger and Zettlemeyer (2006) and Trebesch (2011) report restructuring cases—e.g., Moldova 2001–04 and 2002, Bolivia 1980–88, Vietnam 1982–97—where creditors with the largest exposure to the sovereign debtors were selected as creditor chairs. Asonuma et al. (2017, 2018a, 2018b) document that in recent restructuring episodes—e.g., Belize 2012–13 and 2016–17, Grenada 2004–05 and 2013–15—creditor committees accepted, altered, and rejected the authorities' proposed offers to creditors, and decided the timing of the launch of the exchanges.

To explore the role of foreign creditors in restructurings, we first need to identify whether creditor committees or representations are formed, whether creditor chairs (co-chairs) are appointed, and who are the nominated chairs (co-chairs) during negotiations. For this, we code a new dataset on creditor committees, representatives, and chairs at private external debt restructurings over 1978–2010.[6]

Our data on creditor committees and chairs comprise mainly four sources; (i) a comprehensive dataset on creditor committees for debt restructurings in 1978–2010 from Trebesch (2011) covering 98 episodes (55% of total 179 episodes), (ii) a comprehensive dataset on creditor committees under the Bank Advisory Committee (London Club) process from Rieffel (2003) and Lomax (1986) covering 73 and 32 episodes, respectively (41% and 18% of total episodes), (iii) a dataset on creditor committees for debt restructurings in 1999–2010 from Das et al. (2012) covering 18 episodes (10% of total episodes); and (iv) case studies of debt restructurings from Sturzenegger and Zettlemeyer (2006), Buchheit (2009), and Asonuma et al. (2017, 2018a) covering 5 episodes (3% of total episodes).

- ***Stylized fact 1: Creditor committees are formed and chairs are appointed in almost 75% and 67% of sovereign debt restructurings, respectively.***

We find that formal creditor committees are formed in 130 debt restructuring episodes (73% of total 179 episodes) over 1978–2010 as reported in Table 1. Among these cases, creditor committee chairs were appointed in 118 cases (66% of total episodes). An additional aspect of evidence emerges from Table 1; US banks have served as creditor committee chairs for 59 restructurings, close to a half of restructurings with appointed chairs. European banks have covered 41 restructurings, equivalent to a third of the episodes with chairs. Among them, German, UK and French banks account for 15, 13 and 10 cases, respectively. Table A1 in Appendix A reports creditor committees, chairs, and representatives for all 179 debt restructurings.

[6] The most desirable approach is to code a new dataset on detailed creditor composition, i.e., a list of all creditors and the amount of debt they hold. However, in almost all debt restructuring episodes from 1978–2010, neither creditors nor debtors publicly disclosed such information.

Table 1. Creditor committees, chairs, and representatives at sovereign debt restructurings, 1978–2010.

	Observation	Share
Restructurings with creditor committees	**130**	
Restructurings with appointed creditor committee chairs[a]	**118**	
US banks	58.7	50%
European banks	41.0	35%
German banks	15.0	13%
UK banks	12.5	11%
French banks	10.3	9%
Dutch banks	2.2	2%
Swiss banks	1.0	1%
Canadian banks	8.5	7%
Japanese banks	6.0	5%
Others	3.8	3%
Restructurings without appointed creditor committee chairs	**12**	
with creditor representatives	3	
Restructurings without creditor committees	**49**	
with creditor representatives	2	
Total	**179**	

Sources: Asonuma and Trebesch (2016, restructurings) and Cruces and Trebesch (2013, restructurings)
Notes: a. For episodes with multiple chairs, we assign symmetric weights to all chairs which add up to 1.

2.2 New Data on Creditor Business and Financial Cycles at Sovereign Debt Restructurings

To understand the influence of foreign creditors on both the process and the outcome of debt restructurings, we next explore explicitly the creditors' negotiation stances both during and at the end of restructurings. For this purpose, we also code two new datasets on business and financial cycles of both creditor chairs and committee members built on our dataset on creditor chairs and Trebesch (2011)'s dataset on creditor committee members, respectively at the same sample of sovereign debt restructurings over 1978–2010.

Our two datasets on business and financial cycles of creditor chairs and committee members are comprised of three series; (i) real GDP growth rates; (ii) risk premium on bank lending—bank lending rates minus short-term Treasury bill interest rates (both in nominal terms); (iii) bank interest spreads—bank lending rates minus deposit rates (both in nominal terms). All three series are measured both during and at the end of restructurings separately relying on duration data in Asonuma and Trebesch (2016). They define duration of restructurings as the number of months from the start of distress (default or announcement of a restructuring) until the completion of the debt restructuring process (debt exchange). Given a lack of comprehensive data on creditors' balance sheet, i.e., firm-level data at a monthly frequency over the period of 1978–2010, we rely on enriched data at country (aggregate) level where creditors are located.

To define these series, we follow conventions in the literature on credit and business cycles (Kollmann et al. 2011; Iacoviello 2015). First, economy-wide real GDP growth rates—commonly considered as growth rates of the private sector—are a proxy for the expected return on banks' lending which is positively associated with banks' wealth. Second, both risk premium on bank lending and bank interest spreads are measures of banks' financial conditions in that high interest spreads (or risk premium on bank lending) reflect the loss of bank net worth and signal the unwillingness of banks to lend credit. These, in turn, depress investment and the economic activity. Exploring more specifically on the creditor risk appetite, we also apply Gilchrist and Zakrajsek (2012) excess bond premium only available for the US—a component in corporate bond spreads capturing risk-bearing capacity of the financial sector—for robustness check in Appendix B.4.

Our datasets on creditor business and financial cycles are coded from mainly five sources: (a) quarterly real GDP growth rates for creditor countries over 1978–2010 from the IMF World Economic Outlook (WEO); (b) monthly bank lending rates and deposit rates for creditor countries over 1978–2010 from the IMF International Financial Statistics (IFS), central banks and ministry of finance of the creditors; (c) monthly short-term Treasury bill rates for creditor countries over 1978–2010 from the IMF IFS, financial sector databases (Bloomberg, Datastream, and JP Morgan Markit), (d) duration dataset from Asonuma and Trebesch (2016); (e) data on creditor chairs and committee members from our dataset and Trebesch (2011).

Both datasets on business and financial cycles of the creditor chairs and committee members have strengths and weaknesses. On the one hand, the creditor chair business and financial cycle dataset has a large coverage of restructuring episodes—all business and financial cycle series (both average during duration and levels at the end of restructurings) that cover at least 112 episodes (63% of total 179 episodes)—, while limited coverage of committee members—only representatives of the creditor committees—(range of 1–3 creditors with 1.4 on average). On the other hand, the creditor committee member business and financial cycle dataset has a detailed composition of creditor committee members (range of 4–22 members with 10.4 on average), while limited coverage of restructuring episodes (55 episodes, 31% of total episodes). Tables 2 and A2 in Appendix B.1 summarize key moment statistics in these two datasets, respectively. Means and medians of these series do not differ indicating zero skewness of the distribution.

Furthermore, we merge our new datasets with existing data on duration of restructurings, haircuts, and face value reductions (both from Cruces and Trebesch 2013)—all reported as memo items in Table 2. As defined in Sturzenegger and Zettelmeyer (2008), the haircut is the market value of the new instruments, plus any cash payments received, to the net present value of the remaining contractual payments on the old instruments (inclusive of any principal or interest arrears) using the yield of the new instrument. In contrast, the face value (nominal) reduction is the difference in the face value between new instruments and the remaining old instruments at the exchange.

Table 2. Creditor chair business and financial cycles for sovereign debt restructurings, 1978–2010.

	Observation	Mean	Median	Std Dev.	Observation	Mean	Median	Std. Dev.
	Average over duration[a]				Levels at the end of restructurings[b]			
Creditor chair GDP growth rates (%)[c]	116	3.1	3.1	1.5	114	3.3	3.3	1.9
Creditor chair risk premium on bank lending (%)[d]	112	2.4	2.2	1.3	113	2.6	2.4	1.5
Creditor chair bank interest spreads (%)[e]	112	2.7	2.2	1.5	113	2.8	2.6	1.7
Memo Item:								
GZ US excess bond premium (%)[f]	104	0.10	0.10	0.31	134	0.01	-0.04	0.42
Duration of restructurings (months)	179	41.0	18.7	51.8				
Haircuts (%)	178	36.7	31.7	27.2				
Face value reductions (%)	178	16.5	0.0	30.3				

Notes: a. Monthly average over duration of restructurings.
b. Levels (at a monthly frequency) at the end of restructurings.
c. We transform quarterly creditor chair GDP growth rate series into series at a monthly frequency given a lack of comprehensive monthly series covering the whole sample period.
d. Risk premium on bank lending is the interest rate charged by banks on loans to prime private sector customers minus the interest rate at which short-term government securities are issued or traded in the market.
e. Bank interest spreads is the difference in borrowing and lending rates of banks in nominal terms.
f. Gilchrist and Zakrajsek (2012) excess bond premium for US financial firms.

2.3 New Empirical Findings on Sovereign Debt Restructurings

We focus on post-default restructurings—the government defaults first and renegotiates its debt later. Asonuma and Trebesch (2016) find post-default restructurings account for 62% of total episodes (111 cases) over 1978–2010, while preemptive exchanges—negotiations take place prior to a payment default—account for 38% (68 cases).

Our finding for 1978–2010 can be summarized in three main stylized facts with creditor chair business and financial cycle dataset (below) and with creditor committee member business and financial cycle dataset (Appendix B.1).

- ***Stylized fact 2: Restructurings are protracted when the creditors have high income.***

Figure 1 shows a scatter plot of the creditor chair GDP growth rates—measured as an average during restructurings and the duration of restructurings. The correlation between duration and average GDP growth rates is strong, with an upward-sloping fitted line which indicates that the restructurings are protracted when the creditor chair income is high.

Table 3 provides econometric support for this stylized fact. It reports results of cross-sectional regression of the duration on the creditor chair business and financial cycles as well as the debtors' macroeconomic variables and other controls:

$$Duration_i = c + \beta Creditor\_BFC\_Ave_i + Z_i\gamma^{'} + \epsilon_{i,1} \tag{i}$$

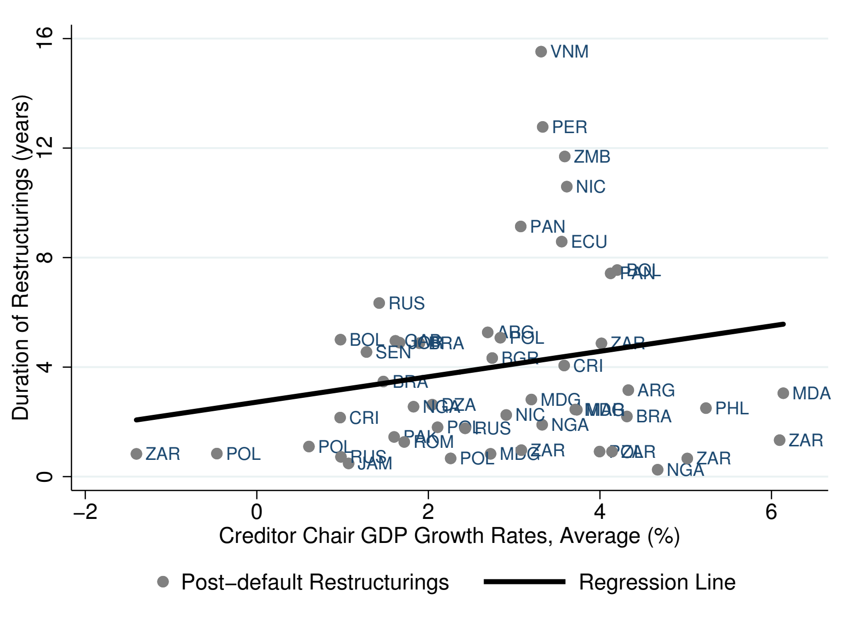


FIGURE 1. Duration and creditor chair GDP growth rates for sovereign debt restructurings, 1978–2010. The figure plots post-default restructuring observations where creditor chair business and financial cycles for restructurings are available. Figure A2 in Appendix B.3 plots post-default restructuring observations differentiated by main creditor chairs.

Here, $Duration_i$, denotes duration of debt restructuring i; $Creditor\_BFC\_Ave_i$ denotes the creditor chair business and financial cycles measured as average during the restructurings i, reflecting the influence over the entire duration; Z_i is a vector of other controls. It is comprised of (i) the debtors' macroeconomic variables—GDP deviation from the trend obtained by applying a Hodrick-Prescott (H-P) filter, external debt-to-GDP ratio, export-to-debt service ratio (both at the end of restructurings), and a dummy variable for an IMF-supported program—; (ii) a global variable e.g., London Interbank Offered Rate (LIBOR), and (iii) a restructuring method variable such as a dummy variable for bond exchanges. For the choice of these controls, we follow the empirical literature on sovereign defaults and debt restructurings, particularly Kohlscheen (2010), Trebesch (2011), Bai and Zhang (2012), and Asonuma (2016).

The main result in Table 3 is that an improvement of the creditor chair business and financial cycles (according to GDP growth rates, risk premium on bank lending, and bank interest spreads) significantly leads to a longer duration of restructurings—quantitatively, a 1% increase in average GDP growth rates during renegotiations results in an increase in duration by 7.7 months on average. Columns (1)–(3) also reveal the effects of other controls which are in line with the aforementioned studies. Restructurings are protracted when external debt is high and sovereign debtors have ample liquidity, i.e., a high export-to-debt service ratio (Trebesch 2011). The debtors' GDP deviation from the trend at the end of restructurings is shown to negatively influence the duration of restructurings (Bi 2008; Benjamin and Wright 2013), but it is insignificant. Both global liquidity tightening and official financing—proxied by an increase in LIBOR and the approval of an IMF-supported program—lead to significantly shorten the duration of restructurings. Bond restructurings result in shorter duration (Bai and Zhang 2012), but the coefficient is insignificant. The effect of the creditor chair business and financial cycles on duration is approximately the same under the cases where the US excess bond premium—a commonly-used proxy for the creditor risk appetite—is applied and we deal with outliers in the sample of duration and creditor GDP growth rate observations as reported in Table A8 in Appendix B.4.

Table 3. Cross-sectional regression results on duration of restructurings—creditor chairs.

	Duration of restructurings (months)		
	(1)	(2)	(3)
	Creditor chair GDP growth rates, average (%)	Creditor chair risk premium on bank lending, average (%)	Creditor chair bank interest spreads, average (%)
	coef/se	coef/se	coef/se
Creditor chair GDP growth rates, average (%)[a]	7.65**	-	-
	(3.76)		
Creditor chair risk premium on bank lending, average (%)[a]		-6.81*	-
		(3.94)	
Creditor chair bank interest spreads, average (%)[a]	-	-	-7.51**
			(3.23)
Debtor GDP deviation from trend, end (%)[b,c]	-0.17	0.04	-0.71
	(0.82)	(0.77)	(0.68)
External debt, end (% of GDP)[b]	0.28**	0.18	0.10
	(0.13)	(0.13)	(0.11)
Export/debt service ratio, end (%)[b]	5.87***	1.82	1.87
	(2.16)	(2.13)	(1.84)
LIBOR 12-month, end (%)[b]	-1.32	-5.82***	-5.85***
	(1.37)	(1.96)	(1.68)
IMF-supported program, end (dummy)[d]	-21.38*	-16.26	-19.48**
	(12.0)	(10.69)	(9.26)
Bond restructurings (dummy)[e]	-18.56	-17.33	-19.74
	(25.54)	(23.71)	(20.23)
Contant	-	107.30***	115.36***
		(26.54)	(24.07)
Sample	49	48	47
Adj-R^2	0.58	0.27	0.32
Root MSE	39.9	35.5	30.6

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is duration of restructurings (months). The main explanatory variables are creditor chair GDP growth rates, risk premium on bank lending—lending rates minus T-bill interest rates—, and bank interest spreads—lending rates minus deposit rates. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses. A smaller sample of observations (47–49 episodes) than a sample of post-default restructurings (111 episodes) is due to availability of creditor chair business and financial cycles for restructurings (112–116 out of 179 episodes) as reported in Table 1.
a. Monthly average over duration of restructurings.
b. Levels (at a monthly frequency) at the end of restructurings.
c. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.
d. A dummy for an IMF-supported program is set to 1 when an IMF-supported program is approved at the year of completion of debt restructurings and 0 otherwise.
e. A dummy for bond restructurings is set to 1 if a restructuring is a bond exchange.

- ***Stylized fact 3: Haircuts are smaller when creditors have high income.***
- ***Stylized fact 4: Face value reductions are smaller when creditors have high income.***

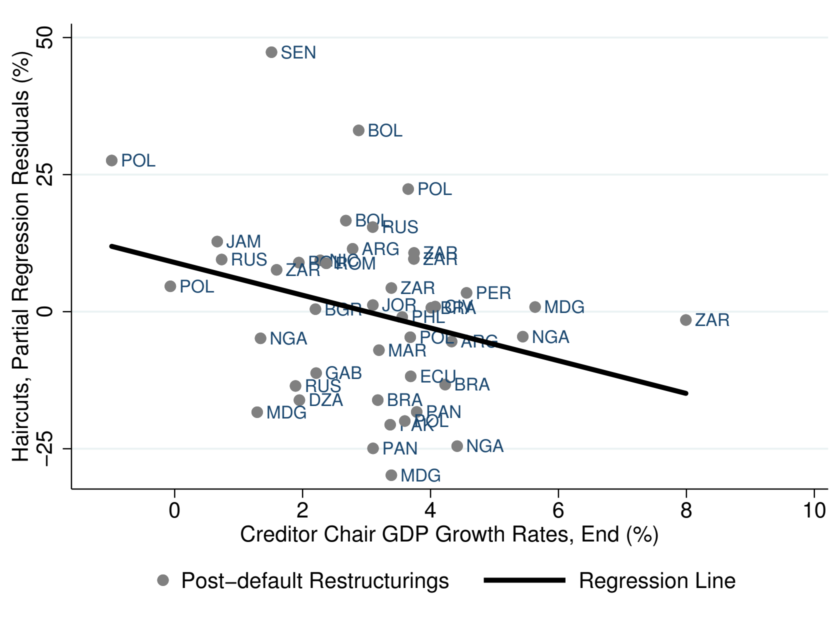


FIGURE 2. Haircuts and creditor chair GDP growth rates for sovereign debt restructurings, 1978–2010. The figure plots post-default restructuring observations where creditor chair business and financial cycles for restructurings are available. Figure A3 in Appendix B.3 plots post-default restructuring observations differentiated by main creditor chairs.

Figure 2 shows a scatter plot of haircuts and the creditor chair GDP growth rates—measured at the end of restructurings. The vertical axis indicates fractions of haircuts that are not explained by other variables e.g., duration of restructurings, the debtors' macroeconomic and global variables etc. The correlation between creditor chair GDP growth rates and haircuts is negative—as shown by a downward fitted line—and strong. This implies that agreed haircuts are smaller when the creditor chair income is high.

We also find a similar pattern for face value reductions. Figure A1 in Appendix B.2 follows the same presentation approach as in Figure 2 and shows a negative correlation between face value reductions and the creditor chair GDP growth rates—measured at the end of restructurings. Indeed, agreed face value reductions are smaller when the creditor chair income is high.

Table 4 and Table A6 in Appendix B.2 provide econometric support for these stylized facts. These tables report results of cross-sectional regressions of the haircuts and face value reductions on the creditor chair business and financial cycles as well as the debtors' macroeconomic variables and other controls:

$$Haircut_i = c + \beta Creditor\_BFC\_End_i + Z_i\gamma' + \epsilon_{i,2} \quad \text{(ii)}$$

$$FV\_Reduction_i = c + \beta Creditor\_BFC\_End_i + Z_i\gamma' + \epsilon_{i,3} \quad \text{(iii)}$$

Here, $Haircut_i$ and $FV\_Reduction_i$ denote haircut and face value reduction agreed at the debt restructuring i; $Creditor\_BFC\_End_i$ denotes the creditor chair business and financial cycles measured at the end of restructuring i reflecting the influence at the settlement; Z_i is a vector of other controls which now includes the duration of restructurings, the debtor per capita GDP in US dollars, and a dummy variable reflecting a change in the IMF's lending paradigm.[7] For the choice of first two variables, we follow the empirical literature on sovereign debt restructurings (Benjamin and Wright 2013).

The main result in Table 4 is that an improvement of the creditor chair business and financial cycles (according to GDP growth rates, risk premium on bank lending, and bank interest spreads) at the settlement reduces haircuts. The effect is significant at the 1 or 5% level, and quantitatively large: a 1% increase in GDP growth rates at the settlement results in a reduction of haircuts by 4.2%. The effects of other controls shown in columns (1)–(3) are in line with findings in the empirical literature. Restructurings with long duration remarkably result in high haircuts (Benjamin and Wright 2013). Haircuts are significantly reduced when external debt is low, repayment capacity—proxied by the debtor per capita GDP in US dollars and debtor GDP deviation from trend—is high, or when the sovereign has ample liquidity (Trebesch 2011). Both global liquidity tightening and official financing reduce haircuts though the coefficients are insignificant. Haircuts are lower when a restructuring is a bond exchange or has been completed after 1989—a change in the IMF's lending paradigm—though the coefficients are insignificant. The effect of the creditor chair business and financial cycles on haircuts is approximately the same under cases where the US excess bond premium is applied and we deal with outliers in the sample of haircut and creditor GDP growth rate observations as reported in Table A9 in Appendix B.4.

Similarly, the main result in Table A6 in Appendix B.2 is that an improvement of the creditor chair business and financial cycles at the settlement substantially reduces face value reductions. This effect is significant, quantitatively large and similar to that on haircuts: a 1% increase in GDP growth rates results in face value reductions by 4.1%. The effects of other controls shown in columns (1)–(3) are the same with those in the regression results on haircuts. Moreover, the effect of the creditor chair business and financial cycles on face value reductions is approximately the same under the cases where the US excess bond premium is applied and outliers in the sample of GDP growth rate observations are dealt as reported in Table A10 in Appendix B.4.

[7] The IMF Executive Board approved its policy on external payment arrears to private creditors ("IMF policy on lending into arrears to private creditors") in May 1989 (IMF 2017).

Table 4. Cross-sectional regression results on haircuts—creditor chairs.

	Haircuts (%)		
	(1)	(2)	(3)
	Creditor chair GDP growth rates, end (%)	Creditor chair risk premium on bank lending, end (%)	Creditor chair bank interest spreads, end (%)
	coef/se	coef/se	coef/se
Creditor chair GDP growth rates, end (%)[a]	-4.23**	-	-
	(2.06)		
Creditor chair risk premium on bank lending, end (%)[a]		4.74***	-
		(1.51)	
Creditor chair bank interest spreads, end (%)[a]	-	-	4.83***
			(1.61)
Duration of restructurings (years)	0.25***	0.18**	0.23**
	(0.09)	(0.09)	(0.09)
Debtor GDP deviation from trend, end (%)[a,b]	-0.48	-0.11	0.02
	(0.36)	(0.38)	(0.40)
Debtor per capita US$ GDP, end (thousand US$)[a]	-5.80*	-0.13	-0.12
	(2.94)	(2.26)	(2.30)
External debt, end (% of GDP)[a]	0.04	0.21***	0.20***
	(0.08)	(0.06)	(0.06)
Export/debt service ratio, end (%)[a]	-1.29	-0.30	-0.28
	(1.13)	(1.08)	(1.10)
LIBOR 12-month, end (%)[a]	-2.15	-	-
	(2.02)		
LIBOR 12-month, average (%)[c]	1.97	-	-
	(2.10)		
IMF-supported program, end (dummy)[d]	-6.80	-2.64	-3.10
	(5.99)	(5.83)	(5.93)
Bond restructurings (dummy)[e]	-4.57	-8.51	-5.40
	(12.34)	(12.38)	(12.43)
Post-1989 IMF lending regime (dummy)[f]	-4.11	2.92	-2.00
	(9.40)	(7.75)	(7.86)
Contant	54.92**	-	-
	(26.65)		
Sample	43	45	45
Adj-R^2	0.29	0.84	0.84
Root MSE	17.6	18.5	18.7

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is haircuts (%). The main explanatory variables are creditor chair GDP growth rates, risk premium on bank lending—lending rates minus T-bill interest rates—, and bank interest spreads—lending rates minus deposit rates. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses. A smaller sample of observations (43–45 episodes) than a sample of post-default restructurings (111 episodes) is due to availability of creditor chair business and financial cycles for restructurings (112–116 out of 179 episodes) as reported in Table 1.

a. Levels (at a monthly frequency) at the end of restructurings.

b. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

c. Monthly average over duration of restructuring.

d. A dummy for an IMF-supported program is set to 1 when an IMF-supported program is approved at the year of completion of debt restructurings and 0 otherwise.

e. A dummy for bond restructurings is set to 1 if a restructuring is a bond exchange.

f. A dummy for post-1989 IMF lending regime is set to 1 if a restructuring is completed after a change in the IMF lending paradigm in 1989.

Lastly, to confirm these stylized facts, we apply multinominal logit and poisson models with our panel dataset. The unbalanced panel is comprised of post-default restructurings over the duration of each episode, i.e., from the start of the restructurings to the completion of exchanges. Following the original classification in Asonuma and Trebesch (2016), we treat two restructuring events separately when one sovereign debtor is negotiating with different creditors over different debt instruments. In this regard, our panel includes the overlapping periods of restructurings for the sovereign debtor.

As in the empirical analysis in Asonuma and Trebesch (2016), we construct our data at an annual frequency, due to the data availability of GDP growth rates and debt for the restructuring countries. Our dependent variables are a binary variable for debt settlement—1 for completion and 0 otherwise—and haircuts—non-zero haircuts (in %) for completion and 0 otherwise. A set of explanatory variables is comprised of creditor chair GDP growth rates, the sovereign debtor GDP growth rates, and public and publicly guaranteed (PPG) external debt (in % of GDP).

The first main result in Table 5 is that high creditor chair GDP growth rates reduce the likelihood of settlement in the same year (columns 1–1')—quantitatively, a 1% increase in current creditor chair GDP growth rates reduces the probability of settlement by 3.2%. The second main result concerns the reduction of agreed haircuts by the creditor chair GDP growth rates (columns 2–2')—quantitatively, a 1% increase in current creditor chair GDP growth rates reduces the agreed haircuts by 4.0%. Moreover, restructurings are more likely to be completed when PPG external debt remains at a low level and the debtors experience high GDP growth rates (columns 1–1'). In contrast, both PPG external debt and debtor GDP growth rates enter with a counter-intuitive sign in poisson regression on the haircuts (columns 2–2'). These coefficients capture two effects in opposite signs; the negative effect of these variables on the likelihood of settlement—captured by logit regression on the settlement in columns 1–1' in Table 5—seem to dominate the positive effect of these variables on the haircuts conditional on the settlement—captured by cross-sectional regression results on haircuts in Table 4.

Similarly, the main result in Table A7 in Appendix B.2 is that high creditor chair GDP growth rates also reduce the face value reductions—quantitatively a 1% increase in current creditor chair GDP growth rates reduces the agreed face value reductions by 3%.

In summary, our panel logit and poisson regression results support the cross-sectional regression results on duration, haircuts and face value reductions in Tables 3, 4 and A6: debt restructurings are delayed and settled with low haircuts and face value reductions when creditor chair GDP growth rates are high.

Table 5. Panel logit and poisson regression results on debt settlement and haircuts.

	Debt settlement (binary)		Haircuts[a]	
	(1)	(1')	(2)	(2)'
	coef/ se	dy/dx / Delta-method se	coef/ se	dy/dx / Delta-method se
Creditor chair GDP growth rates, current (%)	-0.106***	-0.032***	-0.248***	-0.040***
	(0.041)	(0.012)	(0.081)	(0.014)
PPG external debt, lagged (% of GDP)[b]	-0.007**	-0.002***	-0.027***	-0.004***
	(0.002)	(0.0005)	(0.004)	(0.0005)
Debtor GDP growth rates, current (%)	0.032**	0.010**	0.031	0.005
	(0.016)	(0.005)	(0.031)	(0.005)
Episode-specific fixed effects	No		No	
Number of episodes	54		54	
Number of observations	259		259	
χ^2	66.39		107.86	
(p-value)	(0.000)		(0.000)	
Log-likelihood ratio	-136.1		-93.21	

Notes: The table shows results from random effects multinomial logit and poisson regressions. The dependent variables are debt settlement (binary) for logit and haircuts for poisson regressions, respectively. The main explanatory variable is creditor chair GDP growth rates in current year. PPG external debt (in % of GDP) is lagged by one year. Debtor GDP growth rates are in current year. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively. Robust standard errors in parentheses.
a. Haircuts are measured as 1=100% and set as 0 if there is no settlement.
b. Public and publicly guaranteed external debt. Lagged level in terms of GDP.

3 Theoretical Model

3.1 Summary of Theoretical Findings

Our theoretical model is built for exploring on the role of the creditor on restructuring process and outcome. In particular, our model of sovereign debt embeds post-default multi-round renegotiations with a risk averse sovereign debtor and a risk averse creditor, and generates the aforementioned stylized facts. To account for different economic situations of sovereign debtors and creditors, we take a two-step theoretical approach. First, we use a conventional small open economy model—in line with Aguiar et al. (2016) and Lizarazo (2013)—as benchmark and derive main qualitative results in Section 3, 4, and 5. Then, we incorporate each of the specific assumptions used in previous studies (Arellano et al. 2017; Benjamin and Wright 2013; Borri and Verdelhan 2011) in our framework and show robustness of our model in Appendix C.

The model provides main implications on the role of the risk averse creditor on both the process and the outcome of restructurings: high creditor income results in both longer delays in renegotiations and smaller haircuts. A key novelty of our model is that the creditor's state-dependent consumption-smoothing motive through recovered debt payments influences his decisions during renegotiations. When the creditor has high income, he is less eager to recoup losses on defaulted debt for his consumption-smoothing purpose (i.e., low marginal utility of consumption from recovered debt payments) in the current round of renegotiations. Moreover, an outside option for the creditor, defined as the utility value associated with the expected recovery rates in the future period, remains high since his high income is anticipated to persist. As a result, the creditor only requests recovery rates in the current round which are high enough to be comparable to the high expected recovery rates in the next round. This makes it difficult to reach an agreement with the debtor, who suffers the costs of default in the current period resulting in delays. Otherwise, the debtor with recovered repayment capacity—in line with Benjamin and Wright (2013) and Bi (2008)—has no option but to accept high recovery rates (small haircuts) if it prefers to settle the deal in the current period expecting to avoid further output costs and financial exclusion.

3.2 Assumptions in the Model

A risk averse sovereign government makes consumption and borrowing decisions on behalf of the households in a small open economy facing a fluctuating income stream. The economy is small relative to the rest of the world in that the sovereign's decisions do not affect the world risk-free interest rate (r^*). However, the sovereign accesses the segmented international capital market in that it can only borrow from a representative risk averse creditor also facing income fluctuation—his borrowing/lending decisions do not influence the world interest rate.

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \qquad E_0 \sum_{t=0}^{\infty} (\beta^*)^t v(c_t^*)$$

where $0 < \beta < 1$ is a discount factor of the sovereign, and $0 < \beta^* < 1$ is a discount factor of the creditor. c_t and c_t^* denote consumptions of two parties in period t, $u(\cdot)$ and $v(\cdot)$ are one-period utility functions, which are continuous, strictly increasing and strictly concave, and satisfy the Inada conditions. The discount factor of the sovereign reflects both pure time preference and probability that the current government will remain in power in the next period (myopia associated with political uncertainty), whereas the discount factor of the creditor captures only pure time preference. Our assumption of the risk averse creditor is similar to the investor behavior in emerging financial markets avoiding sovereign default risk.[8]

In each period, the sovereign has a credit record $h_t \in [0, 1]$ which indicates whether it has maintained access to the market ($h_t = 0$) or whether it has lost market access due to default ($h_t = 1$). In addition, both the sovereign and the creditor receive stochastic endowment streams y_t^h and y_t^f, respectively. We denote y_t, a vector of two income processes: $y_t = [y_t^h, y_t^f]$. It is stochastic, drawn from a compact set $Y = [y_{min}^h, y_{max}^h] \times [y_{min}^f, y_{max}^f] \subset R_+^2$. $\mu(y_{t+1}|y_t)$ is

[8] Lizarazo (2013) explains that the assumption of the risk averse creditor seems to be justified by characteristics of the investors in emerging financial markets. These investors are both individuals and institutional investors such as banks, mutual funds, hedge funds, pension funds, and insurance companies. For individual investors, it is straightforward to assume that they are risk averse. For institutional investors, risk aversion may follow from two sources: regulations over the composition of their portfolio and the characteristics of the institutions' management.

a probability distribution of a vector of shocks y_{t+1} conditional on its previous realization y_t. These goods endowed in two countries are identical and tradable. The sovereign is in current account deficit (surplus),—its consumption is larger (less) than endowment—when it repays debt ($h_t = 0$) and issues new debt (has new savings). On the contrary, when it defaults on its debt repayment and loses market access ($h_t = 1$), it has a balanced current account and its consumption is equal to endowment.

Both sovereign bond and risk-free bond markets are incomplete. On the one hand, the sovereign can borrow and lend only via one-period, zero-coupon sovereign bonds.[9] b_{t+1} denotes the amount of bonds to be repaid in the next period whose set is shown by $B = [b_{min}, b_{max}] \subset R$ where $b_{min} \leq 0 \leq b_{max}$. We set the lower bound for the sovereign's bond holding at $b_{min} > -y^h_{max}/\underline{r}^*$ which is the highest debt that the sovereign can repay. The upper bound b_{max} is the highest level of assets that the sovereign may accumulate.[10] On the other hand, the risk averse creditor can smooth his consumption through borrowing and lending via both one-period, zero-coupon sovereign bonds and risk-free bonds. b^*_{t+1} and b^{*f}_{t+1} express amounts of sovereign bonds and risk-free bonds to be repaid in the next period whose sets are shown by $B^* = [b^*_{min}, b^*_{max}] \subset R$ and $B^{*f} = [b^{*f}_{min}, b^{*f}_{max}] \subset R$ where $b^*_{min} \leq 0 \leq b^*_{max}$ and $b^{*f}_{min} \leq 0 \leq b^{*f}_{max}$, respectively.

All information on both income processes and bond issuance of two parties, and the sovereign's credit record is perfect and symmetric. We assume $q(b_{t+1}, b^{*f}_{t+1}, 0, y_t)$ to be the price of sovereign bonds with the sovereign's debt position b_{t+1}, the creditor's holding of risk-free bonds b^{*f}_{t+1}, the sovereign's credit record ($h_t = 0$), and a vector of income shocks y_t. The price of sovereign bonds is determined in equilibrium. We assume q^f $(= 1/(1 + r^*))$ to be the price of risk-free bonds which the creditor takes as given.

We assume that the creditor always commits to repay its debt. However, the sovereign is free to decide whether to repay its debt or to default. If the sovereign chooses to repay its debt, it will preserve access to the international capital market in the next period. On the contrary, if it chooses to default, it is then subject to both exclusion from the international capital market and direct output costs.[11] When a default occurs, the sovereign and the creditor

[9] Our model of debt restructuring with one-period bonds follows Yue (2010), Benjamin and Wright (2013), and Asonuma and Trebesch (2016). Relaxing the model to include long-duration bonds does not provide additional insights but increases technical difficulty to track the model. This is because old bonds are exchanged with new bonds with the same maturity and smaller outstanding (debt stock), i.e., no change in maturity structure of bonds due to an exchange (Hatchondo et al. 2014). See Hatchondo and Martinez (2009), Arellano and Ramanarayanan (2012), Chatterjee and Eyingungor (2012), and Hatchondo et al. (2016) for long-duration bond models without debt restructuring accounting for high debt-to-GDP ratio.

[10] b_{max} exists when the interest rate on the sovereign's savings is sufficiently low compared to the discount factor, which is satisfied as $(1 + \underline{r}^*)\beta < 1$.

[11] The output cost assumption is justified both theoretically and empirically. First, Mendoza and Yue (2012) provide theoretical micro-foundation of this conventional assumption that exclusion from credit markets leads to losses in production efficiency which result in output costs due to a lack of import inputs and labor reallocation away from final goods production. Second, there are several estimates for output loss at the time of defaults and restructurings in previous empirical studies. Sturzenegger (2004) estimates output loss as around 2% of GDP. Asonuma and Trebesch (2016) support his finding by reporting output costs of 2.4% for post-default restructurings and lower costs for preemptive episodes. In contrast, Levy-Yeyati and Panizza (2011) show that default episodes mark the beginning of the economic recovery and that the negative effects of a default on output are likely to be driven by the anticipation of default prior to the default event.

negotiate over unpaid debt via multi-round bargaining. At the renegotiation, one party who is randomly selected with exogenous and constant probability chooses whether to propose an offer with haircuts (recovery rates) or to pass. The other party decides whether to accept or to reject the proposal. If the offer with haircuts is proposed and accepted, then the sovereign regains access to the international capital market in the next period ($h_{t+1} = 0$) and the creditor receives his recovered debt payments. Otherwise, both parties continue the negotiation over the debt in arrears in the next period.

In order to avoid permanent exclusion from the international capital market and direct costs, the sovereign has an incentive to negotiate over the unpaid debt. Similarly, the creditor is also willing to negotiate over the debt in arrears because he expects non-zero recovered debt payments.

3.3 Timing of the Model

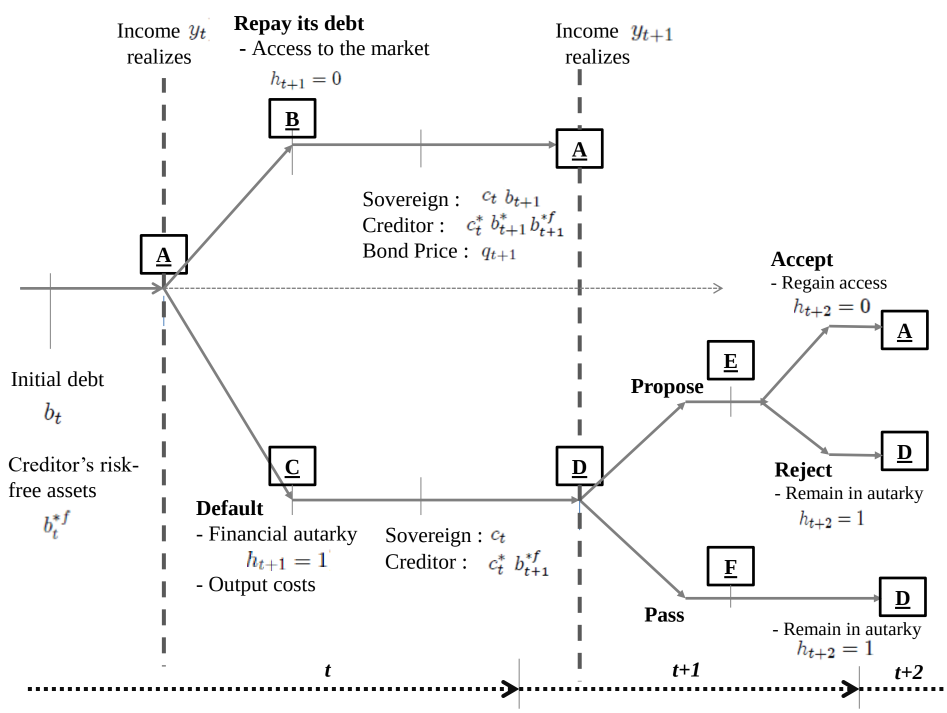


FIGURE 3. Timing of the model.

Figure 3 summarizes the timing of decisions within each period.

1. The sovereign and the creditor start the current period with the sovereign's initial debt (b_t) and the creditor's risk-free assets (b_t^{*f}). We are in node (A).

2. A vector of income shocks (y_t) is realized. The sovereign decides whether to repay its debt or to default after observing the income realization.

3. (a) In node (B) (repayment node), if repayment is chosen, we move to the upper branch of the tree. The sovereign maintains market access ($h_{t+1} = 0$) and chooses its consumption (c_t) and the level of debt in the next period (b_{t+1}). Default risk is determined. The creditor also chooses his consumption (c_t^*) and the levels of sovereign bonds and risk-free bonds in the next period (b_{t+1}^* and b_{t+1}^{f*}). The sovereign bond price is determined in the market. We proceed to node (A) in the next period.

   (b) In node (C) (default node), if default is chosen, we move to the lower branch of the tree. The sovereign suffers output costs ($\lambda_d y_t^h$) and loses access to the international capital market ($h_{t+1} = 1$). The creditor chooses his consumption (c_t^*) and the level of risk-free bonds in the next period (b_{t+1}^{*f}).

4. A vector of income shocks (y_{t+1}) is realized.

5. In node (D) (default node), with constant probability, the sovereign has an opportunity to propose an offer to its creditor. Otherwise, the creditor does. The proposer decides whether to propose an offer or to pass.

6. (a) In node (E) (propose node), if the proposer chooses to propose, the counterpart decides whether to accept or to reject the offer. If the counterpart accepts the offer, the sovereign regains market access in the next period ($h_{t+2} = 0$). We move back to node (A) in the next period. On the contrary, if the counterpart rejects the offer, the sovereign remains in financial autarky ($h_{t+2} = 1$). We move back to node (D) in the next period.

   (b) In node (F) (pass node), if the proposer chooses to pass, the sovereign remains in financial autarky ($h_{t+2} = 1$). We move back to node (D) in the next period.

4 Recursive Equilibrium

4.1 Sovereign's Problem

This section defines the stationary recursive equilibrium of our model. The sovereign maximizes its expected lifetime utility and its value function is denoted by $V(b_t, b_t^{*f}, h_t, y_t)$.

First, we start with its problem when the sovereign has a good credit record ($h_t = 0$).[12] For $b_t \leq 0$ ($h_t = 0$) where the sovereign has debt, it decides whether to repay or to default after observing its income. If the sovereign decides to repay its debt, it chooses its consumption and the level of debt in the next period. In contrast, if it decides to default, it is excluded from the international capital market and its credit record deteriorates to $h_{t+1} = 1$, with debt in arrears $b_{t+1} = (1 + r^*)b_t$ in the next period. Given an option to default,

[12]The case where the sovereign has strictly positive savings ($b > 0$) is excluded. This is because the creditor optimally chooses not to borrow ($b = 0$) from the sovereign when he can purchase risk-free bonds (b^{*f}) and issue debt to the sovereign with the interest rate on debt higher than that on the risk-free bonds simultaneously.

$$V(b_t, b_t^{*f}, 0, y_t) = \max\left[V^R(b_t, b_t^{*f}, 0, y_t), V^D(b_t, b_t^{*f}, 0, y_t)\right] \tag{1}$$

where $V^R(b_t, b_t^{*f}, 0, y_t)$ is its value associated with repayment:

$$\begin{aligned} V^R(b_t, b_t^{*f}, 0, y_t) &= \max_{c_t, b_{t+1}} u(c_t) + \beta \int_Y V(b_{t+1}, b_{t+1}^{*f}, 0, y_{t+1}) d\mu(y_{t+1}|y_t) \\ s.t. \quad & c_t + q(b_{t+1}, b_{t+1}^{*f}, 0, y_t) b_{t+1} = y_t^h + b_t \end{aligned} \tag{2}$$

and $V^D(b_t, b_t^{*f}, 0, y_t)$ is its value associated with default:

$$V^D(b_t, b_t^{*f}, 0, y_t) = u((1-\lambda_d) y_t^h) + \beta \int_Y V^D((1+r^*) b_t, b_{t+1}^{*f}, 1, y_{t+1}) d\mu(y_{t+1}|y_t) \tag{3}$$

The sovereign's default policy can be characterized by its default set $D(b_t, b_t^{*f}, 0) \subset Y$. It is a set of income vectors y_t at which default is optimal:

$$D(b_t, b_t^{*f}, 0) = \left\{ y_t \in Y : V^R(b_t, b_t^{*f}, 0, y_t) < V^D(b_t, b_t^{*f}, 0, y_t) \right\} \tag{4}$$

Next comes the sovereign's problem with a bad credit record and debt in arrears ($h_t = 1$ & $b_t < 0$). The sovereign is currently excluded from the international capital market, suffers output costs, and may settle on recovery rates through renegotiation with the creditor. Its value $V^D(b_t, b_t^{*f}, 1, y_t)$ is an expected payoff that the sovereign obtains from the bargaining which starts in period t:

$$V^D(b_t, b_t^{*f}, 1, y_t) = \Gamma(b_t, b_t^{*f}, y_t) \tag{5}$$

4.2 Foreign Creditor's Problem

We also start with the creditor's problem under the sovereign's good credit record ($h_t = 0$). For $b_t \leq 0$ ($h_t = 0$) where the sovereign has debt, the creditor optimally chooses his consumption (c_t^*), sovereign bonds (b_{t+1}^*), and risk-free bonds (b_{t+1}^{*f}):

$$V^*(b_t, b_t^{*f}, 0, y_t) = \mathbb{1}_{Non-Default} V^{*R}(b_t, b_t^{*f}, 0, y_t) + (1 - \mathbb{1}_{Non-Default}) V^{*D}(b_t, b_t^{*f}, 0, y_t) \tag{6}$$

where $\mathbb{1}_{Non-Default}$ is an indicator function showing 1 if the sovereign does not default and 0 otherwise. $V^{*R}(b_t, b_t^{*f}, 0, y_t)$ is the value of the creditor when the sovereign repays its debt:

$$\begin{aligned} V^{*R}(b_t, b_t^{*f}, 0, y_t) &= \max_{c_t^*, b_{t+1}^*, b_{t+1}^{*f}} v(c_t^*) + \beta^* \int_Y V^*(b_{t+1}, b_{t+1}^{*f}, 0, y_{t+1}) d\mu(y_{t+1}|y_t) \\ s.t. \quad & c_t^* + q(b_{t+1}, b_{t+1}^{*f}, 0, y_t) b_{t+1}^* + q^f b_{t+1}^{*f} = y_t^f + b_t^* + b_t^{*f} \end{aligned} \tag{7}$$

$V^{*D}(b_t, b_t^{*f}, 0, y_t)$ is the value of the creditor when the sovereign defaults:

$$V^{*D}(b_t, b_t^{*f}, 0, y_t) = \max_{c_t^*, b_{t+1}^{*f}} v(c_t^*) + \beta^* \int_Y V^*((1+r^*)b_t, b_{t+1}^{*f}, 1, y_{t+1}) d\mu(y_{t+1}|y_t)$$

$$s.t. \quad c_t^* + q^f b_{t+1}^{*f} = y_t^f + b_t^{*f} \tag{8}$$

Given the sovereign's expected default choice and recovery rates, we obtain the following sovereign bond price function:

$$q(b_{t+1}, b_{t+1}^{*f}, 0, y_t) = \int \beta^* \frac{v'(c_{t+1}^*)}{v'(c_t^*)} \begin{bmatrix} \mathbb{1}_{Non-Default} + \\ (1 - \mathbb{1}_{Non-Default})\gamma(b_{t+1}, b_{t+1}^{*f}, y_{t+1}) \end{bmatrix} d\mu(y_{t+1}|y_t) \tag{9}$$

where $\gamma(b_{t+1}, b_{t+1}^{*f}, y_{t+1})$ is the expected recovery rates at time $t+1$ conditional on default.

For $h_t = 1$ where the sovereign has a bad credit record, the creditor's value $V^{*D}(b_t, b_t^{*f}, 1, y_t)$ is an expected payoff that the creditor obtains from the bargaining which starts in period t:

$$V^{*D}(b_t, b_t^{*f}, 1, y_t) = \Gamma^*(b_t, b_t^{*f}, y_t) \tag{10}$$

4.3 Debt Renegotiation

The debt renegotiation takes the form of a two-player stochastic bargaining game with complete information as in Merlo and Wilson (1995).[13] It is a multi-round stochastic bargaining game in that both the endowment processes of the two parties and the identity of the proposer are stochastic. To account for the creditor's time-variant negotiation stance during debt restructurings in the real world, our model newly assumes the risk averse creditor whose consumption-smoothing motive is state-dependent. This assumption differentiates our paper from previous studies on a multi-round bargaining game (Benjamin and Wright 2013; Bi 2008); in their models, risk-neutral creditors are keen only on the recovery rates, but not on the timing of settlement. This is because the creditors' surplus depends only on the debtor's repayment capacity, but not on the creditors' state. Thus, creditors are willing to wait for the recovery of the debtor's repayment capacity. In contrast, in our framework, the creditor income process influences not only the outcome, but also equally importantly the timing of settlement: when the creditor income is high, he is reluctant to settle the deal and to recoup losses in the current period. Thus, instead he requests higher recovery rates anticipating that the settlement will be postponed and he will receive higher expected recovery rates in the future period. This results in delays in renegotiations since the debtor who suffers costs of defaults cannot meet the requested recovery rates, but postpones the settlement.

In every round, a state is realized and the proposer is randomly selected. For simplicity, we assume that each player has a constant probability of being selected as the proposer in each

[13] Our modeling approach of renegotiation is in line with theoretical studies on delays and inefficiencies in bargaining for instance Merlo and Wilson (1995, 1997), Kennan and Wilson (1993), Yildiz (2004), and Ortner (2013). While there could be other approaches of modeling a bargaining game between two parties, we follow the conventional bargaining game in Merlo and Wilson (1995) for their simplicity and tractability.

round of the negotiation. That is, the identity of the proposer is independent of both parties' income processes. Let ϕ denote the probability that the borrower, B, can propose and $1-\phi$ denote the probability that the lender, L, can propose. The probability with which one of the players is selected as the proposer is a parsimonious way to reflect the bargaining power obtained through one's ability to enjoy the first-mover advantage. The proposer may either propose recovery rates (haircuts) or pass. If he proposes, then the counterpart chooses to accept or to reject the proposal.[14] If the proposal is accepted, then the sovereign debtor immediately repays its reduced debt arrears and resumes access to the international capital market in the next period ($h_{t+1}=0$) with no outstanding debt. If the proposal is rejected, both parties repeat the bargaining game in the next period. If the proposer passes, both parties proceed to the next period and continue the bargaining game.

First, we define some basic concepts of the game. A stochastic bargaining game may be denoted by (C, β, β^*), where for each vector of income processes $y \in Y$, $C(y)$ is the set of feasible utility vectors that may be agreed upon in that state. β and β^* are the discount factors for B and L, respectively.[15] A payoff function is an element $\Delta(y) \in C(y)$, where $\Delta_i(y)$ is the utility to player i, $i = B, L$.

As in Merlo and Wilson (1995), we focus on a game with stationary strategies, that is, the players' actions depend only on the current state $(b_t, b_t^{*f}, h_t, y_t)$ and the current offer. In equilibrium, the proposer's strategy is to propose when the counterpart would accept for certain and to pass otherwise. In contrast, the counterpart's strategy is to accept when the proposal is made and to reject otherwise. Therefore, we can denote the proposer i's and the counterpart j's equilibrium strategies as follows: (a) $\theta_i(b_t, b_t^{*f}, h_t, y_t) = 1$ (propose) when the proposer i proposes and $\theta_j(b_t, b_t^{*f}, h_t, y_t) = 1$ (accept) when the counterpart j accepts the offer, or (b) $\theta_i(b_t, b_t^{*f}, h_t, y_t) = 0$ (pass) when the proposer i passes and $\theta_j(b_t, b_t^{*f}, h_t, y_t) = 0$ (reject) when the counterpart j rejects the offer.[16]

A stationary subgame perfect (SP) equilibrium is defined as the players' equilibrium stationary strategies θ and θ^*, and the payoff functions Γ and Γ^*, associated with these strategies for player B and L. The expected payoffs for the borrower B and lender L in period t, are shown as:

$$\Gamma(b_t, b_t^{*f}, y_t) = \phi\Gamma^B(b_t, b_t^{*f}, y_t) + (1-\phi)\Gamma^L(b_t, b_t^{*f}, y_t) \tag{11}$$

$$\Gamma^*(b_t, b_t^{*f}, y_t) = \phi\Gamma^{*B}(b_t, b_t^{*f}, y_t) + (1-\phi)\Gamma^{*L}(b_t, b_t^{*f}, y_t) \tag{12}$$

[14] We assume that the proposer makes an offer that the counterpart accepts when the value of proposing is higher or equal to the value of passing, and passes otherwise. This assumption can get rid of trivial source of multiplicity. See Merlo and Wilson (1995) and Ortner (2013) for the same treatment.

[15] Merlo and Wilson (1995) assume that the players have the same discount factor. But they also mention that "there is no real restriction implied by the assumption that players discount utility at a common constant rate. So long as the discounted size of the "cake" converges uniformly to 0. $\cdots$ player-dependent discount factors can always be represented by a different cake process with a common fixed discount factor". So in our model we assume that the borrower and the lender have different discount factors.

[16] Benjamin and Wright (2013) theoretically prove both existence and uniqueness of the equilibrium in the multi-round bargaining game over the defaulted debt.

Here the superscript denotes the identity of the proposer: Γ^B (Γ^{*B}) represents the borrower's (lender's) payoff when the borrower is the proposer and Γ^L (Γ^{*L}) refers to the borrower's (lender's) payoff when the lender is the proposer.

First, we start with the case when the borrower B is the proposer. We denote the proposed debt recovery rates as δ_t^B, the borrower's values of proposing and passing as V^{PRO} and V^{PASS}, and the lender's values of accepting and rejecting as V^{*ACT} and V^{*REJ}, respectively. When the borrower B proposes and the proposal is accepted, the sovereign immediately repays reduced debt arrears $-\delta_t^B b_t$ and resumes access to the international capital market in the next period with no outstanding debt as in Bi (2008). Appendix C relaxes the assumption of fully recovered debt payments at the settlement allowing for net issuance as in Benjamin and Wright (2013) and shows that our main qualitative results remain robust.

$$V^{PRO}(b_t, b_t^{*f}, y_t) = u((1-\lambda_d)y_t^h + \delta_t^B b_t) + \beta \int_Y V(0, b_{t+1}^{*f}, 0, y_{t+1}) d\mu(y_{t+1}|y_t) \tag{13}$$

$$\begin{aligned} V^{*ACT}(b_t, b_t^{*f}, y_t) = \max_{c_t^*, b_{t+1}^{*f}} \; & v(c_t^*) + \beta^* \int_Y V^*(0, b_{t+1}^{*f}, 0, y_{t+1}) d\mu(y_{t+1}|y_t) \\ s.t. \quad & c_t^* + q^f b_{t+1}^{*f} = y_t^f - \delta_t^B b_t + b_t^{*f} \end{aligned} \tag{14}$$

When the borrower B passes, both parties proceed to the next period with accumulated arrears $(1+r^*)b_t$.

$$V^{PASS}(b_t, b_t^{*f}, y_t) = u((1-\lambda_d)y_t^h) + \beta \int_Y \Gamma((1+r^*)b_t, b_{t+1}^{*f}, y_{t+1}) d\mu(y_{t+1}|y_t) \tag{15}$$

$$\begin{aligned} V^{*REJ}(b_t, b_t^{*f}, y_t) = \max_{c_t^*, b_{t+1}^{*f}} \; & v(c_t^*) + \beta^* \int_Y \Gamma^*((1+r^*)b_t, b_{t+1}^{*f}, y_{t+1}) d\mu(y_{t+1}|y_t) \\ s.t. \quad & c_t^* + q^f b_{t+1}^{*f} = y_t^f + b_t^{*f} \end{aligned} \tag{16}$$

In equilibrium where off-equilibrium paths are eliminated, the agreed recovery rates δ_t^{B*} satisfy the following:

$$\begin{aligned} \delta_t^{B*} &= argmax V^{PRO}(b_t, b_t^{*f}, y_t) \\ V^{PRO}(b_t, b_t^{*f}, y_t) &\geq V^{PASS}(b_t, b_t^{*f}, y_t) \\ V^{*ACT}(b_t, b_t^{*f}, y_t) &\geq V^{*REJ}(b_t, b_t^{*f}, y_t) \end{aligned} \tag{17}$$

If both parties reach the agreement, two parties' payoffs are as follows:

$$\Gamma^B(b_t, b_t^{*f}, y_t) = V^{PRO}(b_t, b_t^{*f}, y_t) \tag{18}$$

$$\Gamma^{*B}(b_t, b_t^{*f}, y_t) = V^{*ACT}(b_t, b_t^{*f}, y_t) \tag{19}$$

Otherwise,

$$\Gamma^B(b_t, b_t^{*f}, y_t) = V^{PASS}(b_t, b_t^{*f}, y_t) \tag{18'}$$

$$\Gamma^{*B}(b_t, b_t^{*f}, y_t) = V^{*REJ}(b_t, b_t^{*f}, y_t) \tag{19'}$$

The renegotiation settlement can be characterized by the settlement set $R^B(b_t, b_t^{*f}) \subset Y$, defined as the set of income vectors y_t at which both parties reach an agreement:

$$R^B(b_t, b_t^{*f}) = \left\{ \begin{array}{r} y_t \in Y : V^{PRO}(b_t, b_t^{*f}, y_t) \geq V^{PASS}(b_t, b_t^{*f}, y_t) \\ V^{*ACT}(b_t, b_t^{*f}, y_t) \geq V^{*REJ}(b_t, b_t^{*f}, y_t) \end{array} \right\} \tag{20}$$

Similarly, when the lender L is the proposer, we denote the proposed debt recovery rates as δ_t^L, the borrower's values of accepting and rejecting as V^{ACT} and V^{REJ}, and the lender's values of proposing and passing as V^{*PRO} and V^{*PASS}, respectively. When the lender L proposes and the proposal is accepted,

$$V^{*PRO}(b_t, b_t^{*f}, y_t) = \max_{c_t^*, b_{t+1}^{*f}} v(c_t^*) + \beta^* \int_Y V^*(0, b_{t+1}^{*f}, 0, y_{t+1}) d\mu(y_{t+1}|y_t)$$

$$s.t. \quad c_t^* + q^f b_{t+1}^{*f} = y_t^f - \delta_t^L b_t + b_t^{*f} \tag{21}$$

$$V^{ACT}(b_t, b_t^{*f}, y_t) = u((1-\lambda_d) y_t^h + \delta_t^L b_t) + \beta \int_Y V(0, b_{t+1}^{*f}, 0, y_{t+1}) d\mu(y_{t+1}|y_t) \tag{22}$$

When the lender L passes,

$$V^{*PASS}(b_t, b_t^{*f}, y_t) = \max_{c_t^*, b_{t+1}^{*f}} v(c_t^*) + \beta^* \int_Y \Gamma^*((1+r^*) b_t, b_{t+1}^{*f}, y_{t+1}) d\mu(y_{t+1}|y_t)$$

$$s.t. \quad c_t^* + q^f b_{t+1}^{*f} = y_t^f + b_t^{*f} \tag{23}$$

$$V^{REJ}(b_t, b_t^{*f}, y_t) = u((1-\lambda_d) y_t^h) + \beta \int_Y \Gamma((1+r^*) b_t, b_{t+1}^{*f}, y_{t+1}) d\mu(y_{t+1}|y_t) \tag{24}$$

In equilibrium, the agreed recovery rates δ_t^{L*} satisfy the following:

$$\delta_t^{L*} = argmax V^{*PRO}(b_t, b_t^{*f}, y_t)$$

$$V^{*PRO}(b_t, b_t^{*f}, y_t) \geq V^{*PASS}(b_t, b_t^{*f}, y_t)$$

$$V^{ACT}(b_t, b_t^{*f}, y_t) \geq V^{REJ}(b_t, b_t^{*f}, y_t) \tag{25}$$

If both parties reach the agreement, two parties' payoffs are as follows:

$$\Gamma^{*L}(b_t, b_t^{*f}, y_t) = V^{*PRO}(b_t, b_t^{*f}, y_t) \tag{26}$$

$$\Gamma^L(b_t, b_t^{*f}, y_t) = V^{ACT}(b_t, b_t^{*f}, y_t) \tag{27}$$

Otherwise,

$$\Gamma^{*L}(b_t, b_t^{*f}, y_t) = V^{*PASS}(b_t, b_t^{*f}, y_t) \tag{26'}$$

$$\Gamma^L(b_t, b_t^{*f}, y_t) = V^{REJ}(b_t, b_t^{*f}, y_t) \tag{27'}$$

The renegotiation settlement can be characterized by the settlement set $R^L(b_t, b_t^{*f}) \subset Y$, defined as the set of income vectors y_t at which both parties reach an agreement:

$$R^L(b_t, b_t^{*f}) = \left\{ \begin{array}{c} y_t \in Y : V^{*PRO}(b_t, b_t^{*f}, y_t) \geq V^{*PASS}(b_t, b_t^{*f}, y_t) \\ V^{ACT}(b_t, b_t^{*f}, y_t) \geq V^{REJ}(b_t, b_t^{*f}, y_t) \end{array} \right\} \tag{28}$$

4.4 Market Clearing Conditions

If the sovereign repays its debt, a market clearing condition for goods is as follows:

$$c_t + c_t^* = y_t^h + y_t^f \tag{29}$$

On the contrary, if the sovereign defaults, the following market clearing condition for goods holds:

$$c_t = (1 - \lambda_d) y_t^h, \quad c_t^* = y_t^f \tag{29'}$$

A market clearing condition for sovereign bonds is as follows:

$$b_{t+1} + b_{t+1}^* = 0 \tag{30}$$

4.5 Equilibrium

A recursive equilibrium is defined as a set of functions for (a) the sovereign's value function, consumption, debt position, default set, (b) the creditor's consumption, asset positions for sovereign and risk-free bonds, (c) the sovereign's and creditor's decision functions, payoffs, recovery rates, settlement sets (all depending on who is the proposer), and (d) bond price for sovereign bonds such that

[1]. the sovereign's value function, consumption, debt position, and default set satisfy its optimization problem (1)–(5);

[2]. the creditor's consumption and asset positions for sovereign and risk-free bonds satisfy his optimization problem (6)–(10);

[3]. both parties' decision functions, payoffs, recovery rates, and settlement sets solve the multi-round debt renegotiation problem (11)–(28);

[4]. market clearing conditions for goods and sovereign bonds (29)–(30) are satisfied.

In equilibrium, default probability is defined by using the sovereign's default set:

$$p^D(b_{t+1}, b_{t+1}^{*f}, 0, y_t) = \int_{D(b_{t+1}, b_{t+1}^{*f})} d\mu(y_{t+1}|y_t) \tag{31}$$

Similarly, the probability of settlement is defined by using the two settlement sets:

$$p^R(b_{t+1}, b_{t+1}^{*f}, 1, y_t) = \phi \int_{R^B(b_{t+1}, b_{t+1}^{*f})} d\mu(y_{t+1}|y_t) + (1 - \phi) \int_{R^L(b_{t+1}, b_{t+1}^{*f})} d\mu(y_{t+1}|y_t) \tag{32}$$

Expected recovery rates conditional on default choice are shown as:

$$\gamma(b_{t+1}, b^{*f}_{t+1}, y_t) = \int_Y \beta^* \frac{v'(c^*_{t+1})}{v'(c^*_t)} \gamma(b_{t+1}, b^{*f}_{t+1}, y_{t+1}) d\mu(y_{t+1}|y_t)$$

$$= \int_Y \beta^* \frac{v'(c^*_{t+1})}{v'(c^*_t)} \begin{bmatrix} \phi \mathbb{1}_{y_{t+1} \in R^B(b_{t+1}, b^{*f}_{t+1})} \delta^{B*}_t(b_{t+1}, b^{*f}_{t+1}, y_{t+1}) \\ +(1-\phi)\mathbb{1}_{y_{t+1} \in R^L(b_{t+1}, b^{*f}_{t+1})} \delta^{L*}_t(b_{t+1}, b^{*f}_{t+1}, y_{t+1}) \\ + \begin{pmatrix} \phi \mathbb{1}_{y_{t+1} \notin R^B(b_{t+1}, b^{*f}_{t+1})} \\ +(1-\phi)\mathbb{1}_{y_{t+1} \notin R^L(b_{t+1}, b^{*f}_{t+1})} \end{pmatrix} \gamma(b_{t+2}, b^{*f}_{t+2}, y_{t+1}) \end{bmatrix} d\mu(y_{t+1}|y_t) \quad (33)$$

The sovereign bond spread, i.e., the difference between the sovereign's interest rate and the risk-free rate is defined as

$$s(b_{t+1}, b^{*f}_{t+1}, 0, y_t) = \frac{1}{q(b_{t+1}, b^{*f}_{t+1}, 0, y_t)} - (1 + r^*) \quad (34)$$

5 Quantitative Analysis

This section provides the quantitative analysis of the model with two main findings. First, the model predicts that when the creditor income is high, debt restructurings are delayed and settled with low haircuts. As a result, the sovereign is more willing to default ex-ante due to its lower default costs, ceteris paribus, when the creditor income is low. Second, our simulation exercise successfully replicates novel moment statistics that match the data of the Argentine default and restructuring in 2001–05: (i) positive correlations between creditor income and duration/recovery rates, (ii) further delays driven by high creditor income, and (iii) low likelihood of debt settlement and low haircuts at high creditor income.

5.1 Parameters and Functional Forms

All the parameter values and functional forms closely follow those in previous studies on sovereign debt and debt restructurings. The following constant relative risk aversion (CRRA) utility functions are used:

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}, \qquad v(c^*_t) = \frac{c_t^{*1-\sigma^*}}{1-\sigma^*} \quad (35)$$

where σ and σ^* express the degree of risk aversion of the sovereign and the creditor, respectively. We set both σ and σ^* equal to 2—common in the real business cycle (RBC) literature on advanced and emerging market countries—following Aguiar et al. (2016) and Lizarazo (2013). The risk-free interest rate is set to 1% corresponding to the average quarterly interest rate on the 3-month US Treasury bills (Aguiar et al. 2016; Yue 2010). We follow the convention in the literature to set a parameter value for the creditor discount rate matching one-to-one with that for the risk-free interest rate (e.g., Lizarazo 2013: 0.98 vs. 1.7%). The value of $\beta^* = 0.99$ is in the range of commonly used in the RBC literature on advanced economies such that the asset distribution of the creditor is well defined. Output cost parameter λ_d is assumed to be 2% following Sturzenegger (2004)'s empirical findings and theoretical models featuring symmetric lump-sum output costs of default—for example, Aguiar and Gopinath (2006) and Yue (2010).

The market clearing condition for sovereign bonds can be re-written as follows:

$$\tilde{b}_{t+1} + \frac{1}{\pi}\tilde{b}^*_{t+1} = 0 \tag{30'}$$

where $\tilde{b}_{t+1} = \frac{b_{t+1}}{y^h_t}$, $\tilde{b}^*_{t+1} = \frac{b^*_{t+1}}{y^f_t}$ denote the debtor's debt relative to its GDP, and the creditor's assets relative to his GDP, respectively. $\pi (= \frac{y^h_t}{y^f_t})$ is the size of the sovereign debtor relative to the creditor, which is set to 0.025 to reflect the ratio of US-dollar GDP of Argentina to that of the US over 1993–2012 based on the IMF's World Economic Outlook (WEO) database.

The endowment processes are calibrated to match the quarterly seasonally adjusted GDP data from the Ministry of Economy and Production in Argentina (MECON) and the US Bureau of Economic Analysis (BEA) over 1993Q1–2013Q3. The data are detrended using a Hodrick-Prescott filter with a smoothing parameter of 1,600. As in previous studies (Arellano 2008; Benjamin and Wright 2013; D'Erasmo 2011), we assume the income processes of the debtor and the creditor to follow log normal AR(1) processes.

We consider two cases of income processes: (i) independent processes; and (ii) correlated processes. For the first case (hereafter our baseline), we specify the processes as follows:

$$\log(y^i_t) = \rho^i_y \log(y^i_{t-1}) + \epsilon^i_{y,t}, \qquad for \quad i = h, f \tag{36}$$

where an endowment shock $\epsilon^i_{y,t}$ is *i.i.d.* $N(0, \sigma^{i,2})$. With two separate auto-regressive model results, we obtain $\rho^h_y = 0.65$, $\rho^f_y = 0.89$, $\sigma^{h,2} = 0.0030$, and $\sigma^{f,2} = 0.0001$. For the second case, we specify the following vector auto regression (VAR) process:

$$Y_t = AY_{t-1} + \epsilon_t \tag{36'}$$

where $Y_t = [log(y^h_t), log(y^f_t)]'$, $\epsilon_t = [\epsilon^h_{y,t}, \epsilon^f_{y,t}]'$, and a vector of endowment shocks ϵ_t is *i.i.d.* $N(0, \Sigma)$. With VAR estimation result, we obtain

$$A = \begin{bmatrix} 0.53 & 0.77 \\ 0.02 & 0.86 \end{bmatrix}, \quad \Sigma = \begin{bmatrix} 0.0030 & 0.0002 \\ 0.0002 & 0.0001 \end{bmatrix}$$

We approximate these stochastic processes as two discrete Markov chains of equally spaced grids by using the quadrature method in Tauchen (1986).

Sturzenegger and Zettelmeyer (2006) report that Argentina experienced 6 restructurings in 1820–2004. Moreover, Struzenegger and Zettlemeyer (2008) find that the recovery rate (haircut) in Argentina 2001–05 debt restructuring was 25.0% (75.0%). To replicate the average default frequency of 3.26% and a recovery rate of 25.0%, we specify the sovereign's discount factor—similar to those in Yue (2010) and D'Erasmo (2011)—and bargaining power as follows: (i) independent processes, $\beta = 0.70$, $\phi = 0.975$; (ii) correlated processes $\beta = 0.70$, $\phi = 0.95$.[17] Table 6 summarizes the model parameters and our computation algorithm is reported in Appendix D.

Table 6. Model parameters.

Parameter	Value		Source
Symmetric			
Risk aversion	$\sigma = \sigma^* = 2$		Aguiar et al. (2016), Lizarazo (2013)
Risk-free interest rate	$r^* = 0.01$		Yue (2010) - US Treasury bill rate
Output costs	$\lambda_d = 0.02$		Sturzenegger (2004)
Relative size of sovereign	$\pi = 0.025$		IMF WEO
Discount factor - creditor	$\beta^* = 0.99$		Computed - Risk-free interest rate
Case specific	(i) Independent processes	(ii) Correlated processes	
Autocorrelation of income	$\rho_y^h = 0.65$ $\rho_y^f = 0.89$	$A = \begin{bmatrix} 0.53 & 0.77 \\ 0.02 & 0.86 \end{bmatrix}$	Computed - Argentina/US GDP MECON/US BEA
Variance/covariance	$\sigma^{h,2} = 0.0030$ $\sigma^{f,2} = 0.0001$	$\Sigma = \begin{bmatrix} 0.0030 & 0.0002 \\ 0.0002 & 0.0001 \end{bmatrix}$	Computed - Argentina/US GDP MECON/US BEA
Discount factor - sovereign	$\beta = 0.70$	$\beta = 0.70$	Computed
Bargaining power	$\phi = 0.975$	$\phi = 0.95$	Computed

5.2 Numerical Results on Equilibrium Properties

We provide the qualitative equilibrium properties of our theoretical model for the case when the sovereign proposes—proved in two steps; (i) with independent income processes below; and (ii) with correlated income processes in Appendix E.1. Appendix C explores the equilibrium properties for key assumptions in the model: size of the sovereign, output costs for the creditor, stochastic bargaining power, and different independent income processes. Similarly, Appendix E.2 discusses the equilibrium properties for the case when the creditor proposes—underlying mechanisms apply symmetrically and generate identical results.

Figure 4 reports agreed recovery rates when the sovereign proposes. In both panels A and B, the horizontal axis is the creditor income and the vertical axis is recovery rate. To demonstrate our new findings, two panel charts are classified as follows: panel A: the debtor income at the mean level, and panel B: debt at the 25% of mean GDP, respectively. In both panels A and B, our model discovers one new feature of recovery rates: agreed recovery rates are low (high) when the creditor has low (high) income (black solid lines)—for instance, lower by 5% (higher by 5%) than those at mean creditor income when debt is 25% of mean GDP and the debtor income is mean (panel i). When the creditor income is low, the creditor has a high degree of

[17] Previous studies (Yue 2010; Bi 2008; D'Erasmo 2011; Asonuma and Trebesch 2016) use different parameter values for bargaining power. This is because no good proxy indicator corresponds to bargaining power and these values are set to replicate recovery rates specifically in their models with different assumptions (income, bargaining game, etc). Section 5.5 provides sensitivity analysis with different parameter values for bargaining power.

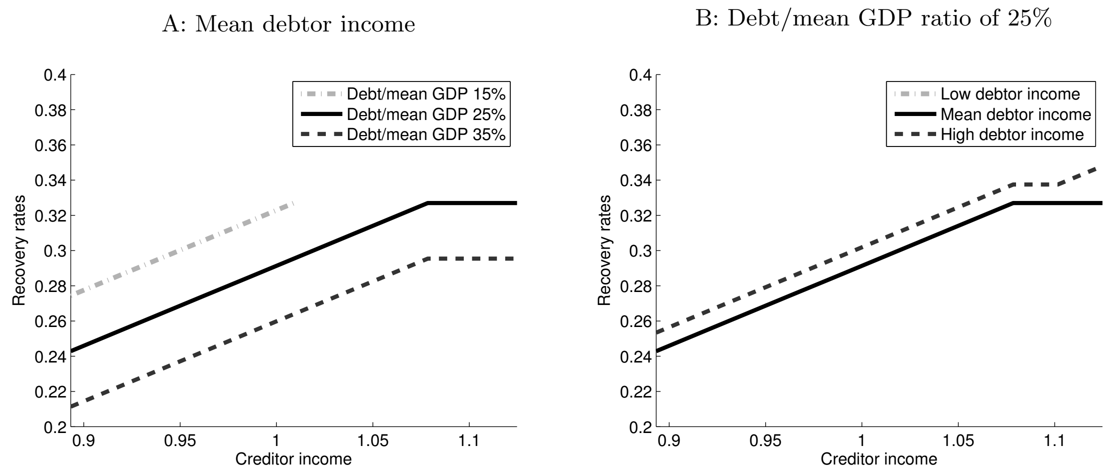


FIGURE 4. Agreed recovery rates.

consumption-smoothing motive by receiving recovered debt payments in the current period (i.e., marginal utility from an additional unit of consumption is high). Though not the most favorable offer, the creditor, ceteris paribus, still accepts the lower proposed recovery rates than those at the mean creditor income.

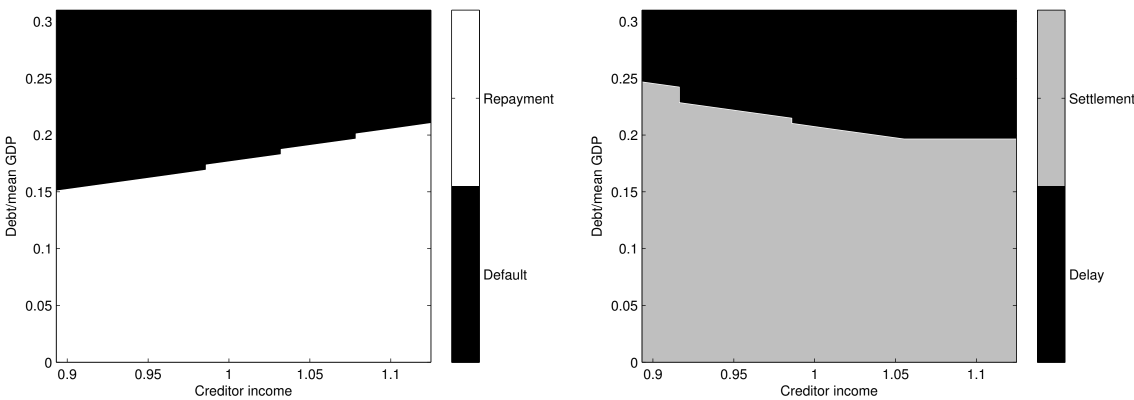
On the contrary, when the creditor enjoys high income, he is more patient and is less eager to recoup losses on the defaulted debt in order to smooth consumption in the current period. This is because he anticipates high expected recovery rates in the next period due to the persistency of his income. Thus, he only accepts recovery rates proposed in the current period which are preferable to or at least equivalent to high expected recovery rates in the next period. As a result, agreed recovery rates are higher than those at mean creditor income.

In addition, panel A also shows that agreed recovery rates are higher (lower) when debt is at 15% (35%) of mean GDP shown in the light gray dotted (dark gray dashed) line. Moreover, the light gray dotted line is truncated and partial reflecting the sovereign's repayment choice at high creditor income. Similarly, panel B shows that agreed recovery rates are higher when the debtor income is high as shown by the dark gray dashed line. There is no light gray dotted line in panel B because the sovereign always delays the renegotiations when the debtor income is low. These are general patterns of recovery rates as in previous work on debt restructurings, for instance Yue (2010), Bi (2008), and Asonuma and Trebesch (2016).

We then explore the sovereign's choice between repayment and default, and between settlement and delay in Figure 5. We follow the same classification approach as in Figure 4: panel A: the debtor income at the mean/low level, and panel B: debt at the 25% of mean GDP, respectively. The horizontal axis is the creditor income in both panels A and B. The vertical axis is debt/mean GDP ratio in panel A and debtor income in panel B, respectively. Both panels A-(i) and B-(i) are divided into two regions corresponding to the sovereign's choice of "repayment" in white color and "default" in black color. Similarly, both panels A-(ii) and B-(ii) are divided into two regions corresponding to the sovereign's choice of "settlement" in gray color and "delay" in black color.

A: Mean/low debtor income

(i) Good credit record (ii) Bad credit record



B: Debt/mean GDP ratio of 25%

(i) Good credit record (ii) Bad credit record

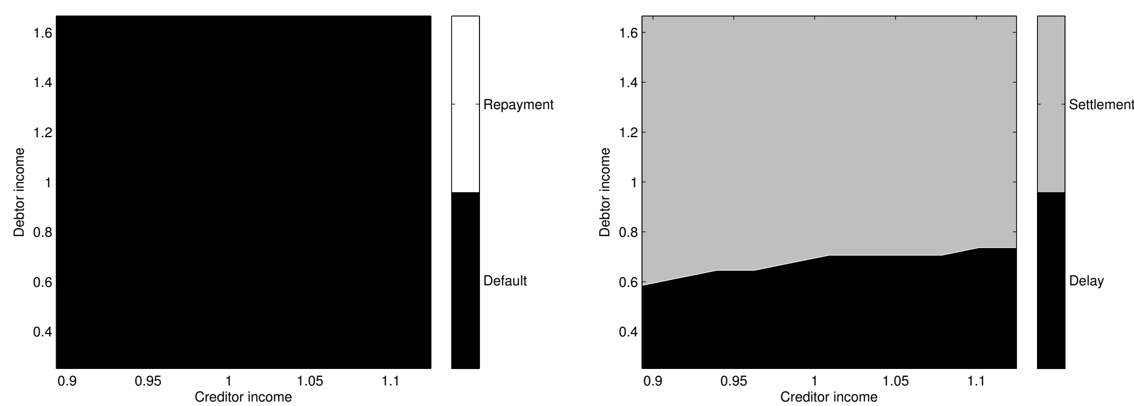


FIGURE 5. Repayment/default and settlement/delay choice.

First, we focus on the sovereign's decision when the debtor income is at the mean/low level in panel A. More importantly, on its choice between settlement and delay reported in panel A-(ii), what our model explains newly is that the sovereign opts to delay (settle), ceteris paribus, when the creditor income is high (low). When the creditor income is low, the sovereign is more willing to settle (less willing to delay) at a moderate level of debt. This is reflected in the enlarged "settlement" region in gray color and the shrunk "delay" region in black color. In this case, the creditor is less patient due to his low income and more eager to recoup losses on the defaulted debt to smooth consumption in the current period (i.e., marginal utility from an additional unit of consumption is high). As explained in Figure 4, the creditor accepts the lower proposed recovery rate than that when his income is at the mean level. As a result, it is more likely that both parties settle the deal.

In contrast, when the creditor income is high, the sovereign is less willing to settle the deal shown by the shrunk "settlement" region in gray color. This is because the creditor with high income is patient and reluctant to receive unfavorable recovered debt payments (i.e., marginal utility from an additional unit of consumption is low) and also because he expects higher recovery rates in the next period. Therefore, the creditor sets a high criteria for recovery rates and makes it difficult for the sovereign to meet the criteria in the current period.

Moreover, on its choice between repayment and default reported in panel A-(i), when the creditor income is low (high), the sovereign is more (less) willing to default due to smaller (larger) costs of default—both a quick settlement and lower recovery rates (renegotiation delays and higher recovery rates). This is reflected in the shrunk (enlarged) "repayment" region in white color. Though this is qualitatively aligned with conventional models, with a risk averse creditor (Borri and Verdelhan 2011), the main mechanism of willingness to default differs completely between ours and their model: the creditor's state-dependent consumption-smoothing motive directly influences default costs through delays in renegotiations and the terms of the settlement in our model. On the contrary, how the creditor with time-varying risk aversion perceives the riskiness of sovereign bonds affects cost of borrowing, and in turn, indirectly influences default cost in their model.

Second, we explore the sovereign's decision when debt is at the 25% of mean GDP in panel B. On its choice between settlement and delay reported in panel B-(ii), when the creditor income is low (high), the sovereign is more (less) willing to settle the deal at a moderate level of debtor income. This is reflected in the enlarged (shrunk) "settlement" region in gray color and the shrunk (enlarged) "delay" region in black color. On its choice between repayment and default in panel B-(i), the sovereign is more willing to default (less willing to repay). This is reflected in no "repayment" region in white color.

In addition, panel B-(ii) shows that on its choice between settlement and delay, when the debtor income is high (low), the sovereign is more (less) willing to settle the deal shown by the enlarged "settlement" region in gray color (shrunk "delay" region in black color). This is the general pattern of the sovereign's choice between settlement and delay as in previous studies on delays in renegotiations (Benjamin and Wright 2013; Bi 2008).

Lastly, in the case of correlated income processes, underlying mechanisms apply symmetrically and generate identical qualitative results as reported in Figure A9 and A10 in Appendix E.1.

5.3 Simulation Results

Next, we provide simulation results to show how precisely our model predicts the Argentine default and restructuring in 2001–05. Following a conventional approach, this subsection applies 1000 rounds of simulations with 2000 periods per round and extracts the last 200 observations. In the last 200 observations, we withdraw 40 observations before and observations during the last default/restructuring event at the stationary distribution to compute key moment statistics

(Arellano 2008; Yue 2010).

For the Argentine and US data, output, consumption, and the trade balance are all seasonally adjusted from the MECON and the US BEA for 1993Q1–2001Q4 (prior to default) and 2002Q1–2005Q2 (during default/restructuring), respectively. The trade balance is measured as a percentage of GDP. The Argentine external debt data are from the IMF WEO for 1993–2001 (prior to default) and 2002–05 (during default/restructuring). Average external debt is also measured as a percentage of GDP. Bond spreads are from the J.P. Morgan's Emerging Markets Bond Index Global (EMBIG) for 1997Q1–2001Q4 (prior to default). We compare our non-target statistics to those in the data, as well as those in (i) a model with exogenous reentry and zero recovery rates and (ii) a model with a one-round negotiation—replication of Arellano (2008) and Yue (2010) are reported in Table A13 in Appendix F—which are commonly used as benchmark cases for Argentina.

Panel (i) in Table 7 shows that similar to previous studies (Arellano 2008; Yue 2010; Benjamin and Wright 2013) business cycle statistics in our baseline model (with independent income processes) fit closely to those in the data—those of the creditor are reported in Table A12 in Appendix F. Our model replicates both volatile consumption (of the same magnitude with output volatility) and trade balance-to-GDP ratio, which are prominent features of emerging market RBC models. One remark is that during renegotiations the sovereign remains in financial autarky and its trade balance is constant at zero (no volatility) in our model. However, the model fails to generate a negative correlation between trade balance and output in pre-default periods. This is because the sovereign is more willing to pay its debt in full and borrow more (trade deficit) given larger default costs due to longer delays in renegotiations when the debtor income is low. This is a common by-product in models with multi-round renegotiations and constant bargaining power which successfully replicate both longer delays in renegotiations and higher debt-to-GDP ratio (Bi 2008), while it does not appear in models with a one-round negotiation or without renegotiations due to smaller default costs.[18]

Our calibration results outperform previous studies (Benjamin and Wright 2013; Bi 2008) in that our baseline model (with independent income processes) accounts for three prominent non-business cycle statistics as shown in panel (ii) in Table 7. First, most importantly, our model successfully replicates both positive correlations between average creditor GDP growth rates during restructuring and delays in renegotiations (0.63 vs. 0.15 in the data), and between creditor GDP growth rates at the end and recovery rates (0.70 vs. 0.30 in the data). These are consistent with Stylized facts 2 and 3 in Section 2.3 and are prominent features of our model with the risk averse creditor—models with risk-neutral creditors (Benjamin and Wright 2013; Bi 2008) fail to account. What generates these two statistics is the creditor's state-dependent consumption-smoothing motive through recovered debt payments.

Second, the model replicates the average restructuring duration of 5.8 quarters, which is substantially longer than that in models with a one-round negotiation (Yue 2010) but still

[18] An alternative approach to account for the negative correlation between trade balance and output is to introduce a stochastic process of bargaining power that depends on both the party who proposes in the current round and the current debtor income (Benjamin and Wright 2013).

shorter than that in the data (14.0 quarters). This is the main advantage of models with multi-round negotiations driven by both slow recovery in the debtor's repayment capacity (Benjamin and Wright 2013; Bi 2008) and the creditor's state-dependent consumption-smoothing motive through recovered debt payments. These two drivers match with the data: low debtor income at the start (-4.4% vs. -11.2% in the data) and its improvement during restructuring (21.1% vs. 12.6% in the data), and low creditor income at the start (-5.0% vs. -1.0% in the data) and its improvement during restructuring (4.5% vs. 1.5% in the data).

Third, the model additionally accounts for higher level of debt in both pre-default and restructuring periods than those in models with a one-round negotiation (Yue 2010) or exogenous reentry and zero recovery rates (Arellano 2008) but still lower than that in the data. Contrary to models with a one-round negotiation (Yue 2010), default costs in models with multi-round renegotiations are larger due to longer renegotiations (associated with output costs and financial exclusion). This in turn, makes the sovereign to default only at a higher level of debt (30.0% of GDP). Our model also replicates higher debt-to-GDP ratio in renegotiation periods than that in pre-default periods as in the data due to slow recovery of the debtor income. Both average and standard deviation of bond spreads in our model (1.5% and 1.1%)—similar to those in Yue (2010)—are lower than those in the data due to a combination of one-period bonds and the creditor with time-invariant risk aversion.[19] Our model moments also accord with observed relationships among bond spreads, debt and output.

Lastly, we use simulated data series obtained from our baseline model and apply logit and poisson regressions on debt settlement (binary) and haircuts. Logit and poisson regression results reported in panel (iii) in Table 7 show that an increase in current creditor GDP growth rates significantly reduces both the likelihood of settlement and agreed haircuts. Therefore, our theoretical model shows that when the creditor income is high, debt restructurings are delayed and settled with low haircuts.

In the case of the model with correlated income processes, both business and non-business cycle statistics—reported in column 3 in panels (i) and (ii) in Table 7—are quite the same with those in our baseline model (with independent income processes). This case also accounts for the three novel features of our model. We also have the same logit and poissoon regression results as reported in Table A11 in Appendix E.3.

[19]In a model with one-period bonds and the creditor with time-invariant risk aversion, spreads in periods prior to a default are low. This is driven by both highly persistent income processes of the debtor and the creditor, and no option to "dilute" previously-issued debt—the outstanding debt level is zero—regardless of higher default frequency over a long horizon. To match moment statistics of spreads with the data, previous studies introduce long-duration bonds (Hatchondo and Martinez 2009, Chatterjee and Eyingungor 2012) or time-varying risk aversion (Borri and Verdelhan 2011).

Table 7. Simulation results of the model.

(i) Business cycle statistics—debtor.

	Data	Baseline model (independent income processes)	Model (correlated income processes)	Exogenous re-entry and zero recovery rates[a]	One-round negotiation[b]
Pre-default periods					
Consumption (std dev.)/output (std dev.)	1.10	0.99	1.00	1.02	1.04
Trade balance/output: std dev. (%)	1.28	1.23	1.10	0.17	0.17
Corr.(trade balance, output)	-0.87	0.10	0.04	-0.05	-0.54
Renegotiation periods					
Consumption (std dev.)/output (std dev.)	1.17	1.00	1.00	-	-
Trade balance/output: std dev. (%)	2.20	0.00	0.00	-	-
Corr.(trade balance, output)	-0.97	0.00	0.00	-	-

(ii) Non-business cycle statistics.

	Data	Baseline model (independent income processes)	Model (correlated income processes)	Exogenous re-entry and zero recovery rates[a]	One-round negotiation[b]
Target statistics					
Default frequency (%)[c]	3.26	3.10	2.90	3.01	3.88
Average recovery rate (%)	25.0	29.5	35.0	-	34.4
Non-target statistics					
Pre-default periods					
Average debt/GDP ratio (%)[d]	45.4	30.0	27.9	8.9	5.7
Bond spreads: average (%)[e]	9.4	1.5	5.8	0.55	1.3
Bond spreads: std dev. (%)[e]	7.6	1.1	2.7	0.98	3.9
Corr.(spreads, output)	-0.88	-0.15	-0.10	-0.15	-0.68
Corr.(debt/GDP, spreads)	0.92	0.04	0.05	0.08	0.51
Corr.(debt/GDP, output)	-0.97	-0.90	-0.94	-0.75	-0.73
Renegotiation periods					
Average debt/GDP ratio (%)[d]	130.5	31.8	35.2	-	5.7
Duration of restructurings (quarters)	14.0	5.8	6.6	-	2.0
Debtor output deviation (level at start, %)	-11.2	-4.4	-18.7	-	-
Debtor output deviation (difference between start & end, %)[f]	12.6	21.1	28.4	-	-
Creditor output deviation (level at start, %)	-0.96	-5.0	-1.4	-	-
Creditor output deviation (difference between start & end, %)[f]	1.5	4.5	0.80	-	-
Corr.(debt/GDP, output)	-0.95	-0.98	-0.98	-	-
Corr.(average creditor GDP growth rates during restructurings, duration)[g]	0.15	0.63	0.50	-	-
Corr.(creditor GDP growth rates at the end of restructurings, recovery rates)[g]	0.30	0.70	0.10	-	-

Sources: Datastream, IMF WEO, MECON, and US BEA.

Notes: a. Model with exogenous re-entry with zero recovery rates corresponds to our model (with the same parameter values) without debt renegotiations (e.g., exogenous re-entry) as in Arellano (2008).

b. Model with a one-round negotiation corresponds to our model (with the same parameter values) with a one-round negotiation (Nash bargaining game) as in Yue (2010).

c. As commonly used in theoretical literature on sovereign debt, this corresponds to a number of actual default events over the simulation horizon (i.e., 100 years).

d. The ratio of government debt service (including short-term debt) to GDP is also commonly used in the literature as an alternative measure of government indebtedness. See Arellano (2008), Yue (2010), and Asonuma and Trebesch (2016).

e. This includes expected probability of default next period.

f. A difference in output deviation between the start and end.

g. Correlation based on post-default restructuring observations discussed in Section 2.3.

Table 7. Simulation results of the model (cont.).

(iii) Logit and poisson regression results on debt settlement and haircuts—baseline model.

	Debt settlement (binary)		Haircuts[a]	
	(1)	(1')	(2)	(2')
	coef/ se	dy/dx / Delta-method se	coef/ se	dy/dx / Delta-method se
Creditor GDP growth rates, current (%)	-3.65**	-0.87***	-9.37***	-0.86***
	(1.44)	(0.29)	(1.83)	(0.20)
External debt, current (% of GDP)	-4.05**	-0.96***	-11.72***	-1.07***
	(0.72)	(0.08)	(0.80)	(0.11)
Debtor GDP growth rates, current (%)	14.15***	3.35***	9.75***	0.89***
	(2.29)	(0.62)	(2.45)	(0.26)
Episode-specific fixed effects	No		No	
Number of episodes	87		87	
Number of observations	658		658	
χ^2	81.47		286.31	
(p-value)	(0.000)		(0.000)	
Log-likelihood ratio	-189.2		-168.5	

Notes: The table shows results from random effects multinomial logit and poissson regressions. The dependent variables are debt settlement (binary) for logit and haircuts for poisson regressions, respectively. The main explanatory variable is current creditor GDP growth rates. External debt (in % of GDP) is current, but chosen in the previous year. Debtor GDP growth rates are in current year. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively. Robust standard errors (Delta-method standard errors) in parentheses.
a. Haircuts are measured as 1=100% and set as 0 if there is no settlement.

5.4 Comparison with Models of Multi-round Renegotiations

Table 8 contrasts non-business cycle statistics in our baseline model (independent income processes) with those in previous models of multi-round renegotiations. Business cycle statistics and recalibration results are reported in Tables A12 and A13 in Appendix F, respectively. We consider two cases: (i) a model with risk-neutral creditors as in Benjamin and Wright (2013) and Bi (2008), and (ii) a model with zero debtor country size (and a risk averse creditor) as in Borri and Verdelhan (2011). To generate moments comparable to ours, we embed an assumption of the risk-neutral creditors for the case (i), and an assumption of the creditor's consumption relying on his income, not on the debtor's debt payments ($\pi = 0$) for the case (ii) in our model, respectively leaving all other parameters unchanged.

Comparing our model with the case (i), the most striking result is a sizable difference in the average restructuring duration between our model and the model with risk-neutral creditors (5.8 quarters vs. 3.8 quarters). Slow recovery of the debtor's repayment capacity drives renegotiation delays in both models shown by low debtor income at the start (-4.4% vs. -4.1%) and its improvement during restructurings (21.1% vs. 20.0%). However, the creditor's state-dependent consumption-smoothing motive through recovered debt payments—reflected by low creditor income at the start (-5.0%) and its improvement during restructurings (4.5%)—is present only in

TABLE 8. Simulation results of models of multi-round renegotiations—non-business cycle statistics.

	Data	Baseline model (independent income processes)	Model with risk neutral creditor (case i)[a]	Model with zero debtor country size (risk averse creditor) (case ii)[b]
Target statistics				
Default frequency (%)[c]	3.26	3.10	3.69	2.62
Average recovery rate (%)	25.0	29.5	29.9	0.0
Non-target statistics				
Pre-default periods				
Average debt/GDP ratio (%)	45.4	30.0	28.1	7.0
Bond spreads: average (%)[d]	9.4	1.5	0.5	1.9
Bond spreads: std dev. (%)[d]	7.6	1.1	1.2	2.5
Corr.(spreads, output)	-0.88	-0.15	-0.05	-0.03
Corr.(debt/GDP, spreads)	0.92	0.04	0.02	-0.05
Corr.(debt/GDP, output)	-0.97	-0.90	-0.93	-0.90
Renegotiation periods				
Average debt/GDP ratio (%)	130.5	31.8	28.2	9.5
Duration of restructurings (quarters)	14.0	5.8	3.8	2.0
Debtor output deviation (level at start, %)	-11.2	-4.4	-4.1	-10.1
Debtor output deviation (difference between start & end, %)[e]	12.6	21.1	20.0	9.3
Creditor output deviation (level at start, %)	-0.96	-5.0	-	- 5.9
Creditor output deviation (difference between start & end, %)[e]	1.5	4.5	-	0.10
Corr.(debt/GDP, output)	-0.95	-0.98	-0.98	-0.88
Corr.(average creditor GDP growth rates during restructurings, duration)	0.15	0.63	-	-
Corr.(creditor GDP growth rates at the end of restructurings, recovery rates)	0.30	0.70	-	-

Sources: Datastream, IMF WEO, MECON, and US BEA.
Notes: a. Model with risk-neutral creditors corresponds to our model (with the same parameter values) with risk-neutral creditors.
b. Model with zero debtor country size (and the risk averse creditor) corresponds to our model (with the same parameter values) with zero debtor country size ($\pi = 0$).
c. As commonly used in theoretical literature on sovereign debt, this corresponds to a number of actual default events over the simulation horizon (i.e., 100 years).
d. This includes expected probability of default next period.
e. A difference in output deviation between the start and end.

our model generating further delays. Moreover, it is equally important to observe positive correlations between average GDP growth rates during restructurings and duration, and between creditor GDP growth rates at the end and recovery rates both of which are replicated only by our model. Lastly, the average recovery rate in our model differs only marginally from that in the model with risk-neutral creditors (29.5% vs. 29.9%). The small difference is driven by the fact that in our model, debt settlement is more (less) likely to occur and agreed recovery rates are lower (higher) when the creditor income is low (high) than when the creditor income is at the mean level (corresponding to the fixed level of the creditor income in the model with risk-neutral creditors).

Next, when we compare our model to case (ii), the difference in average restructuring duration becomes more prominent (5.8 quarters vs. 2.0 quarters). The model with zero debtor country size does not generate any delays as shown in models with a one-round negotiation (Yue 2010; Asonuma 2016)—2 quarters are the minimum length of negotiations in the current set-up. This is because in the model with zero debtor country size, the risk averse creditor's business cycle influences the renegotiation process and outcome only indirectly and marginally through his stochastic discount rate, but not directly through proposed recovery rates and his outside option in the current round. The risk averse creditor's surplus at the bargaining game does not reflect the debtor's repayment capacity—changing over both the debtor income realization and the random selection of proposers. In addition, it is also obvious that only our model replicates both positive correlations between average creditor GDP growth rates and duration, and between creditor GDP growth rates at the end and recovery rates. Moreover, in the model with zero debtor country size, average recovery rate is zero. This differs significantly from that in our model because the recovered debt payments from the debtor do not influence the creditor's consumption smoothing but they influence the debtor's consumption smoothing. Lastly, a further and equally important consideration is the low average debt-to-GDP ratio in pre-default periods (7.0% of GDP), similar to that in models with a one-round negotiation. As it is less costly to default due to no renegotiation delays, the debtor is willing to default at low levels of debt as reported in panel A in Figure A5 in Appendix C.

5.5 Robustness Checks

The creditor's output volatility/persistency and discount rate together with output costs and bargaining power are key parameters pinning down the debt restructuring process and outcome. Table 9 reports how changes in these parameter values (keeping other parameter values constant) influence the main moment statistics. A decrease in the creditor output volatility from the benchmark case increases both restructuring duration (6.3 quarters) and recovery rates (33%). In this case, the creditor has a limited consumption-smoothing motive through recovered debt payments and opts to delay the settlement until high recovery rates are proposed.

When the creditor income becomes more mean reverting (more persistent), the restructuring duration gets shorter (longer). The creditor has a high (low) consumption-smoothing motive through receipt of the recovered debt payments to respond to highly mean-reverting (highly persistent) income. Similarly, when the creditor becomes less patient ($\beta = 0.98$ corresponding to an upper limit of quarterly interest rate on 3-month US Treasury bills over 1993Q1–2013Q3), the restructuring duration gets shorter. This is also the case where the creditor has a high consumption-smoothing motive by receiving the recovered debt payments in the current round. Smaller (larger) output costs result in both shorter (longer) restructuring duration and higher (lower) recovery rates. In this case, the debtor's repayment capacity recovers quickly (slowly) to its pre-default level.

Lastly, when the debtor is less likely to be selected to be a proposer ($\phi = 0.95$), the restructuring duration gets longer and recovery rates get higher. This is because the creditor's state-dependent consumption-smoothing motive plays a larger role resulting in delays in renegotiations and higher recovery rates. Moreover, we also apply a parameter value used in models with a one-round negotiation (Yue 2010 – $\phi = 0.72$). In this case, the model replicates neither the default frequency nor the average recovery rate because a default/restructuring is an extremely rare event.

Table 9. Sensitivity analysis.

	Creditor output volatility			Creditor output persistency			Creditor discount rate		Output costs			Bargaining power		
	$(0.005)^2$	$(0.012)^2$	$(0.017)^2$	0.80	0.89	0.95	0.98	0.99	0.0125	0.02	0.025	0.72	0.95	0.975
Default frequency (%)	2.4	3.1	2.7	2.7	3.1	4.1	3.9	3.1	4.3	3.1	4.1	0.7	2.6	3.1
Average recovery rate (%)	32.8	29.5	31.8	31.5	29.5	29.2	33.5	29.5	33.4	29.5	29.1	53.7	36.1	29.5
Non-target statistics														
Pre-default periods														
Average debt/GDP ratio (%)	32.5	30.0	28.4	26.1	30.0	30.5	26.3	30.0	16.8	30.0	36.8	54.0	39.9	30.0
Renegotiation periods														
Duration of restructurings (quarters)	6.3	5.8	5.6	4.2	5.8	5.9	5.1	5.8	4.4	5.8	9.3	73.2	11.1	5.8
Debtor output deviation (level at start, %)	-2.8	-4.4	-4.1	-3.8	-4.4	-4.6	-4.7	-4.4	-5.7	-4.4	-5.1	-13.5	-3.9	-4.4
Debtor output deviation (difference between start & end, %)[a]	27.7	21.1	26.4	25.1	21.1	24.4	25.0	21.1	23.2	21.1	25.6	61.8	31.5	21.1
Creditor output deviation (level at start, %)	-2.8	-5.0	-8.6	-5.1	-5.0	-6.1	-2.2	-5.0	-5.4	-5.0	-5.5	-7.4	-5.3	-5.0
Creditor output deviation (difference between start & end, %)[a]	2.6	4.5	9.2	5.4	4.5	6.7	2.1	4.5	4.5	4.5	4.9	6.9	5.8	4.5

Source: Authors' computation
Notes: a. A difference in output deviation between at the start and end.

6 Conclusion

This paper explores the role of foreign creditors at sovereign debt restructurings. We newly code two datasets on the creditor committees and chairs and on the creditors' business and financial cycles at the debt restructurings. Our compiled datasets show that when foreign creditors experience high GDP growth rates, restructurings are protracted and settled with smaller haircuts and face value reductions. We embed multi-round debt renegotiations between a risk averse sovereign and a risk averse creditor in an otherwise standard sovereign debt model to replicate these stylized facts. The quantitative analysis of the model shows that high creditor income results in both longer delays in renegotiations and smaller haircuts. Our theoretical predictions are supported by data through a calibration exercise for the Argentine default and restructuring episode.

On the basis of better understanding of whether creditor committees or representations are formed, whether creditor chairs (co-chairs) are appointed, and who the nominated chairs (co-chairs) are during renegotiations, future research may explore a joint decision of the sovereign debtors and creditors between collective and decentralized bargaining (and creditor holdouts) and the consequence of the bargaining (including its influence to the economy). This may contribute to the literature on sovereign debt restructurings which has explored these two types of bargaining only in a partial equilibrium model (Pitchford and Wright 2012) and not in a general equilibrium framework.

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Appendix A Dataset on Creditor Committees, Chairs, and Representatives

Table A1. Creditor committees, chairs, and representatives at sovereign debt restructurings, 1978–2010.

(A) 1st group – 30 episodes (1–30)

ISO Code	Country	Restructuring End (Exchange) Month	Creditor Committee Yes/No	Creditor Committee Chair Yes/No	Creditor Representative Yes/No	Committee Chair Institution	Committee Chair Nationality	Source
ALB	Albania	Aug-1995	Yes	Yes	No	Creditanstalt-Bankverein	Austria	Das et al. (2012), Trebesch (2011)
ARG	Argentina	Aug-1985	Yes	Yes	No	Citibank	US	Rieffel (2003), Trebesch (2011)
ARG	Argentina	Aug-1987	Yes	Yes	No	Citibank	US	Rieffel (2003), Trebesch (2011)
ARG	Argentina	Apr-1993	Yes	Yes	No	Citibank	US	Rieffel (2003), Trebesch (2011)
ARG	Argentina	Jun-2005	No	No	Yes	-	-	Trebesch (2011)
BGR	Bulgaria	Jun-1994	Yes	Yes	No	Deutsche Bank	Germany	Rieffel (2003)
BIH	Bosnia and Herzegovina	Dec-1997	Yes	Yes	No	Chase Manhattan	US	Trebesch (2011)
BLZ	Belize	Feb-2007	Yes	No	No	-	-	Buchheit (2009), Asonuma et al. (2017)
BOL	Bolivia	Mar-1988	Yes	Yes	No	Bank of America	US	Lomax (1986), Trebesch (2011)
BOL	Bolivia	Apr-1993	Yes	Yes	No	Bank of Nova Scotia	Canada	Trebesch (2011)
BRA	Brazil	Feb-1983	Yes	Yes	No	Citibank, Lloyds Bank (deputy) Morgan Guaranty (deputy),	US UK (deputy) US (deputy)	Rieffel (2003)
BRA	Brazil	Jan-1984	Yes	Yes	No	Citibank, Lloyds Bank (deputy) Morgan Guaranty (deputy),	US UK (deputy) US (deputy)	Rieffel (2003) Trebesch (2011)
BRA	Brazil	Sep-1986	Yes	Yes	No	Citibank, Lloyds Bank (deputy) Morgan Guaranty (deputy),	US UK (deputy) US (deputy)	Rieffel (2003) Trebesch (2011)
BRA	Brazil	Nov-1988	Yes	Yes	No	Citibank, Lloyds Bank (deputy) Morgan Guaranty (deputy),	US UK (deputy) US (deputy)	Rieffel (2003) Trebesch (2011)
BRA	Brazil	Nov-1992	Yes	Yes	No	Citibank, Lloyds Bank (deputy) Morgan Guaranty (deputy),	US UK (deputy) US (deputy)	Rieffel (2003)
BRA	Brazil	Apr-1994	Yes	Yes	No	Citibank, Lloyds Bank (deputy) Morgan Guaranty (deputy),	US UK (deputy) US (deputy)	Rieffel (2003)
CHL	Chile	Nov-1983	Yes	Yes	No	Manufacturers Hanovers	US	Rieffel (2003)
CHL	Chile	Jan-1984	Yes	Yes	No	Manufacturers Hanovers	US	Rieffel (2003)
CHL	Chile	Apr-1986	Yes	Yes	No	Manufacturers Hanovers	US	Rieffel (2003) Trebesch (2011)
CHL	Chile	Jun-1987	Yes	Yes	No	Manufacturers Hanovers	US	Rieffel (2003)
CHL	Chile	Dec-1990	Yes	Yes	No	Manufacturers Hanovers	US	Rieffel (2003)
CIV	Cote d'Ivoire	Mar-1998	Yes	Yes	No	BNP	France	Rieffel (2003) Trebesch (2011)
CIV	Cote d'Ivoire	Apr-2010	No	No	No	-	-	-
CMR	Cameroon	Aug-2003	No	No	No	-	-	-
COG	Congo, Rep	Feb-1988	No	No	No	-	-	-
COG	Congo, Rep	Dec-2007	No	No	No	-	-	-
CRI	Costa Rica	Sep-1983	Yes	Yes	No	Bank of America	US	Rieffel (2003) Trebesch (2011)
CRI	Costa Rica	May-1985	Yes	Yes	No	Bank of America	US	Rieffel (2003)
CRI	Costa Rica	May-1990	Yes	Yes	No	Bank of America	US	Rieffel (2003)
CRO	Croatia	Jul-1996	No	No	No	-	-	-

Appendix B Further Empirical Analysis

B.1 Creditor Committee Members – Dataset on Business and Financial Cycles and Cross-sectional Regression Results

Trebesch (2011) provides well-refined data on creditor committees at sovereign debt restructurings —total number, institutions and nationality of creditor committee members for each restructuring episode. While the data have the limited coverage of restructuring episodes (55 episodes, 31% of total episodes), have the large coverage of creditor committee members (range of 4–22 creditors with 10.4 on average).

Table A2 provides a summary of moment statistics of the creditor committee member business and financial cycles—measured as both average during duration and at the end of restructurings. As we expect, beside standard deviations, there is no major difference between moment statistics of the creditor committee member business and financial cycle and those of the creditor chairs reported in Table 2 in Section 2.2. Standard deviations of the creditor committee member business and financial cycles are substantially smaller than those of the creditor chair business and financial cycles due to average over a larger sample of creditor committee members and over a smaller sample of restructuring episodes.

Table A2. Creditor committee member business and financial cycles for sovereign debt restructurings, 1978–2010.

	Observation	Mean	Median	Std Dev.	Observation	Mean	Median	Std. Dev.
	Average over duration[a]				**Levels at the end of restructurings**[b]			
Creditor committee member GDP growth rates (%)[c]	55	3.0	2.9	1.1	55	3.0	3.2	1.6
Creditor committee member risk premium on bank lending (%)[d]	55	2.0	1.9	0.7	55	2.2	2.2	0.7
Creditor committee member bank interest spreads (%)[e]	54	2.6	2.5	0.8	55	2.7	2.6	0.8
Memo Item:								
GZ US excess bond premium (%)[f]	104	0.10	0.10	0.31	134	0.01	-0.04	0.42
Duration of restructurings (months)	179	41.0	18.7	51.8				
Haircuts (%)	178	36.7	31.7	27.2				
Face value reductions (%)	178	16.5	0.0	30.3				

Notes: a. Monthly average over duration of restructurings.
b. Levels (at a monthly frequency) at the end of restructurings.
c. We transform quarterly GDP growth rate series for creditor committee members into series at a monthly frequency given a lack of comprehensive monthly series covering the whole sample period.
d. Risk premium on bank lending is the interest rate charged by banks on loans to prime private sector customers minus the interest rate at which short-term government securities are issued or traded in the market.
e. Bank interest spreads is a difference in borrowing and lending rates of banks in nominal terms.
f. Gilchrist and Zakrajsek (2012) excess bond premium for US financial firms.

Since we focus on post-default restructuring episodes, our sample of creditor committee member business and financial cycles is reduced to around 30 observations. Therefore, we are only allowed to include a limited set of controls in regression analysis below.

Table A3 confirms our main result on duration of restructurings in Table 3: an improvement of the creditor committee member business and financial cycles (according to GDP growth rates, risk premium on bank lending, and bank interest spreads) significantly leads to a longer duration of restructurings. The effect is significant at 5 and 10% levels, and quantitatively large and similar to that of the creditor chair business and financial cycles.

Table A3. Cross-sectional regression results on duration of restructurings—creditor committee members.

	Duration of restructurings (months)		
	(1)	(2)	(3)
	Creditor committee member GDP growth rates, average (%)	Creditor committee member risk premium on bank lending average (%)	Creditor committee member bank interest spreads, average (%)
	coef/se	coef/se	coef/se
Creditor committee member GDP growth rates, average (%)[a]	9.35**	-	-
	(4.33)		
Creditor committee member risk premium on bank lending, average (%)[a]	-	-18.10*	-
		(9.34)	
Creditor committee member bank interest spreads, average (%)[a]	-	-	-13.07*
			(6.66)
Debtor GDP deviation from trend, end (%)[b,c]	0.17	-0.46	-0.04
	(1.10)	(1.01)	(0.91)
External debt, end (% of GDP)[b]	0.16	-0.20	-0.11
	(0.19)	(0.17)	(0.17)
Contant	-	90.50***	83.58***
		(22.02)	(19.00)
Sample	28	28	28
Adj-R^2	0.44	0.09	0.09
Root MSE	39.9	31.4	31.4

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is duration of restructurings (months). The main explanatory variables are creditor committee member GDP growth rates, risk premium on bank lending—lending rates minus T-bill interest rates—, and bank interest spreads—lending rates minus deposit rates. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses.
a. Monthly average over duration of restructurings.
b. Levels (at a monthly frequency) at the end of restructurings.
c. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

Table A4 proves the validity of our main result on haircuts in Table 4: an improvement of the creditor committee member business and financial cycles (according to GDP growth rates, risk premium on bank lending, and bank interest spreads) at the settlement reduces haircuts. The effect is significant at 1 and 5% levels, and quantitatively large and identical to that of the creditor chair business and financial cycles.

Table A4. Cross-sectional regression results on haircuts—creditor committee members.

	Haircuts (%)		
	(1)	(2)	(3)
	Creditor committee member GDP growth rates, end (%)	Creditor committee member risk premium on bank lending, end (%)	Creditor committee member bank interest spreads, end (%)
	coef/se	coef/se	coef/se
Creditor committee member GDP growth rates, end (%)[a]	-4.09**	-	-
	(1.95)		
Creditor committee member risk premium on bank lending, end (%)[a]	-	9.73***	-
		(2.71)	
Creditor committee member bank interest spreads, end (%)[a]	-	-	10.83***
			(2.57)
Duration of restructurings (years)	0.15	0.15	0.09
	(0.10)	(0.09)	(0.09)
Debtor GDP deviation from trend, end (%)[a,b]	-0.73	-0.34	-0.40
	(0.45)	(0.47)	(0.44)
External debt, end (% of GDP)[a]	0.02	0.06	-0.01
	(0.09)	(0.07)	(0.08)
Contant	35.15***	-	-
	(9.45)		
Sample	28	28	28
Adj-R^2	0.16	0.83	0.85
Root MSE	16.3	16.3	15.4

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is haircuts (%). The main explanatory variables are creditor committee member GDP growth rates, risk premium on bank lending—lending rates minus T-bill interest rates—, and bank interest spreads—lending rates minus deposit rates. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses.

a. Levels (at a monthly frequency) at the end of restructurings.

b. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

Similarly, Table A5 also show support for our main result on face value reductions in Table A6 in Appendix B.2: an improvement of the creditor committee business and financial cycles at the settlement substantially reduces face value reductions. The effect is significant at 1 and 5% levels, and quantitatively large and similar to that of the creditor chair business and financial cycles.

Table A5. Cross-sectional regression results on face value reductions—creditor committee members.

	Face value reductions (%)		
	(1)	(2)	(3)
	Creditor committee member GDP growth rates, end (%)	Creditor committee member risk premium on bank lending, end (%)	Creditor committee member bank interest spreads, end (%)
	coef/se	coef/se	coef/se
Creditor committee member GDP growth rates, end (%)[a]	-3.78*	-	-
	(2.20)		
Creditor committee member risk premium on bank lending, end (%)[a]	-	12.50**	-
		(4.75)	
Creditor committee member bank interest spreads, end (%)[a]	-	-	5.36*
			(3.00)
Duration of restructurings (years)	0.17	0.07	0.06
	(0.11)	(0.10)	(0.11)
Debtor GDP deviation from trend, end (%)[a,b]	-0.62	0.30	-0.40
	(0.50)	(0.58)	(0.51)
External debt, end (% of GDP)[a]	-0.03	0.06	-0.10
	(0.10)	(0.09)	(0.09)
Contant	11.64***	-	-
	(10.63)		
Sample	28	28	28
Adj-R^2	0.08	0.41	0.34
Root MSE	18.3	17.0	18.0

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is face value reductions (%). The main explanatory variables are creditor committee member GDP growth rates, risk premium on bank lending—lending rates minus T-bill interest rates—, and bank interest spreads—lending rates minus deposit rates. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses.

a. Levels (at a monthly frequency) at the end of restructurings.

b. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

B.2 Face Value Reductions and Creditor Chair Business and Financial Cycles for Restructurings in 1978–2010

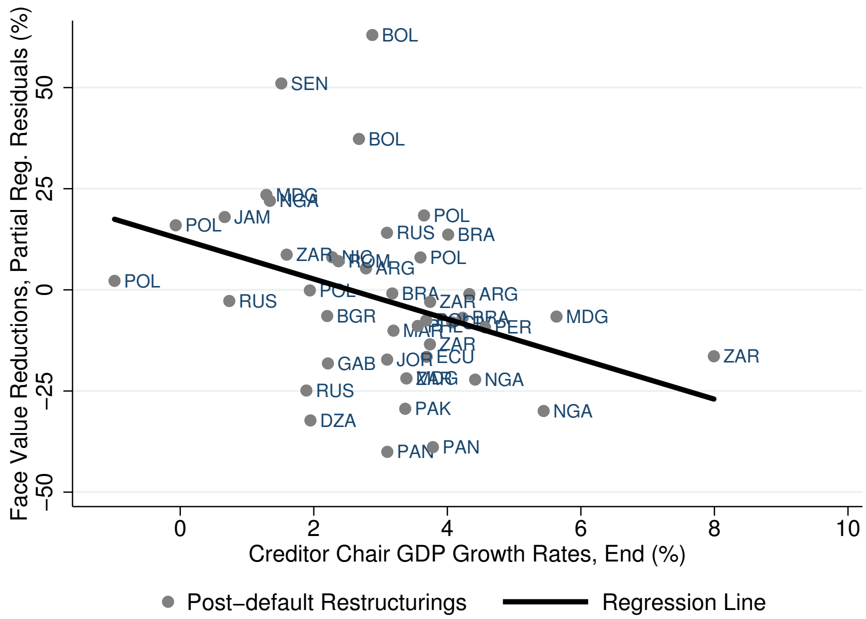


FIGURE A1. Face value reductions and creditor chair GDP growth rates for sovereign debt restructurings, 1978-2010. The figure plots post-default restructuring observations where creditor chair business and financial cycles for restructurings are available.

Table A6. Cross-sectional regression results on face value reductions—creditor chairs.

	Face value reductions (%)		
	(1)	(2)	(3)
	Creditor chair GDP growth rates, end (%)	Creditor chair risk premium on bank lending, end (%)	Creditor chair bank interest spreads, end (%)
	coef/se	coef/se	coef/se
Creditor chair GDP growth rates, end (%)[a]	-4.10*	-	-
	(2.22)		
Creditor chair risk premium on bank lending, end (%)[a]		4.04*	-
		(2.38)	
Creditor chair bank interest spreads, end (%)[a]	-	-	3.48*
			(2.05)
Duration of restructurings (years)	0.35***	0.32***	0.32***
	(0.10)	(0.10)	(0.09)
Debtor GDP deviation from trend, end (%)[a,b]	-0.38	-0.31	-0.21
	(0.44)	(0.46)	(0.48)
Debtor per capita US$ GDP, end (thousand US$)[a]	-5.79*	-4.58	-5.85*
	(3.35)	(3.34)	(3.09)
External debt, end (% of GDP)[a]	0.11	0.32***	0.12
	(0.10)	(0.10)	(0.09)
Export/debt service ratio, end (%)[a]	-1.53	-1.57	-1.80
	(1.29)	(1.28)	(1.25)
LIBOR 12-month, end (%)[a]	-1.76	-2.19	-2.59
	(2.09)	(2.09)	(1.97)
LIBOR 12-month, average (%)[c]	0.55	2.19	1.94
	(2.35)	(2.33)	(2.18)
IMF-supported program, end (dummy)[d]	-4.23	-13.51	-5.39
	(6.97)	(24.54)	(6.76)
Contant	29.15	-	-
	(25.18)		
Sample	43	44	44
Adj-R^2	0.41	0.49	0.62
Root MSE	20.6	20.5	20.3

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is face value reductions (%). The main explanatory variables are creditor chair GDP growth rates, risk premium on bank lending—lending rates minus T-bill interest rates—, and bank interest spreads—lending rates minus deposit rates. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses. A smaller sample of observations (43–44 episodes) than a sample of post-default restructurings (111 episodes) is due to availability of creditor chair business and financial cycles for restructurings (112–116 out of 179 episodes) as reported in Table 1.

a. Levels (at a monthly frequency) at the end of restructurings.

b. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

c. Monthly average over duration of restructurings.

d. A dummy for an IMF-supported program is set to 1 when an IMF-supported program starts at the year of completion of debt restructurings and 0 otherwise.

Table A7. Panel poisson regression results on face value reductions.

	Face value reductions[a]	
	(1)	(1')
	coef/ se	dy/dx / Delta-method se
Creditor chair GDP growth rates, current (%)	-0.312***	-0.030***
	(0.105)	(0.011)
PPG external debt, lagged (% of GDP)[b]	-0.038***	-0.004***
	(0.006)	(0.003)
Debtor GDP growth rates, current (%)	0.019	0.002
	(0.040)	(0.004)
Episode-specific fixed effects	No	
Number of episodes	54	
Number of observations	259	
χ^2	93.09	
(p-value)	(0.000)	
Log-likelihood ratio	-63.39	

Notes: The table shows results from random effects multinomial poisson regression. The dependent variable is face value reductuions. The main explanatory variable is creditor chair GDP growth rates. PPG external debt (in % of GDP) is lagged by one year. Debtor GDP growth rates are in current year. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Robust standard errors in parentheses.

a. Face value reductions are measured as 1=100% and set as 0 if there is no settlement.

b. Public and publicly guaranteed external debt. Lagged level in terms of GDP.

B.3 Figures on Duration and Haircuts Differentiated by Main Creditor Chairs

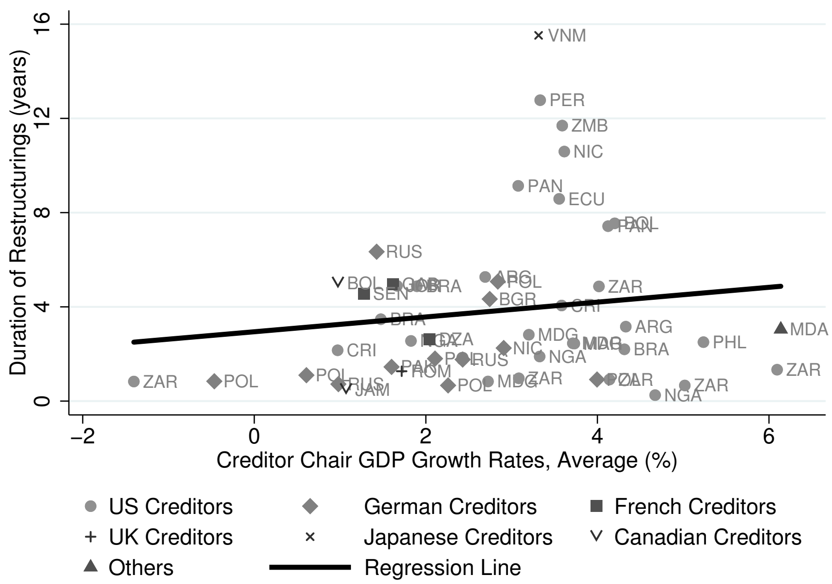


FIGURE A2. Duration and creditor chair GDP growth rates for sovereign debt restructurings differentiated by main creditor chairs, 1978–2010.

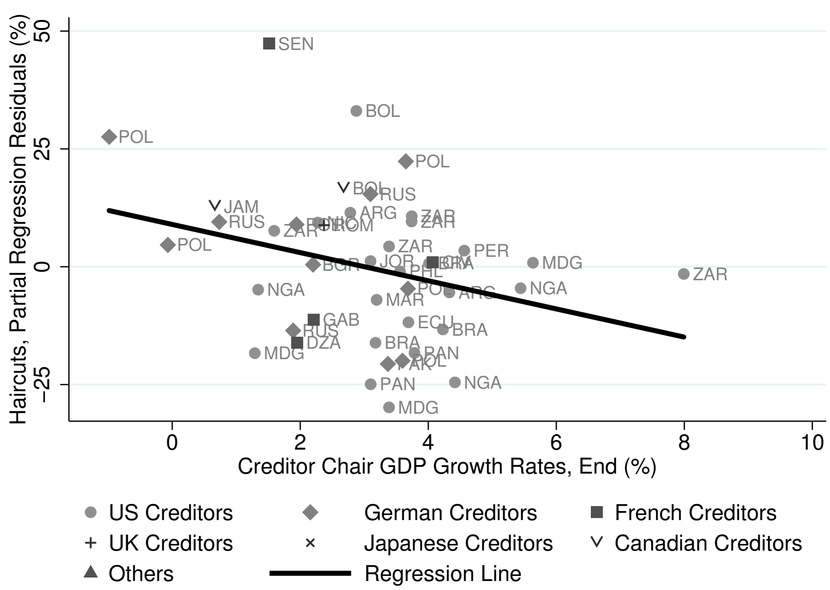


FIGURE A3. Haircuts and creditor chair GDP growth rates for sovereign debt restructurings differentiated by main creditor chairs, 1978–2010.

B.4 Robustness Check on Regression Results for Creditor Chair Business and Financial Cycles

We explore whether our baseline regression results for creditor chair business and financial cycles are robust under additional cases of using an alternative proxy for creditor chair business and financial cycles and dealing with heterogeneity in our sample.

First, we use Gilchrist and Zakrajsek's (GZ hereafter 2012) excess bond premium for US financial firms which is commonly used as a proxy for the creditor risk appetite. GZ credit spread is representative of the entire maturity spectrum of the range of bonds issued by financial firms constructed on the basis of the prices of individual US corporate bonds in the secondary markets. They decompose the GZ spread into two components: a component capturing the usual countercyclical movements in expected defaults—defined as default risk—, and a component representing the cyclical changes in the relationship between measured default risk and credit spreads—defined as excess bond premium. The excess bond premium reflects a change in the effective risk-bearing capacity of the financial sector.

Second, we follow the convention in the literature to deal with heterogeneity in our sample by two approaches: dropping outliers—observations which are either below 2.5^{th} percentile or above 97.5^{th} percentile of distribution—and applying generalized least square (GLS) estimation.

All our baseline cross-sectional regression results on duration of restructurings, haircuts and face value reductions are shown to be robust. When we apply GZ US excess bond premium—negatively correlated with US business cycle—and control for heterogeneity in our sample, we prove the validity of our baseline results on duration of restructurings as reported in Table A8. Similarly, these two approaches validate the robustness of the baseline results on both haircuts and face value reductions as reported in Table A9 and A10, respectively.

Table A8. Cross-sectional regression results on duration of restructurings—robustness check for creditor chairs.

	Duration of restructurings (months)			
	(1)	(2)	(3)	(4)
	GZ US excess bond premium, average (%)	Dropping outliers (duration): creditor chair GDP growth rates, average (%)[g]	Dropping outliers (GDP growth rates): creditor chair GDP growth rates, average (%)[g]	Generalized least square: creditor chair GDP growth rates, average (%)[h]
	coef/se	coef/se	coef/se	coef/se
Creditor chair GDP growth rates, average (%)[a]	-	8.75**	11.40**	7.65**
		(3.64)	(4.55)	(3.76)
GZ US excess bond premium, average (%)[a]	-42.49*	-	-	-
	(21.73)			
Debtor GDP deviation from trend, end (%)[b,c]	1.34*	-0.42	-0.32	-0.17
	(0.75)	(0.79)	(0.83)	(0.82)
External debt, end (% of GDP)[b]	0.30**	0.31**	0.26*	0.28**
	(0.13)	(0.13)	(0.13)	(0.13)
Export/debt service ratio, end (%)[b]	3.32***	5.44**	5.76**	5.87***
	(0.96)	(2.08)	(2.16)	(2.16)
LIBOR 12-month, end (%)[b]	-11.87***	-1.43	-2.13	-1.32
	(2.95)	(1.31)	(1.48)	(1.37)
LIBOR 12-month, average (%)[a]	13.99***	-	-	-
	(3.14)			
IMF-supported program, end (dummy)[d]	-33.29**	-24.96**	-24.87	-21.38*
	(13.11)	(11.62)	(12.25)	(12.00)
Bond restructurings (dummy)[e]	11.08	-22.32	-21.54	-18.56
	(18.41)	(24.55)	(25.59)	(25.54)
Contant	-	-	-	-
Sample	62	48	47	49
Adj-R^2 [f]	0.69	0.63	0.60	10.34
Root MSE	45.7	38.2	39.8	-

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is duration of restructurings (months). The main explanatory variables are creditor chair GDP growth rates and GZ US excess bond premium. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses.

a. Monthly average over duration of restructurings.

b. Levels (at a monthly frequency) at the end of restructurings.

c. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

d. A dummy for an IMF-supported program is set to 1 when an IMF-supported program starts at the year of completion of debt restructurings and 0 otherwise.

e. A dummy for bond restructurings is set to 1 if a restructuring is a bond exchange.

f. AIC for generalized least square estimation.

g. We omit duration or creditor GDP growth rate observations which are either below 2.5^{th} percentile or above 97.5^{th} percentile of distribution.

h. Regression results are based on generalized least square (maximum likelihood) estimation.

Table A9. Cross-sectional regression results on haircuts—robustness check for creditor chairs.

	Haircuts (%)			
	(1)	(2)	(3)	(4)
	GZ US excess bond premium, end (%)	Dropping outliers (haircuts): creditor chair GDP growth rates, end (%)[h]	Dropping outliers (GDP growth rates): creditor chair GDP growth rates, end (%)[h]	Generalized least square: creditor chair GDP growth rates, end (%)[i]
	coef/se	coef/se	coef/se	coef/se
Creditor chair GDP growth rates, end (%)[a]	-	-3.76*	-5.60**	-4.23**
		(1.97)	(2.39)	(2.06)
GZ US excess bond premium, end (%)[a]	14.66**	-	-	-
	(7.10)			
Duration of restructurings (years)	0.18***	0.17*	0.26***	0.25**
	(0.05)	(0.09)	(0.09)	(0.09)
Debtor GDP deviation from trend, end (%)[a,b]	0.17	-0.26	-0.51	-0.48
	(0.29)	(0.38)	(0.38)	(0.38)
Debtor per capita US$ GDP, end (thousand US$)[a]	-3.11**	-5.12*	-5.42*	-5.80**
	(1.53)	(2.81)	(2.94)	(2.94)
External debt, end (% of GDP)[a]	0.15***	0.07	0.04	0.04
	(0.05)	(0.08)	(0.08)	(0.08)
Export/debt service ratio, end (%)[a]	0.31	-0.88	-1.46	-1.29
	(0.42)	(1.09)	(1.14)	(1.13)
LIBOR 12-month, end (%)[a]	-0.08	-1.43	-2.38	-2.15
	(1.46)	(1.95)	(2.02)	(2.02)
LIBOR 12-month, average (%)[c]	-3.16**	1.33	1.85	1.97
	(1.46)	(2.01)	(2.09)	(2.10)
IMF-supported program, end (dummy)[d]	-6.53	-9.04	-5.13	-6.80
	(5.46)	(5.78)	(6.15)	(5.99)
Bond restructurings (dummy)[e]	-5.94	-5.91	-4.79	-4.57
	(9.46)	(11.73)	(12.29)	(12.34)
Post-1989 IMF lending regime (dummy)[f]	7.94	2.83	-5.73	-4.11
	(6.82)	(9.52)	(9.48)	(9.40)
Contant	59.14**	49.60*	60.86**	54.92**
	(16.83)	(25.42)	(27.07)	(26.65)
Sample	76	42	42	43
Adj-R^2 [g]	0.55	0.25	0.30	8.81
Root MSE	25.09	16.7	17.6	-

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is haircuts (%). The main explanatory variables are creditor chair GDP growth rates and GZ US excess bond premium. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses.

a. Levels (at a monthly frequency) at the end of restructurings.

b. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

c. Monthly average over duration of restructurings.

d. A dummy for an IMF-supported program is set to 1 when an IMF-supported program starts at the year of completion of debt restructurings and 0 otherwise.

e. A dummy for bond restructurings is set to 1 if a restructuring is a bond exchange.

f. A dummy for post-1989 regime is set to 1 if a restructuring completed after a change in the IMF lending paradigm in 1989.

g. AIC for generalized least square estimation.

h. We omit haircut or creditor GDP growth rate observations which are either below 2.5^{th} percentile or above 97.5^{th} percentile of distribution.

i. Regression results are based on generalized least square (maximum likelihood) estimation.

Table A10. Regression results on face value reductions—robustness check for creditor chairs.

	Face value reductions (%)		
	(1)	(2)	(3)
	GZ US excess bond premium, end (%)	Dropping outliers (GDP growth rates): creditor chair GDP growth rates, end (%)[f]	Generalized least square: creditor chair GDP growth rates, end (%)[g]
	coef/se	coef/se	coef/se
Creditor chair GDP growth rates, end (%)[a]	-	-5.23*	-4.10*
		(2.56)	(2.22)
GZ US excess bond premium, end (%)[a]	18.18**	-	-
	(8.47)		
Duration of restructurings (years)	0.22***	0.36***	0.35***
	(0.06)	(0.10)	(0.10)
Debtor GDP deviation from trend, end (%)[a,b]	0.36	-0.41	-0.38
	(0.38)	(0.44)	(0.44)
Debtor per capita US$ GDP, end (thousand US$)[a]	-3.75*	-5.54	-5.79*
	(2.01)	(3.38)	(3.35)
External debt, end (% of GDP)[a]	0.23***	0.10	0.11
	(0.06)	(0.10)	(0.10)
Export/debt service ratio, end (%)[a]	0.44	-1.70	-1.53
	(0.55)	(1.31)	(1.29)
LIBOR 12-month, end (%)[a]	-4.07**	-1.82	-1.76
	(1.74)	(2.09)	(2.09)
LIBOR 12-month, average (%)[c]	-2.46	0.48	0.55
	(1.82)	(2.36)	(2.35)
IMF-supported program, end (dummy)[d]	-8.07	-2.73	-4.23
	(7.13)	(7.20)	(6.97)
Contant	61.35***	32.21	29.15
	(16.35)	(25.50)	(25.18)
Sample	76	42	43
Adj-R^2 [e]	0.55	0.41	9.09
Root MSE	25.1	20.6	-

Notes: The table shows results from ordinary least square (OLS) regressions. The dependent variable is face value reductions (%). The main explanatory variables are creditor chair GDP growth rates and GZ US excess bond premium. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$, respectively. Standard errors are in parentheses.

a. Levels (at a monthly frequency) at the end of restructurings.

b. GDP deviation from the trend is a percentage deviation from the trend, obtained by applying a Hodrick-Prescott (H-P) filter to annual GDP series.

c. Monthly average over duration of restructurings.

d. A dummy for an IMF-supported program is set to 1 when an IMF-supported program starts at the year of completion of debt restructurings and 0 otherwise.

e. AIC for generalized least square estimation.

f. We omit creditor GDP growth rate observations which are either below 2.5^{th} percentile or above 97.5^{th} percentile of distribution.

g. Regression results are based on generalized least square (maximum likelihood) estimation.

Appendix C Implications for Key Theoretical Assumptions

We explore model implications for following five key theoretical assumptions; (1) size of the sovereign; (2) net issuance at the settlement; (3) output costs for the creditor; (4) different independent income processes; and (5) stochastic bargaining power. In particular, for each case, we discuss how a change in the assumption keeping other assumptions and parameter values unchanged influences the sovereign's repayment, default/settlement, and default/delay choice. Our main qualitative implications are robust except the case where size of the sovereign is zero.

Panel A in Figure A4 repeats panel A in Figure 5: the sovereign's decision when the borrower income is at the mean/low level. Panels A-(i) and A-(ii) report the sovereign choice at good credit record ($h = 0$) and at bad credit record ($h = 1$), respectively. In panel B in Figure A4, we combine the two top panels on the sovereign's choice between repayment and default, and between settlement and delay. The white region corresponds to its choice of repayment. The region highlighted in gray shows its settlement choice after the default choice in the previous periods. The delay choice after the default choice in the previous periods is represented by the black region

Figure A5 reports two cases for different size for the sovereign debtor. Panel A reports the case where size of the sovereign is assumed to be negligibly small ($\pi = 0.0$ in our model framework) as in Borri and Verdelhan (2011). In this case, repayments on sovereign bonds do not affect the creditor's surplus at all since the share of sovereign bonds in his portfolio is almost zero. The debtor easily reaches an agreement with the creditor (the enlarged "Default/Settlement" region). Panel B reports the case where size of the sovereign is larger ($\pi = 0.05$ in our model framework) in line with previous models with the risk averse creditor (Lizarazo 2013). Repayments on sovereign bonds heavily influence the creditor's surplus and the creditor requests higher recovery rates resulting in longer delays. Higher default costs for the sovereign due to both high recovery rates and longer delays conditional on default result in high likelihood of repayments (the enlarged "Repayment" region).

Figure A6 reports cases with net issuance at the settlement and the creditor's output costs. When we incorporate net issuance at the time of settlement as in Benjamin and Wright (2013), the sovereign is more willing to settle since the net lending reduces the costs of debt settlement (larger "Default/Settlement" region in panel A). Next, if we allow for the creditor's output costs due to the sovereign's or other debtors' defaults (0.00005% of his income—one tenth of the 2%-output costs on its own default) as in Arellano et al. (2017), the sovereign is more willing to default ex-ante and more likely to settle (smaller "Repayment" and larger "Default/Settlement" regions in panel B). This is because the creditor is more willing to settle immediately to avoid further costs.

Figure A7 reports the sovereign's choice in two cases of different independent income processes; (i) German GDP process; (ii) advanced economies' GDP process for the creditor. Our baseline results remain robust. Using other parameter values for the creditor income process (German or advanced economies' GDP process) does not influence the sovereign's choice: except smaller standard deviation for advanced economies' GDP, German and advanced economies' GDP processes are quite similar to that of the US.

Lastly, Figure A8 reports cases for stochastic bargaining power. When bargaining power is stochastic, i.e., different probability for the selection of the proposer in the next round given the identity of proposer in the current round, the sovereign is less willing to default ex-ante given higher default costs and is more likely to delay conditional on default (larger "Repayment" and larger "Delay" regions in panel B).

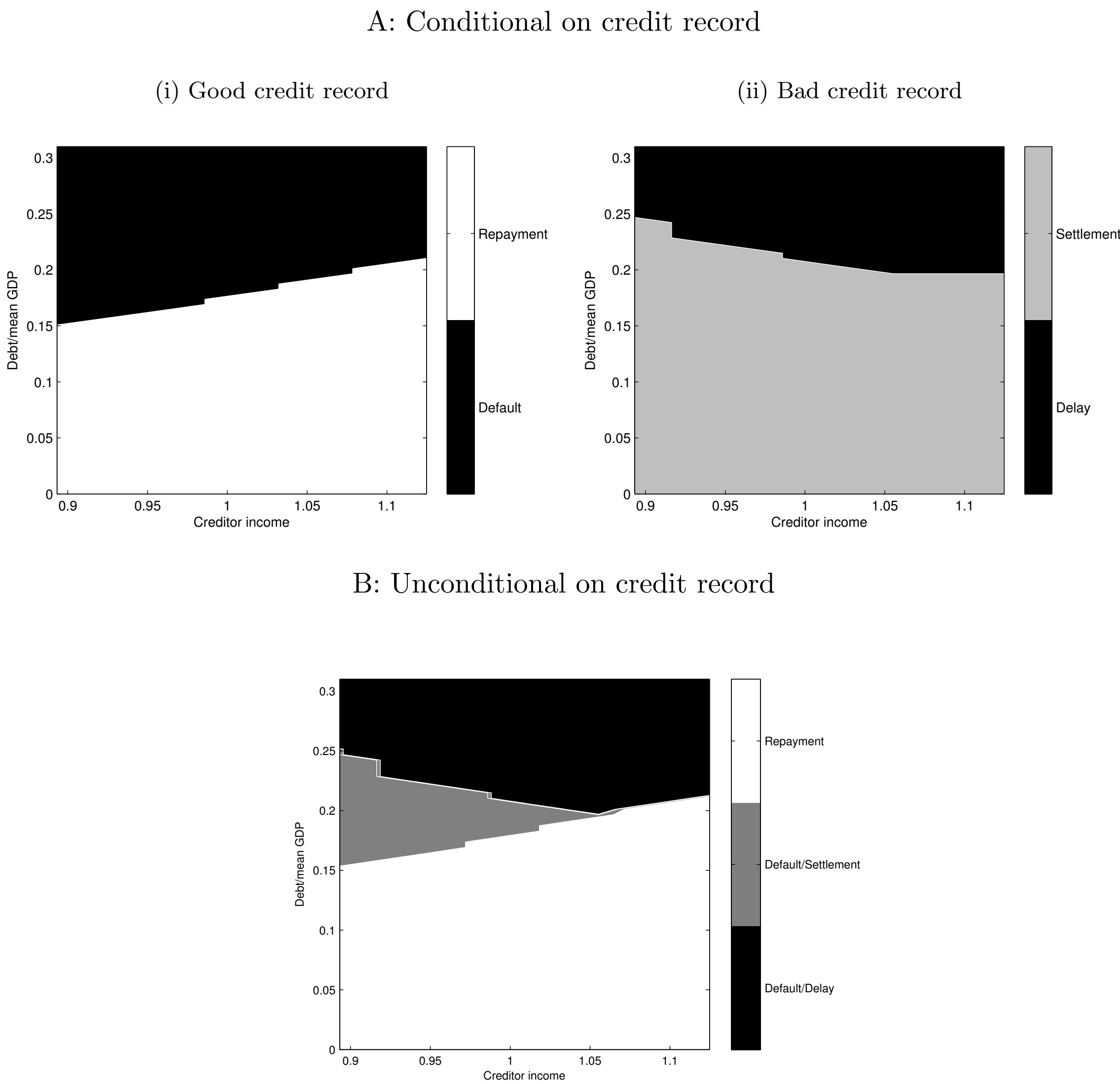


Figure A4. Baseline model.

(i) Zero size of the sovereign (π=0.0) (ii) Large size of the sovereign (π=0.05)

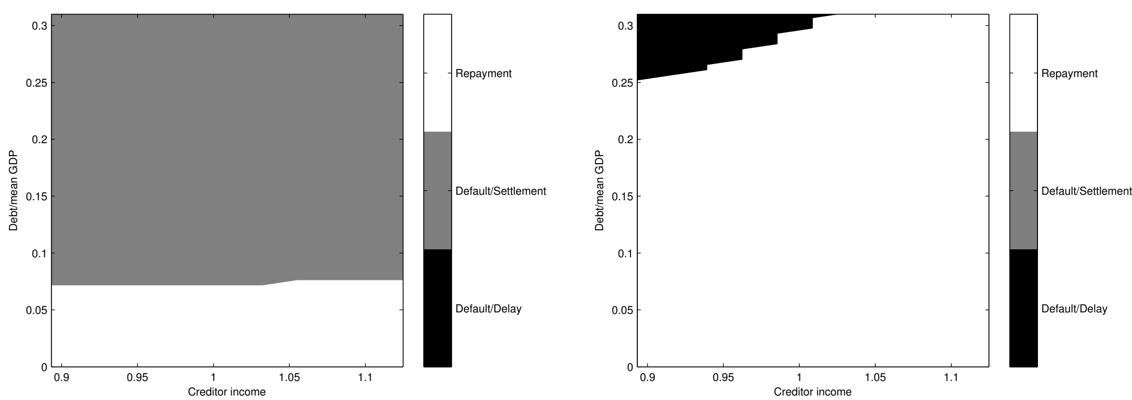


Figure A5. Size of the Sovereign

(i) Net Issuance (ii) Creditor's Output Costs (0.00005%)

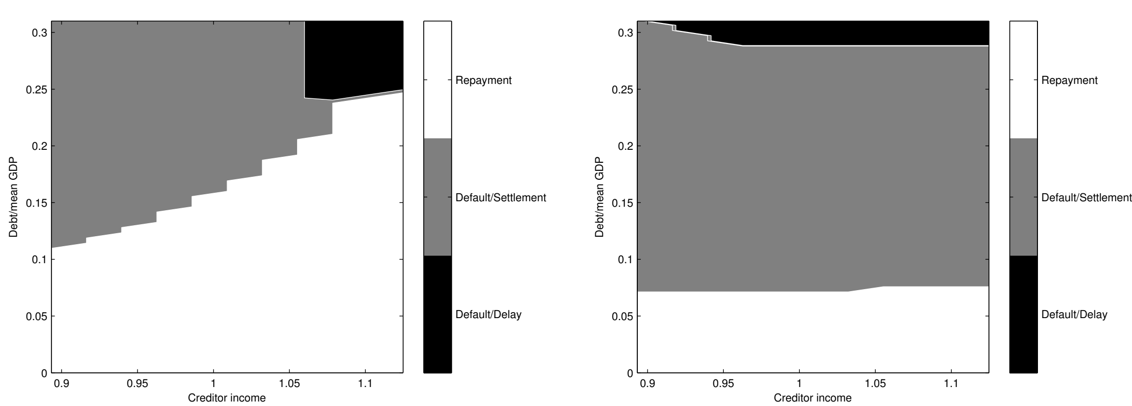


Figure A6. Net Issuance and the Creditor's Output Costs

A: German GDP

B: Advanced economies' GDP

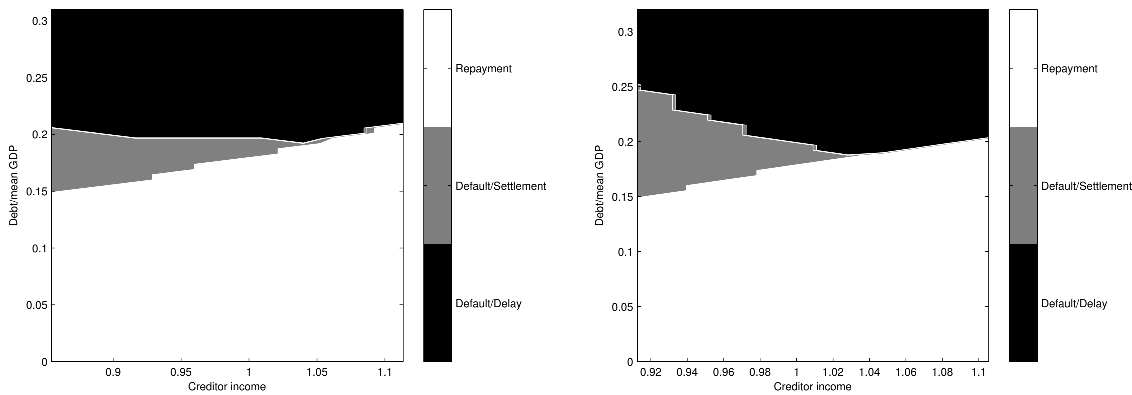


FIGURE A7. Different income processes.

A: Baseline constant high prob. (0.975, 0.975)

B: Stochastic low prob. when B proposes/high prob. when L proposes (0.90, 0.975)

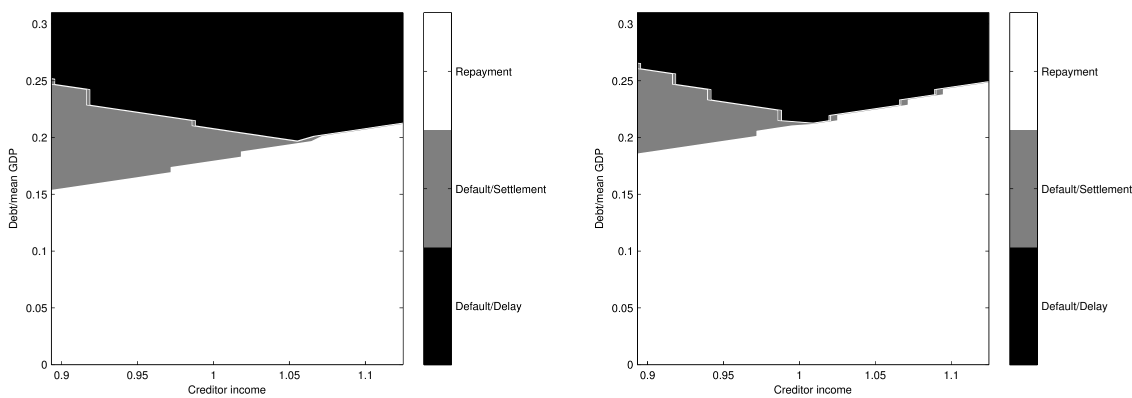


FIGURE A8. Stochastic bargaining power.

Appendix D Computation Algorithm

The procedure to compute the equilibrium distribution of the model is the following:

1. First, we set finite grids on the space of asset holdings and endowments as $B = [b_{min}, 0]$, $B^{*f} = [b^{*f}_{min}, b^{*f}_{max}]$, $Y^h = [y^h_{min}, y^h_{max}]$, and $Y^f = [y^f_{min}, y^f_{max}]$. Limits of endowments are large enough to include large deviations from mean value of shocks. We approximate the stochastic income processes of the sovereign and the creditor shown by equation (36) using a discrete Markov chain of 61 and 11 equally spaced grids, respectively, as in Tauchen (1986). Moreover, we compute the transition matrix based on the probability distribution $\mu(y_{t+1}|y_t)$.

2. Second, we set finite grids on the space of recovery rates (δ_t). Limits of recovery rates are to ensure that they do not bind in equilibrium.

3. Third, we set the initial values for equilibrium sovereign bond price, the amount of risk-free bonds, payoffs of debt renegotiations for the sovereign and the creditor, and value functions for the sovereign and the creditor. We use the risk-free bond price ($q^0 = (1+r^*)^{-1}$) for the baseline equilibrium bond price. We set payoffs for debt renegotiations for the sovereign and the creditor as $\Delta^{B,0}_t = \Delta^{L,0}_t = 0$. As for the initial value functions for the sovereign and the creditor, we set $V^0 = V^{R,0} = V^{D,0} = 0$ and $V^{*0} = V^{*R,0} = V^{*D,0} = 0$ respectively.

4. Fourth, given the baseline equilibrium bond price, amount of risk-free bonds, and debt renegotiation payoffs, we solve for the sovereign's optimization problem for both good and bad credit records ($h_t = 0, 1$). This procedure finds the value functions for the sovereign and the optimal asset functions for each state ($b^1, b^{R,1}, b^{D,1}$). Furthermore, we obtain the default choice, which requires a comparison of the value functions of defaulting and non-defaulting. By comparing these two value functions, we derive the corresponding default set. Based on the default set, we also evaluate the default probability using the transition matrix.

5. Fifth, given the default set, optimal asset functions obtained in step 4, and the constant risk-free bond price, we solve for the creditor's optimization problem for both good and bad credit records ($h_t = 0, 1$) and obtain new price of sovereign bonds and the amount of risk-free bonds. The procedure finds the value functions for the creditor ($V^{*1}, V^{R*,1}, V^{D*,1}$) and optimal asset functions for sovereign bonds and risk-free bonds ($b^{*,1}, b^{f*,1}, b^{R*,1}, b^{f,R*,1}$, $b^{D*,1}, b^{f,D*,1}$). Based on the optimal choice for bond holdings, we derive the new price of sovereign bonds (q^1).

6. Sixth, given the value functions for the sovereign, we solve the bargaining problem and compute the new payoffs for two cases either the sovereign or the creditor is the proposer ($\Delta^{B,1}_t, \Delta^{L,1}_t$).

7. We iterate steps 4, 5, and 6 to have fixed optimal value functions of the sovereign and the creditor, debt renegotiation payoffs, and bond price.

Appendix E Equilibrium Properties in Different Cases

E.1 Equilibrium Properties in the Case of Correlated Income Processes

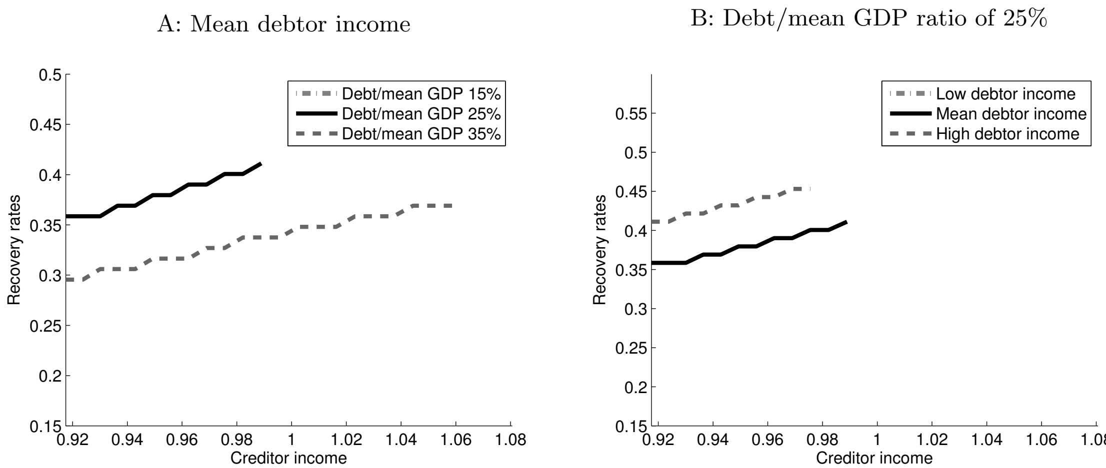
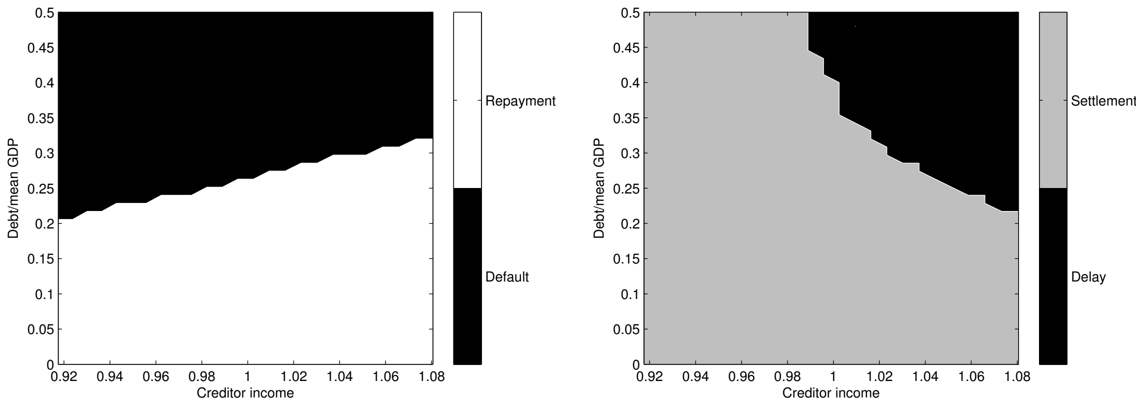


FIGURE A9. Agreed recovery rates.

A: Mean/low debtor income

(i) Good credit record (ii) Bad credit record



B: Debt/mean GDP ratio of 25%

(i) Good credit record (ii) Bad credit record

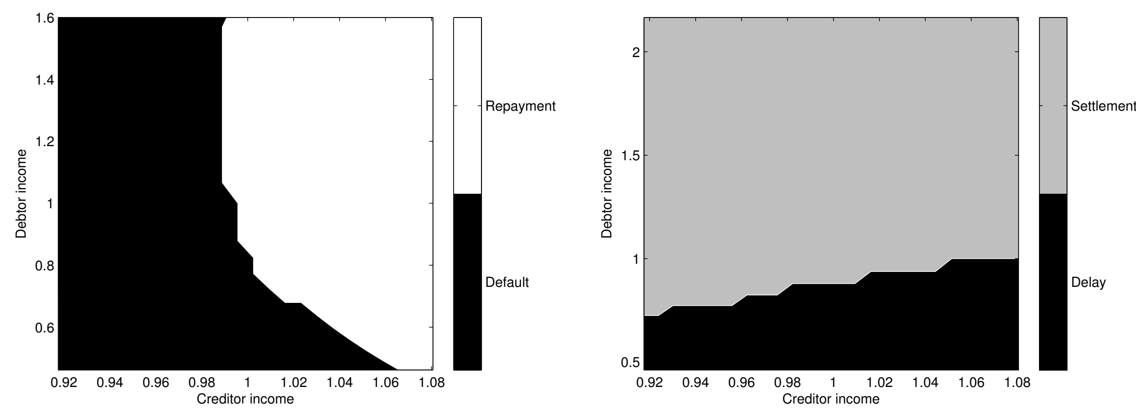


FIGURE A10. Repayment/default and settlement/delay choice.

E.2 Equilibrium Properties in the Case the Creditor Proposes

Proposition 1. *When the lender is the proposer and both parties settle, agreed recovery rates are weakly increasing with respect to the creditor income: If* $y_1 = (\bar{y}^h, y_1^f) \in R^L(b, b^f)$ *and* $y_2 = (\bar{y}^h, y_2^f) \in R^L(b, b^f)$*, where* $y_2^f \geq y_1^f$*, then* $\delta^{L*}(y_2) \geq \delta^{L*}(y_1)$*. Note that* $P^L(b, b^{*f})$ *is the delay region where* $P^L(b, b^{*f}) \cap R^L(b, b^{*f})$=Ø.

Proof. Assume that $\delta^{L*}(y_1) > \delta^{L*}(y_2)$ i.e., agreed recovery rates are lower. Since $y_1 = (\bar{y}^h, y_1^f) \in R^L(b, b^{*f})$, then from equation (25) with $\delta^{L*}(y_1)$

$$\delta^{L*}(y_1) = argmax V^{*PRO}(b, b^{*f}, y_1)$$

$$V^{*PRO}(b, b^{*f}, y_1; \delta^{L*}(y_1)) \geq V^{*PASS}(b, b^{*f}, y_1; \delta^{L*}(y_1))$$

$$V^{ACT}(b, b^{*f}, y_1; \delta^{L*}(y_1)) \geq V^{REJ}(b, b^{*f}, y_1; \delta^{L*}(y_1))$$

Similarly, since $y_2 = (\bar{y}^h, y_2^f) \in R^L(b, b^f)$, then from equation (25) with $\delta^{L*}(y_2)$

$$\delta^{L*}(y_2) = argmax V^{*PRO}(b, b^{*f}, y_2)$$

$$V^{*PRO}(b, b^{*f}, y_2; \delta^{L*}(y_2)) \geq V^{*PASS}(b, b^{*f}, y_2; \delta^{L*}(y_2))$$

$$V^{ACT}(b, b^{*f}, y_2; \delta^{L*}(y_2)) \geq V^{REJ}(b, b^{*f}, y_2; \delta^{L*}(y_2))$$

However, the lender could propose recovery rates equivalent to $\delta^{L*'}(y_2) = \delta^{L*}(y_1) > \delta^{L*}(y_2)$ which still satisfy

$$V^{*PRO}(b, b^{*f}, y_2; \delta^{L*'}(y_2)) \geq V^{*PASS}(b, b^{*f}, y_2; \delta^{L*'}(y_2))$$

$$V^{ACT}(b, b^{*f}, y_2; \delta^{L*'}(y_2)) \geq V^{REJ}(b, b^{*f}, y_2; \delta^{L*'}(y_2))$$

And also $V^{*PRO}(b, b^{*f}, y_2; \delta^{L*'}(y_2)) > V^{*PRO}(b, b^{*f}, y_2; \delta^{L*}(y_2))$ since $v(\cdot)$ is strictly increasing. This contradicts to the definition of $\delta^{L*}(y_2)$.

□

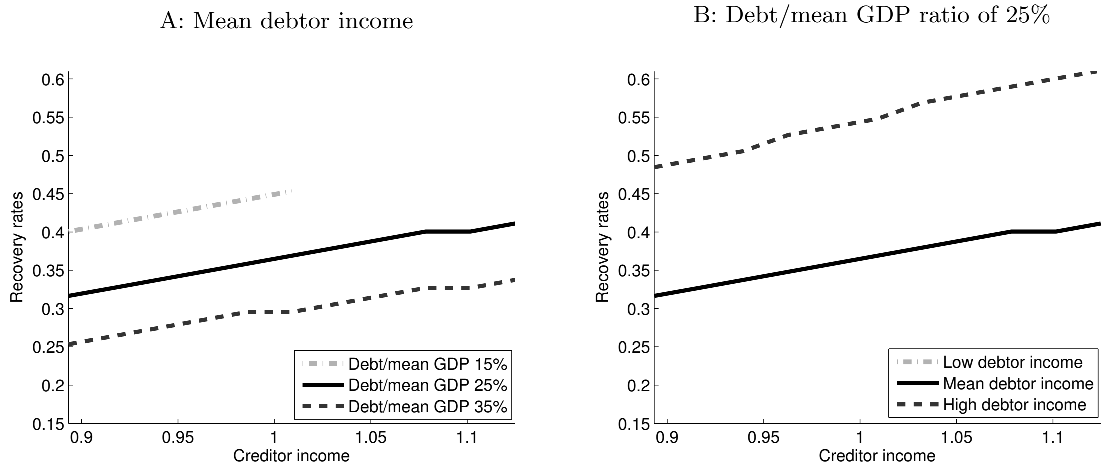


FIGURE A11. Agreed recovery rates.

Figure A11 reports agreed recovery rates when the creditor proposes. We follow the same presentation approach as in Figure 4 in terms of axes and panel classifications. Our model also shows that in the case where the creditor proposes agreed recovery rates are low (high) when the creditor has low (high) income (black solid lines). The same logic applies as in the case where the debtor proposes: in the case of low (high) creditor income, the creditor proposes low (high) recovery rates at least equivalent to the low (high) expected recovery rates in the next period expecting that the debtor accepts the offer for sure.

Agreed recovery rates when the creditor proposes are slightly higher than those when the debtor proposes (Figure 4) as in previous studies on multi-round renegotiations (Bi 2008). This is due to the "advantage of the first mover"; the party who proposes can choose the best term of offer from a wide range of recovery rates which the counterpart would accept, while the counterpart can only choose to accept or reject the offer. Therefore, he is willing to offer more favorable term for him than the term of the offer he receives from the alternative party.

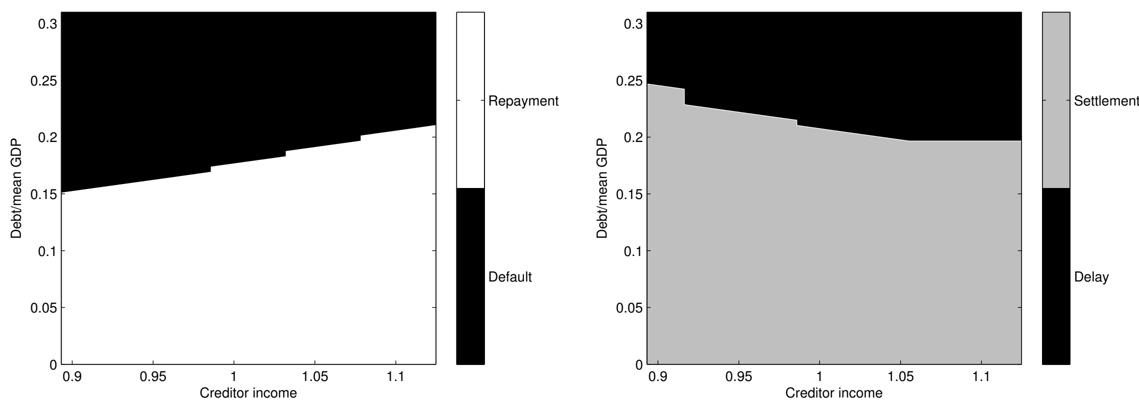
We show the sovereign's choice between repayment and default, and between settlement and delay when the creditor proposes in Figure A12. We follow the same presentation approach as in Figure 5 in terms of axis, panel classifications and regions. The sovereign's choice when the creditor proposes is exactly identical to that when the sovereign proposes (Figure 5). This is the finding in the literature of multi-round renegotiations (Bi 2008); whether an agreement on restructuring can be reached in the current period does not depend on the identity of the proposer.[20] Intuitively, if one party proposes recovery rates that make both parties at least weakly better off by settling the deal than postponing, this offer of recovery rates could identically be proposed by the alternative party and accepted.

[20]Bi (2008) provides a theoretical proof of this statement. A more general theoretical proof is shown in Merlo and Wilson (1995).

A: Mean/low debtor income

(i) Good credit record

(ii) Bad credit record



B: Debt/mean GDP ratio of 25%

(i) Good credit record

(ii) Bad credit record

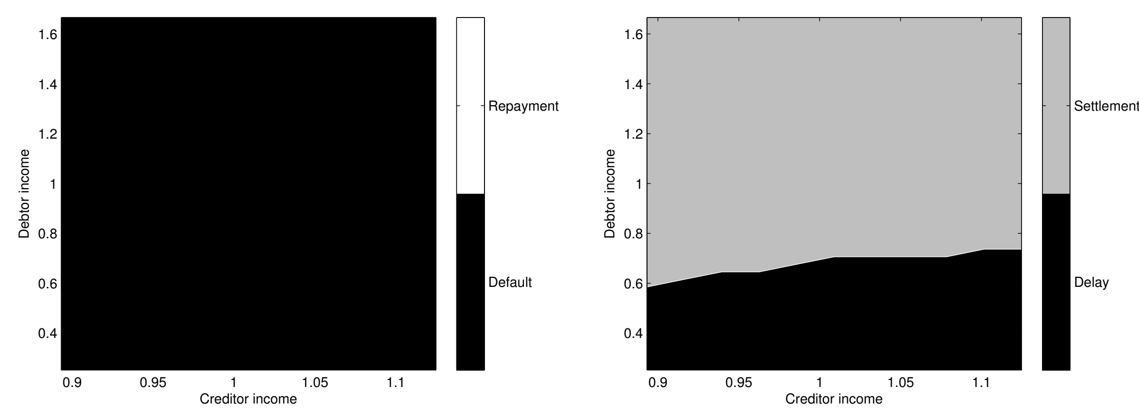


FIGURE A12. Repayment/default and settlement/delay choice.

E.3 Simulation Results in the Case of Correlated Income Processes

TABLE A11. Simulation results of model.

(i) Logit and poisson regression results on debt settlement and haircuts —correlated income processes.

	Debt settlement (binary)		Haircuts[a]	
	(1)	(1')	(2)	(2)'
	coef/ se	dy/dx / Delta-method se	coef/ se	dy/dx / Delta-method se
Creditor chair GDP growth rates, current (%)	-4.52**	-0.22**	-5.03**	-0.34**
	(1.95)	(0.10)	(2.01)	(0.14)
External debt, current (% of GDP)	-9.04***	-0.45***	-12.72***	-0.85***
	(0.98)	(0.02)	(0.78)	(0.09)
Debtor GDP growth rates, current (%)	16.19***	0.80***	11.29***	0.76***
	(2.04)	(0.05)	(0.89)	(0.11)
Episode-specific fixed effects	No		No	
Number of episodes	106		106	
Number of observations	1077		1077	
χ^2	85.35		284.5	
(p-value)	(0.000)		(0.000)	
Log-likelihood ratio	-107.7		-145.8	

Notes: The table shows results from random effects multinomial logit and poissson regressions. The dependent variables are debt settlement (binary) for logit and haircuts for poisson regressions, respectively. The main explanatory variable is current creditor GDP growth rates. External debt (in % of GDP) is current, but chosen in the previous year. Debtor GDP growth rates are in current year. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively. Robust standard errors (Delta-method standard errors) in parentheses.
a. Haircuts are measured as 1=100% and set as 0 if there is no settlement.

Appendix F Further Simulation Analysis

Panel (i) in Table A12 shows that business cycle statistics of the creditor in our model fit closely to those in the data. As explained in Section 5.3, during renegotiations the sovereign remains in financial autarky and trade balance for both the sovereign and the creditor is constant at zero (no volatility) in our model. However, the model fails to generate a negative correlation between trade balance and output in pre-default periods. This is because the creditor's trade balance surplus is a mirror of the sovereign's trade balance deficit.

Panel (ii) in Table A12 contrasts business cycle statistics in our model with those in previous models of multi-round renegotiations. Business cycle statistics in models with risk-neutral creditors and with zero debtor country size are quite similar to those in our model.

Next, we compare our non-target statistics with those obtained from recalibration exercises of Arellano (2008), Yue (2010), Benjamin and Wright (2013), and Borri and Verdelhan (2011), respectively. We follow the same approaches in these models in that we target some statistics (for instance, default frequency, standard deviation of trade balance-to-GDP ratio, and average debt service-to-GDP ratio in case of Arellano 2008) by setting parameter values accordingly. To have moment statistics comparable to our model, the recalibration of Benjamin and Wright (2013) assumes both constant bargaining power and keeps our Argentine income process. This differs slightly with Benjamin and Wright (2013) which assume both stochastic process of bargaining power, and income process—estimated from 27 emerging market countries and close to that of Thailand. We also include the reported moment statistics in Benjamin and Wright (2013) in column (7).

Our calibration results reported in column (2) continue to outperform recalibration results of previous studies as shown in panel (ii) in Table A13. First, our model is the only one which successfully replicates both positive correlations between average GDP growth rates and delays in renegotiations, and between GDP growth rates at the end and recovery rates. Second, average restructuring duration in our model (5.8 quarters) is remarkably longer than that in replication results of Yue (2010) and Benjamin and Wright (2013) (2.0 and 3.5 quarters). Average duration reported in Benjamin and Wright (2013) (33 quarters) might be possibly due to both stochastic process of bargaining power and its correlation with income process neither of which are explicitly specified—are missing in our model. Third, together with a recalibration of Benjamin and Wright (2013), our model accounts for higher level of debt in both pre-default and restructuring periods owing to larger default costs associated with longer duration of renegotiations.

Similar to our model, both a model with risk-neutral creditors and a recalibration of Benjamin and Wright (2013)—with constant bargaining power—also fail to generate a negative correlation between trade balance and output in pre-default periods. As explained in Section 5.3, this is because the sovereign is more willing to pay its debt in full and borrow more (trade deficit) given larger default costs due to longer delays in renegotiations when the debtor income is low. This is a common by-product in models with multi-round renegotiations and constant bargaining power which successfully replicate both longer delays in renegotiations and higher debt-to-GDP ratio (Bi 2008). In contrast, it does not appear in models with a one-round negotiation or with exogenous re-entry and zero recovery rates—recalibrations of Yue (2010) and Arellano (2008)—owing to smaller default costs (i.e., a quick settlement or exogenous period of autarky).[21]

Table A12. Simulation results of model—business cycle statistics.

(i) Creditor.

	Data	Baseline model (independent income processes)
Pre-default periods		
Consumption (std dev.)/output (std dev.)	0.91	0.99
Trade balance/output: std dev. (%)	0.27	2.00
Corr.(trade balance, output)	-0.63	0.33
Renegotiation periods		
Consumption (std dev.)/output (std dev.)	0.63	1.00
Trade balance/output: std dev. (%)	0.21	0.00
Corr.(trade balance, output)	-0.48	0.00

(ii) Debtor.

	Data	Baseline model (independent income processes)	Model with risk-neutral creditors (case i)[a]	Model with zero debtor country size (risk averse creditor) (case ii)[b]
Pre-default periods				
Consumption (std dev.)/output (std dev.)	1.10	0.99	0.99	1.00
Trade balance/output: std dev. (%)	1.28	1.71	1.60	0.26
Corr.(trade balance, output)	-0.87	0.10	0.43	-0.01
Renegotiation periods				
Consumption (std dev.)/output (std dev.)	1.17	1.00	1.00	1.00
Trade balance/output: std dev. (%)	2.20	0.00	0.00	0.00
Corr.(trade balance, output)	-0.97	0.00	0.00	0.00

Sources: MECON and US BEA.

a. Model with risk-neutral creditors corresponds to our model (with the same parameter values) with the risk-neutral creditors.

b. Model with zero debtor country size (and the risk averse creditor) corresponds to our model (with the same parameter values) with zero debtor country size ($\pi = 0$).

[21] An alternative approach to account for the negative correlation between trade balance and output is to introduce a stochastic process of bargaining power that depends on both the party who proposes in the current round and the current debtor income (Benjamin and Wright 2013).

Table A13. Simulation results of models of multi-round renegotiations—recalibration.

(i) Business cycle statistics—debtor.

	Data	Baseline model (independent income processes)	Arellano (2008) recalibration[a]	Yue (2010) recalibration[b]	Benjamin and Wright (2013) recalibration[c]	Borri and Verdelhan (2011) recalibration[d]	Benjamin and Wright (2013) statistics[e]
Target statistics							
Trade balance/output: std dev. (%)	1.28	-	1.20	-	-	-	-
Average debtor output deviation during restructurings (%)	-4.4	-	-	-	-4.0	-	-
Non-target statistics							
Pre-default periods							
Consumption (std dev.)/output (std dev.)	1.10	0.99	0.95	1.01	0.99	1.01	1.02
Trade balance/output: std dev. (%)	1.28	1.71	1.20	0.43	2.07	0.31	-
Corr.(trade balance, output)[f]	-0.87	0.10	-0.05	-0.02	0.34	-0.02	-0.10
Renegotiation periods							
Consumption (std dev.)/output (std dev.)	1.17	1.00	-	-	1.00	1.00	-
Trade balance/output: std dev. (%)	2.20	0.00	-	-	0.00	0.00	-
Corr.(trade balance, output)	-0.97	0.00	-	-	0.00	0.00	-

(ii) Non-business cycle statistics.

	Data	Baseline model (independent income processes)	Arellano (2008) recalibration[a]	Yue (2010) recalibration[b]	Benjamin and Wright (2013) recalibration[c]	Borri and Verdelhan (2011) recalibration[d]	Benjamin and Wright (2013) statistics[e]
Target statistics							
Default frequency (%)[g]	3.26	3.10	3.13	3.03	3.12	3.30	5.2
Average recovery rate (%)	25.0	29.5	-	26.1	28.0	-	50.0
Average debt service/GDP ratio (%)	8.0	-	7.9	-	-	-	-
Non-target statistics							
Pre-default periods							
Average debt/GDP ratio (%)	45.4	30.0	-	5.8	25.6	6.0	76.0
Bond spreads: average (%)[h]	9.4	1.5	1.4	1.2	0.70	1.8	-
Bond spreads: std dev. (%)[h]	7.6	1.1	0.66	3.5	0.80	3.5	-
Corr.(spreads, output)	-0.88	-0.15	-0.45	-0.04	-0.48	-0.01	-0.12
Corr.(debt/GDP, spreads)	0.92	0.04	0.01	0.03	0.50	-0.08	-
Corr.(debt/GDP, output)	-0.97	-0.90	-0.58	-0.57	-0.91	-0.82	-
Renegotiation periods							
Average debt/GDP ratio (%)	130.5	31.8	-	5.9	25.8	7.2	84.0
Duration of restructurings (quarters)	14.0	5.8	-	2.0	3.5	2.0	33.2
Debtor output deviation (difference between start & end, %)[i]	12.6	21.1	-	-	18.0	3.9	-
Creditor output deviation (difference between start & end, %)[i]	1.5	4.5	-	-	-	1.5	-
Corr.(debt/GDP, output)	-0.95	-0.98	-	-	-0.98	-0.73	-
Corr.(average creditor GDP growth rates during restructurings, duration)	0.15	0.63	-	-	-	-	-
Corr.(creditor GDP growth rates at the end of restructurings, recovery rates)	0.30	0.70	-	-	-	-	-

Sources: Benjamin and Wright (2013 Table 6–8), Datastream, IMF WEO, MECON, and US BEA.

a. Arellano (2008) recalibration corresponds to calibration results with three target statistics (i) default frequency, (ii) standard deviation of trade balance/GDP ratio, and (iii) average debt service/GDP ratio as in Arellano (2008).

b. Yue (2010) recalibration corresponds to calibration results with two target statistics (i) default frequency and (ii) average recovery rate as in Yue (2010).

c. Benjamin and Wright (2013) recalibration corresponds to calibration results with three target statistics (i) default frequency, (ii) average recovery rate, and (iii) average debtor output deviation during renegotiations as in Benjamin and Wright (2013).

d. Borri and Verdelhan (2011) recalibration corresponds to calibration results with one target statistic (i) default frequency as in Borri and Verdelhan (2011).

e. Benjamin and Wright (2013) statistics correspond to their moment statistics in calibration results using average emerging market income process and stochastic bargaining power.

f. Corr.(trade balance/output, output) reported for Benjamin and Wright (2013) recalibration.

g. As commonly used in theoretical literature on sovereign debt, this corresponds to a number of actual default events over the simulation horizon (i.e., 100 years).

h. This includes expected probability of default next period.

i. A difference in output deviation between the start and end.