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

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Abstract

Foreign creditors’ business cycles influence both the process and outcome of sovereign debt restructurings. We compile two new datasets on creditor committees and on creditors’ business cycles during debt restructurings and find that when creditors experience high GDP growth, restructurings are protracted and settled with smaller haircuts. To explain these stylized facts, we develop a theoretical model of sovereign debt that embeds multi-round negotiations between a risk-averse debtor and a risk-averse creditor. The quantitative analysis shows that high creditor income results in both longer delays in restructurings and smaller haircuts. Our theoretical findings are also confirmed through an empirical analysis.

JEL Classification Codes: F34, F41, H63

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

1 Introduction

Foreign creditors’ business cycles influence both the process and outcome of sovereign debt restructurings. We compile two new datasets on the creditor committees and on creditors’ business

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cycles during restructurings with private external creditors and show that when foreign creditors are facing high gross domestic product (GDP) growth rates, restructurings are protracted and settled with smaller net present value (NPV) haircuts and face value reductions. To explain these stylized facts, we develop a theoretical model of defaultable debt that explicitly embeds multi-round debt negotiations between a risk-averse sovereign and a risk-averse creditor. Our quantitative analysis shows that high creditor income results in both longer delays of restructurings and smaller haircuts. Our theoretical findings are supported both by a calibration exercise for Argentine restructuring in 2001–2005 and by the data through our empirical analysis.

First, the paper demonstrates two new datasets on (a) the creditor committees and (b) creditors’ business cycle statistics at the debt restructurings with private external creditors. On the former, we newly code data on the creditor committees—normally comprised of groups of 5–20 representative creditors (mostly banks)—and respective chairs who consult with the delegations from the debtor countries in a regular basis and discuss exchange proposals during restructurings. Our dataset shows a new stylized fact that the creditors establish formal committees in 131 debt restructuring episodes (73 percent of total 179 episodes) over 1978–2010. Among these cases, 121 cases (68 percent of total cases) are successfully identified as episodes with the chairmen, mostly the US and European banks.

On the latter, we also construct a new, comprehensive dataset on creditor GDP growth rates and risk aversion at a monthly frequency during sovereign debt restructurings. Our data comprise mainly two indicators: (1) GDP growth rates in the US and Germany,—consistent with the aforementioned stylized fact—, and (2) risk aversion of the US and German creditors. Risk aversion indicators are proxied by credit spreads for US financial firms originally compiled by Gilchrist and Zakrajsek (2012) and German term premia. We then combine our new dataset with two existing datasets on the duration of restructurings at a monthly frequency from Asonuma and Trebesch (2016) and on creditor losses (haircuts and face value reduction) from Cruces and Trebesch (2013), both of which cover the same 179 episodes of restructurings over 1978–2010.

Additionally, three new stylized facts on the foreign creditors’ GDP growth rates (risk aversion indicators) and the process and outcome of post-default debt restructurings—countries negotiate with creditors after payments are missed (default)—emerge from our consolidated datasets. When foreign creditors are experiencing high GDP growth rates, restructurings are: (i) protracted (have longer delays), (ii) result in lower NPV haircuts (higher recovery rates), and
(iii) lower face value reductions. We confirm these findings through cross-sectional regressions using 111 episodes of post-default debt restructurings over the last 3 decades controlling for relevant macroeconomic and financial market variables.

These empirical facts unveil a new dimension of sovereign defaults and debt restructuring which the literature has not fully explored yet. In particular, two new questions emerge: Why are restructurings protracted (have longer delays) when the foreign creditors are experiencing high income? Why are agreed haircuts (recovery rates) low (high) when the creditors are facing high income? These questions are contrary to the current understanding in the literature in that the creditors’ negotiation stances remain unchanged. To our knowledge, this is the first paper to shed light on the role of creditors at sovereign debt restructurings, in particular the influence of the creditors’ business cycles on processes and outcomes of debt restructurings.

To achieve this goal, we develop a theoretical sovereign debt model with endogenous default and multi-round debt renegotiations with a sovereign debtor and its creditor. The basic structure of the model closely follows the recent quantitative analysis of sovereign debt—built on the classic setup of Eaton and Gersovitz (1981)—such as Aguiar and Gopinath (2006), Arellano (2008) and Tomz and Wright (2007). In particular, our two-country framework with the risk-averse creditor is aligned with Arellano and Bai (2014) and Lizarazo (2013). On the basis of an interdependent relationship, the creditor’s surplus at the bargaining game fully reflects the debtor’s capacity to pay the recovered debt payments changing over both the debtor income realization and the random selection of proposer, which is assessed symmetrically by the creditor in a conventional, small open-economy model with the risk-averse creditor (Borri and Verdelhan, 2011).

What differentiates our theoretical model from standard sovereign debt negotiation models is the incorporation of multi-round renegotiations between a risk-averse debtor and a risk-averse creditor whose consumption smoothing motive and outside option are state-dependent. 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 (2009) and Bi (2008). At each period (each round of negotiation), both the sovereign and the creditor face stochastic income processes. After observing its income, the sovereign chooses to pay the debt in full or

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1 See also the survey by Augiar and Amador (2014) and Aguiar et al. (2016).

2 A conventional small open economy model with the risk-averse creditor, for instance, Borri and Verdelhan (2011) does not generate either delays in restructurings or high average debt-to-GDP ratio. See Section 5.4 for discussion in depth.
to default. When a default occurs, the debtor and the creditor negotiate a reduction of 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 its option. The other party decides whether to accept the proposal or to reject
the offer. If the offer with haircuts (recovery rates) is proposed and accepted, then the sovereign
resumes access to the market in the next period and the creditor receives the recovered debt
payments. Otherwise, both parties continue the negotiation over the debt in arrears in the next
period.

The risk-averse creditor in our model decides whether to complete the exchange with the
proposed recovery rates or postpone the settlement by comparing the utility value from the com-
pletion of the exchange with that of his/her outside option, 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 payment and the related outside option.\footnote{We
focus on the situations where creditors have long-term relationships with sovereign debtor
countries, as was commonly seen in the London Club restructuring and Brady bond restructuring
eras, i.e., 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.} Therefore, the creditor’s environment differs substantially from the traditional assumption of the
risk-neutral creditor with no uncertain income, where the creditor is totally indifferent to the
timing of the settlement of restructurings because there was no change in the present value of
the recovery rates; the rate of arrears accumulation is identical to the risk-neutral creditor’s
discount rate.

We emphasize two new key points in our theoretical model. First, we show that haircuts are
smaller (recovery rates are higher) when the creditor is facing high income as observed in the
data. In this case, the creditor is less financially constrained and less eager to recoup losses on
defaulted debt at the current round of negotiation. The outside option for the creditor, defined
as the utility value associated with the expected recovery rates in the future period, remains
high since his/her high income is anticipated to persist. The creditor simply requests current
recovery rates high enough (haircuts low enough) to be comparable to the expected high recovery
rates in the future. Otherwise, he/she merely opts to postpone the settlement. This is because
in the next period, the creditor, who has persistently high income, can afford to wait and this
contributes to the demand for high recovery rates in the current round. As a consequence, the
sovereign has no choice but to accept high recovery rates (low haircuts) if it opts to settle the deal in the current period expecting to avoid further output costs and financial exclusion.

Next, we demonstrate two mechanisms of delays, originated by two different drivers. On the former, recovery of the debtor’s income to its pre-default level takes time, which generates delays. This mechanism is explained by Benjamin and Wright (2009) and Bi (2008) who show that both the sovereign and the creditor prefer to “wait for a larger cake” i.e., wait for recovery of the debtor’s income. High output costs of defaults undermine the debtor’s repayment capacity during negotiations. This reduces the proposed recovery rates which lead to an increase in the likelihood of delaying the settlement.

On the latter, more importantly, the creditor with high income can afford to wait and requests high recovery rates, resulting in delays. Our model explicitly demonstrates the state-dependent creditor’s consumption smoothing motive through recovered debt payments driven by the creditor’s income process. When the creditor’s income is high—they are more patient and less reluctant to receive unfavorable recovered debt payments for the current consumption given the expectation of higher expected recovery rates in the next period—he/she demands higher recovery rates that are at least comparable to the high, expected recovery rates in future periods corresponding to the creditor’s value of postponing the negotiation. This makes an agreement with the debtor more difficult in the current period and hence results in delays.

The theoretical model is calibrated to the case of Argentina’s default and restructuring in 2001–2005. Our quantitative exercise successfully replicates both the business cycle and non-business cycle moments that match with the data as in models with endogenous negotiations, such as Yue (2010), Benjamin and Wright (2009), Bi (2008), and Asonuma and Trebesch (2016). One main accomplishment is that our model succeeds in generating longer periods of debt restructuring than those in models with one-round negotiations (Yue 2010; Asonuma and Trebesch 2016; D’Erasmo 2010) or conventional models of multi-round negotiations (Benjamin and Wright 2009; Bi 2008). Moreover, high average debt-to-GDP ratios in both the pre-default and restructuring periods in our model closely matches those of the data. This stands as one of the main contributions of models with multi-round negotiations as shown in Benjamin and Wright (2009) and Bi (2008), that models with one-round negotiations (Yue 2010) fail to explain.4

4Models with long maturity bonds without restructurings also account for a high average debt-to-GDP ratio, which conventional models with one-period bonds fail to explain. See Chatterjee and Eyingunor (2012, 2015), Hatchondo and Martinez (2009a), and Hatchondo, et al. (2015).
Finally, the empirical analysis shows that our theoretical findings are supported by the data. We apply a probit regression on an unbalanced panel of 179 restructurings at annual frequency. Our regression specification is aligned with our theoretical model and a binary variable of settlement of restructurings is set as a dependent variable. Our panel regression results confirm that debt restructurings are protracted when creditor’s GDP growth rates are high.

**Literature Review**  The theoretical analysis of the paper is aligned with 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.\(^5\)\(^6\) In particular, our paper is closely related to Benjamin and Wright (2009), Bi (2008), and Bai and Zhang (2010) which embed a multi-round bargaining game to analyze delays in debt renegotiations.\(^7\) Benjamin and Wright (2009) explain that delays arise due to the same commitment issues such as the borrower’s limited ability to repay the newly issued debt, and Bi (2008) finds that delays can be beneficial for both parties in that they allow the economy to recover from a crisis first and make more resources available to settle the renegotiation.\(^8\) This paper contributes to the literature by explaining an additional channel of delays driven by foreign creditors’ state-dependent consumption-smoothing motive.\(^9\)

The second stream of literature studies sovereign debt and risk-averse creditors. These

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\(^6\) More generally, our modeling approach of debt renegotiation is aligned with the literature on delays and inefficiencies in bargaining theory. See for instance, Merlo and Wilson (1995,1997), Kennan and Wilson (1993), Yildiz (2004), and Ortner (2013).

\(^7\) Arellano and Bai (2014) 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 debtor’s debt, in particular whether the other debtor 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 a discounted value of the expected recovery rates of the negotiations in the future periods. Our modeling approach is aligned with observed stylized facts of longer duration of restructurings when creditors are experiencing high GDP growth rates. In addition, we newly provide comprehensive data and stylized facts on creditors’ GDP growth rate and risk aversion during private external restructurings over 1978–2010.

\(^8\) In a different set-up, Bai and Zhang (2010) show that the secondary market plays an information revelation role to shorten the costly delays.

\(^9\) Political factor could potentially be an additional driver of delays in negotiation. Ongoing work by Asonuma et al. (2016) model multi-round negotiations with political uncertainty. There is an emerging literature on political uncertainty and sovereign debt for instance, Amador (2012), Cuadra and Sapriza (2008), Hatchondo and Martinez (2009b), Hatchondo et al. (2009), and Trebesch (2013).
studies, such as Broner et al. (2013), Borri and Verdelhan (2011), Arellano and Bai (2014), Lizarazo (2013), Pouzo and Presno (2015), Gilchrist et al. (2014), Gu (2016), and Asonuma (2016b) show that the creditor’s risk aversion allows the model to generate spreads larger than default probabilities, as observed in emerging market countries. Arellano and Bai (2014) and Lizarazo (2009) analyze contagion in a model in which multiple borrowers trade with risk-averse lenders. Our paper fills a gap in the literature by exploring how creditors’ business cycles influence debt restructuring processes and outcomes.

The paper also contributes to empirical literature on sovereign debt restructurings, for instance Benjamin and Wright (2009), Sturzenegger and Zettelmeyer (2006, 2008), Reinhart and Rogoff (2009, 2011), Cruces and Trebesch (2013), Kaminsky and Vega-Garcia (2016), and Asonuma and Trebesch (2016). On private external debt restructurings, Benjamin and Wright (2009) first document a new perspective on the relationship between restructuring delays and haircut size, and Asonuma and Trebesch (2016) show that preemptive restructurings have much lower haircuts and shorter durations. 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 creditor committee and creditors’ business cycles in private external debt restructurings.

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10 Some studies on sovereign debt restructurings apply detailed case studies such as, Sturzenegger and Zettelmeyer (2006, 2008), Finger and Mecagni (2007), Diaz-Cassou et al. (2008), Panizza et al. (2009), Das et al. (2012), and Erce (2013).

11 Reinhart and Rogoff (2009, 2011) demonstrate that domestic default tends to occur under situations of greater distress than for external default—both in terms of an output decline and escalation of inflation. With a focus on Latin America from 1820 to the Great Depression, Kaminsky and Vega-Garcia (2016) find that almost 60 percent of sovereign defaults are of a systemic nature, different from those with an idiosyncratic nature.

12 In contrast, Gelos et al. (2011) show that the probability of market access after a default is not influenced by a country’s frequency of defaults, and that a default, if resolved quickly, does not reduce significantly the probability of tapping the markets. Trebesch (2013) suggests that sovereign factors such as political instability, weak institutions and strategic government behavior, influence delays in restructurings more than creditor characteristics.

13 Similarly, Asonuma (2016a) also find that higher haircuts (lower recovery rates) at renegotiation are associated with larger increase in yield spreads representing trade-offs of both debtors and creditors.
2 Dataset, Stylized Facts and Empirical Analysis

2.1 New Dataset on Creditor Committees at Sovereign Debt Restructurings

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—often creditor committees—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 capacity of repayment over the medium term and evaluate their expected recovery on defaulted debt depending on their total assets and total return on the overall portfolio. During negotiation, the debtor usually proposes indicative scenarios and the creditors express their views. At the end, the debtor presents a final restructuring proposal, i.e., exchange offer, to the creditors. The creditors then decide to accept or reject the offer.

In this regard, Ecuador’s debt buyback in 2008–2009 is a representative episode in which the creditors’ business cycle played a critical role in renegotiation. In November 2008, President Correa announced that an upcoming $31 million coupon payment on the 2012 bonds would be skipped. A formal default on the foreign debt was declared on December 2008. In April 2009, Ecuador launched a cash buyback offer to repurchase the two series of defaulted bonds with a base price of 30 cents on the dollar of outstanding principal. The buyback was successfully completed in June 2009. Clearly, 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. Indeed, Ecuador succeeded in a quick settlement with creditors (a short duration of 7 months) despite the post-default case, which resulted in large creditor losses (NPV haircut of 68 percent).

To explore explicitly the role of foreign creditors in restructurings, we first need to identify whether creditor committees are formed during negotiation and who are the chairmen (co-chairs) of the creditor committees at restructurings. For this purpose, we code new data on creditor committees and the respective chairmen at private external debt restructurings over 1978–2010.

Our data on creditor committees comprise of mainly four sources: (a) a comprehensive

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14 See Das et al. (2012) for in-depth explanations on process of debt restructurings.
15 See also Buchheit and Gulati (2009) and Porzecanski (2010).
16 See Asonuma and Trebesch (2016) for classification of preemptive and post-default restructurings.
dataset on creditor committees under the Bank Advisory Committee (London Club) process for 1975–1995 from Lomax (1986) and Rieffel (2003):\(^{17}\) (b) comprehensive data on creditor committees for debt restructurings over 1978–2010 in Trebesch (2011); (c) creditor committees on recent debt restructurings in 1999–2010 in Das et al. (2012); and (d) country case studies of debt restructurings, such as by Asonuma et al. (2014, 2016), Buchheit (2009), Diaz-Cassou et al. (2008), and Sturzenegger and Zettlemeyer (2006, 2008).\(^{18}\)

We newly find that formal creditor committees are formed during negotiations in 131 debt restructuring episodes (73 percent of total 179 episodes) over 1978–2010. Among these cases, we identify 121 cases (68 percent of total cases) with chairmen (or co-chairmen) of the creditor committees who consult with delegations from the debtor countries. Additional aspect of evidence emerges from Table 1; US banks have served as chairmen of the creditor committees for 60 restructurings, more than a half of restructurings with identified committee chairmen. European banks have covered 46 restructurings, equivalent to a third of episodes with identified chairmen. Among them, German, UK and French banks account for 16, 14 and 12 cases, respectively. Appendix A reports the creditor committees and respective chairs for 18 selective restructuring cases.

\(^{17}\)As documented in Rieffel (2003), some selective commercial banks were repeatedly serving as a chairman of the creditor committee. This is because sovereigns that had selected a creditor committee at previous negotiations usually choose the same bank(s) and first time negotiating debtors were advised to approach the bank that was the sovereign’s largest creditor or had the most active in arranging syndicated loans.

\(^{18}\)Detailed discussion of communication between the debtor and the creditor committee in Belize 2012–2013 and Grenada 2013–15 restructurings is provided in Asonuma et al. (2014, 2016), respectively.
Table 1: Chairmen of the Creditor Committees at Sovereign Debt Restructurings, 1978–2010

<table>
<thead>
<tr>
<th>Restructuring</th>
<th>Observation</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restructuring with the creditor committees</td>
<td>131</td>
<td></td>
</tr>
<tr>
<td>Restructuring with identified chairmen of the creditor committees</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>US banks</td>
<td>60</td>
<td>49%</td>
</tr>
<tr>
<td>European banks</td>
<td>46</td>
<td>38%</td>
</tr>
<tr>
<td>German banks</td>
<td>16</td>
<td>13%</td>
</tr>
<tr>
<td>UK banks</td>
<td>14</td>
<td>11%</td>
</tr>
<tr>
<td>French banks</td>
<td>12</td>
<td>10%</td>
</tr>
<tr>
<td>Swiss banks</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Dutch banks</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Canadian banks</td>
<td>8</td>
<td>6%</td>
</tr>
<tr>
<td>Japanese banks</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Restructuring without identified chairmen</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Restructuring without committees/ with unidentified chairmen</td>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

- **Stylized fact 1**: Creditor committees are formed in almost 75 percent of sovereign debt restructurings and the US and European banks have served as creditor committee chairs.

2.2 New Stylized Facts on Sovereign Debt Restructurings

Next we shed light on the creditors’ business cycle during restructurings. Our empirical analysis uses mainly two sets of data. One of them is existing dataset on durations, NPV haircuts and face value reductions for 179 private, external debt restructurings over 1978–2010 from Cruces and Trebesch (2013) and Asonuma and Trebesch (2016). As defined in Sturzenegger and Zettelmeyer (2006, 2008), the NPV 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, as commonly used in financial markets, the face value (nominal) reductions is a difference in the face value between new instruments and remaining old instruments at exchange. Asonuma and Trebesch (2016) define the duration of restructurings as the

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19In contrast, financial market participants use haircut measures which compare the market value of the new debt and cash received to the sum of outstanding face value of the old debt and past due interest.
number of months from the start of distress (default or announcement of a restructuring) until
the completion of the debt restructuring process (debt exchange).

The other part that is newly constructed in this paper is a dataset on creditors’ GDP
growth rates—consistent with the aforementioned stylized fact 1—and risk aversion indicators
in monthly frequency during debt restructurings. The new dataset comprises (i) US GDP
growth rates from the Bureau of Economic Analysis (US), (ii) German GDP growth rates from
the Federal Statistical Office (Germany), (iii) Gilchrist and Zakrjasjek's (2012) credit spreads
for US financial firms, and (iv) German corporate bond yields from the Bundesbank.20,21,22 We
complement GDP growth rates with monthly risk-aversion indicators which similarly capture
creditors’ business cycle features. Table 2 reports the duration of restructurings, NPV haircuts
and face value reductions, investors’ GDP growth rates and risk aversion which are averaged
over the duration of the restructurings. For further robustness check, we use other proxies for
creditors’ wealth, in particular for US banks in Appendix B: (a) growth rate of US commercial
banks’ assets and (b) growth rate of US equity price.

Asonuma and Trebesch (2016) find preemptive exchanges—negotiations take place prior to
a payment default—account for 38% of all restructurings (68 cases) over 1978–2010, while post-
default restructurings—the government defaults first and renegotiate its debt later—(111 cases)
for 62%. Focusing on post-default episodes, it is apparent in Figure 1 that restructurings are
protracted when investors’ income is high.23 This is clearly the case for both average US and

20Gilchrist and Zakrjasjek (2012)'s credit spread index 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. It measures the disruption of the financial market and has higher predictability for future
economic activity than the widely used default-risk indicators, for instance the Baa-Aaa corporate bond credit
spread and the paper-bill spread. We also use a conventional indicator, Aaa-rated long-term industrial corporate
bond yields in the US (from the Board of Governors of the Federal Reserve System), and obtain similar panel
regression results.

21For Germany or the euro zone, the credit risk indicator from Gilchrist and Mojon (2014), applying the same
method as in Gilchrist and Zakrjasjek (2012), covers only the period 1999–2013. This substantially reduces our
sample of restructurings to about 20 episodes, one-tenth of the original sample. Instead, to preserve our large
sample coverage, we use the commonly used indicator, Aaa-rated corporate bond yields. Given the unavailability
of monthly Baa-rated corporate bond yields in Germany, we rely on the levels of Aaa-rated corporate bond yields.
Since the Landesbank (Landesbanken) in Germany that are in charge of the issuance and placement of corporate
bonds, are a group of state-own banks of a type unique to Germany, corporate bonds yields is “quasi-market”
price. Due to a lack of “pure-market priced” bond yields, we use this series. We also use term premia for Germany
Treasury bills, a difference between 1-year and 10-year yields, and obtain similar panel regression results.

22The Chicago Board Options Exchange Market Volatility Index (VIX), which is a key measure of market
expectations of near-term volatility conveyed by S&P 500 stock index option prices. Due to limited coverage of
this index (starting only from January 1993) our sample of restructuring episodes is drastically reduced if we use
VIX indicator. Nevertheless, we obtain similar panel regression results.

23In addition, when the creditors’ income is high, they are less willing to sell defaulted or distressed bonds at
Table 2: Duration, Haircuts, Face Value Reductions, Investors’ GDP Growth Rates and Risk Aversion for Restructuring in 1978–2010

<table>
<thead>
<tr>
<th></th>
<th>Observation</th>
<th>Mean</th>
<th>Median</th>
<th>std dev.</th>
<th>Ave. 1978–2010(^3)/</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration of Restructurings (# of months)</strong></td>
<td>179</td>
<td>39.6</td>
<td>18.7</td>
<td>49.4</td>
<td>-</td>
</tr>
<tr>
<td><strong>NPV Haircuts (%)</strong></td>
<td>178</td>
<td>36.7</td>
<td>31.7</td>
<td>27.2</td>
<td>-</td>
</tr>
<tr>
<td><strong>Face Value Reduction (%)</strong></td>
<td>178</td>
<td>16.5</td>
<td>0.0</td>
<td>30.3</td>
<td>-</td>
</tr>
<tr>
<td><strong>Investor’s GDP Growth Rate Ave.(^1)/</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US GDP Growth Rate (%)</td>
<td>177</td>
<td>3.4</td>
<td>3.4</td>
<td>1.8</td>
<td>2.8</td>
</tr>
<tr>
<td>German GDP Growth Rate (%)</td>
<td>177</td>
<td>2.1</td>
<td>2.2</td>
<td>1.5</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Investor’s Risk Aversion Ave.(^2)/</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Credit Spreads (GZ) (%)</td>
<td>104</td>
<td>1.7</td>
<td>1.7</td>
<td>0.8</td>
<td>-</td>
</tr>
<tr>
<td>German Term Premia (%)</td>
<td>177</td>
<td>1.2</td>
<td>1.4</td>
<td>1.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Sources: Asonuma and Trebesch (2016), Bureau of Economic Analysis (US), Cruces and Trebesch (2013), Deutsche Bundesbank, Federal Statistical Office (Germany) and Gilchrist and Zakajsek (2012).

\(^1\)/ Monthly average over duration of restructurings. We transform quarterly GDP series for both the US and Germany into series in monthly frequency given a lack of comprehensive monthly GDP series covering the whole sample period.

\(^2\)/ Monthly average over duration of restructurings,


German GDP growth rates during restructurings as shown in panel A and B. Regression lines highlighted in red correspond to the estimated lines from regression results reported in Table 3 below. Creditors are willing to avoid a quick resolution and opt to postpone the settlement when they have high income during renegotiations.

In a similar vein, NPV haircuts are smaller (recovery rates are larger) when creditor’s income is high as presented in Figure 2. GDP growth rates for the US and Germany at the end of restructuring are negatively associated with haircuts (panel A and B). A vertical axis indicates fractions of NPV haircuts that are not explained by a partial regression including all explanatory variables other than creditors’ GDP growth rates. We also find a similar pattern for face value reductions: face value reductions are smaller when creditors’ income is high, as reported in Figure A1 in Appendix B.

With our combined sample of 111 post-default episodes, cross-sectional analysis attempts to confirm how the creditors’ income influences duration and haircuts. We have the following three specifications using our indicators for the creditors’ income (\(Creditor\_Income\_i\)):

\[
Duration_i = c + \beta_1 Creditor\_Income_i + Z_i \gamma + \epsilon_{i,1}
\] (i)

the secondary market and instead willing to hold anticipating high recovery rates at the exchange.
Figure 1: Durations and Creditors’ GDP Growth Rates for Restructurings in 1978–2010

(i) US GDP Growth Rate

(ii) German GDP Growth Rate

Sources: Asonuma and Trebesch (2016), Bureau of Economic Analysis (US), Federal Statistical Office (Germany).
Figure 2: Haircuts and Creditors’ GDP Growth Rates for Restructurings in 1978–2010

(i) US GDP Growth Rate/1

(ii) German GDP Growth Rate/1

Sources: Cruces and Trebesch (2013), Bureau of Economic Analysis (US), and Federal Statistical Office (Germany)

Note: /1 Vertical axis in two panel charts corresponds to estimated residuals from a partial regression over NPV haircuts using explanatory variables except creditors’ growth rates.
Haircut$_i = c + \beta_1 \text{Creditor Income}_i + Z_i \gamma' + \epsilon_{i,2} \quad (ii)

FVReduction$_i = c + \beta_1 \text{Creditor Income}_i + Z_i \gamma' + \epsilon_{i,3} \quad (iii)

where Duration$_i$, Haircut$_i$, and FVReduction$_i$ correspond to the duration, NPV haircut and face value reduction of debt restructuring $i$, respectively. $Z_i$ is a vector of the other explanatory variables. To reflect the influence over the whole duration of the restructurings, average creditors’ income is used for specification (i). On the contrary, to capture the effect at the time of settlements, creditors’ income at end of restructurings is used for specification (ii) and (iii). For the choice of the other control variables, we follow the empirical literature on sovereign defaults and restructurings, particularly Kohlscheen (2009), Trebesch (2013), and Asonuma (2016a). We have the debtors’ GDP deviation from the trend and growth rate of the GDP trend obtained by applying a Hodrick-Prescott (H-P) filter, external debt-to-GDP ratio and export-to-debt service ratio at the end of restructurings, which are considered to be key factors in debt renegotiation. To capture the influence of global liquidity, we also include London Interbank Offered Rate (LIBOR).

On the duration of restructurings, baseline regression results (columns 1 and 2 in Table 3) show that high average creditors’ income during negotiation, measured by the average GDP growth rates for the US and Germany, leads to a longer duration of restructurings. When creditors are facing high income, they are willing to postpone the settlement to later periods. As in previous studies on sovereign debt restructurings, (Trebesch, 2013), restructurings tend to be protracted when external debt is large and sovereigns have ample liquidity (high export-to-debt service ratio). The debtors’ GDP deviation from trend and growth rate of the GDP trend at the end of restructurings are shown to positively influence the duration of restructuring, but this is possibly due to that fact that restructurings are completed after economic recovery (Bi, 2008; Benjamin and Wright 2009). Similarly, lower average risk aversion of creditors—highly correlated with the creditors’ high income—is highly associated with a longer length of restructurings (columns 3 and 4 in Table 3).

Next, NPV haircuts are substantially reduced by an increase in creditors’ income at the end of restructurings (US and German GDP growth rates) reported in columns 1 and 2 in Table 4. Creditors receiving high income demand lower haircuts (higher recovery rates), while accepting higher haircuts (lower recovery rates) when their income is low. In line with empirical findings in
the sovereign debt restructuring and crisis literature, haircuts are high if external debt is large. The export-to-debt service ratio exhibits a positive sign possibly because sovereigns with high liquidity (a high export-to-debt service ratio) are less reluctant to accept low haircuts (high recovery rates) in exchange for regaining market access. Despite the insignificance, haircuts are lower with US per capita (US dollar), since countries that are highly developed in the US dollar terms, have a higher capacity to repay debt. GDP deviation from trend at the end of restructurings enters as a counter-intuitive sign insignificantly, but this is possibly due to that fact that restructurings are completed after economic recovery, as mentioned previously. Moreover, when creditors are less risk-averse—highly correlated with the creditors’ high income process—they demand lower haircuts (higher recovery rates), as reported in columns 3 and 4 in Table 4.

The same pattern is confirmed for face value reductions (Table A2 in Appendix B): an increase in average creditors’ income (US and German GDP growth rates) remarkably reduces face value reductions at restructurings. Creditors with high income request higher recovery rates (lower haircuts) not only in NPV terms but also in nominal terms. Three stylized facts are confirmed from Figures 1, 2, and A1 and Tables 3, 4, and A2:

- **Stylized fact 2: Restructurings tend to be protracted when foreign creditors’ income is high.** The duration of restructurings is extended by about 6.6 years due to a 1-percent increase in creditors’ average GDP growth rate.

- **Stylized fact 3: Haircuts are smaller (recovery rates are higher) when foreign creditors are facing high income.** A 1-percent increase in creditors’ GDP growth rate at the end of restructurings reduces haircuts by 2.5–3.1 percent.

- **Stylized fact 4: Face value reductions are small when foreign creditors are facing high income.** Face value reductions are reduced by 3.2–4.4 percent by a 1-percent increase in creditors’ GDP growth rate at the end of restructurings.
Table 3: Regression Results on Duration of Restructurings

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(1) US GDP Growth Rate</th>
<th>(2) German GDP Growth Rate</th>
<th>(3) US Credit Spreads (GZ)</th>
<th>(4) German Term Premia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of Restructurings (year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| US GDP Growth Rate, average (%)
 1/ Monthly average over duration of restructurings | 6.61**                | -                         | -                         | -                      |
| German GDP Growth Rate, average (%)
 1/ Monthly average over duration of restructurings | -                     | 6.62*                     | -                         | -                      |
| US Credit Spreads (GZ), average (%)
 1/ Monthly average over duration of restructurings | -                     | -                         | -14.57**                  | -                      |
| German Term Premia, average (%)
 1/ Monthly average over duration of restructurings | -                     | -                         | -19.54**                  | -                      |
| GDP Deviation from Trend, end (%)
 2/ Levels at end of restructurings | 1.62***               | 1.60**                    | 1.62**                    | 1.52**                 |
| Growth Rate of GDP Trend, end (%)
 2/ Levels at end of restructurings | 11.50***              | 11.09***                  | 9.84***                   | 12.82***               |
| External Debt/GDP Ratio, end (%)
 2/ Levels at end of restructurings | 0.22**                | 0.23**                    | 0.18                      | 0.36***                |
| Export-to-debt Service Ratio, end (%)
 2/ Levels at end of restructurings | 2.47**                | 2.44**                    | 2.26**                    | 2.83***                |
| LIBOR 12-month, average (%) | 9.72***               | 6.25**                    | 6.21**                    | 4.65                   |
| LIBOR 12-month, end (%) | -12.17***             | -10.46***                 | -10.06***                 | -                      |
| German 1-year Yield, end (%) | -                     | -                         | -14.60                    | -                      |
| Contant | -3.55                 | 22.47                     | 58.44*                    | 42.05                  |
| Sample | 89                    | 89                        | 62                        | 89                     |
| Adj-R^2 | 0.44                  | 0.44                      | 0.42                      | 0.38                   |
| Root MSE | 44.5                  | 44.9                      | 42.18                     | 47.1                   |


Notes: All regression results are based on ordinary least square (OLS) estimation. Standard errors are in parentheses. ***, **, * show significance at 1, 5, and 10 percent levels, respectively.

1/ Monthly average over duration of restructurings.

2/ Levels at end of restructurings.

3/ GDP deviation from the trend and growth rate of GDP trend are a percentage deviation from the trend and annual change in the trend obtained by applying a Hodrick-Prescott (H-P) filter to quarterly GDP series.
Table 4: Regression Results on Haircuts

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(1) US GDP Growth Rate</th>
<th>(2) German GDP Growth Rate</th>
<th>(3) US Credit Spreads (GZ)</th>
<th>(4) German Term Premia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haircuts (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US GDP Growth Rate, end (%)</td>
<td>-3.09***</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1.09)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>German GDP Growth Rate, end (%)</td>
<td>-</td>
<td>-2.52**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Credit Spreads (GZ), end (%)</td>
<td>-</td>
<td>-</td>
<td>9.02***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3.08)</td>
<td></td>
</tr>
<tr>
<td>German Term Premia, end (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.49*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.85)</td>
</tr>
<tr>
<td>Length of Restructurings (years)</td>
<td>0.22***</td>
<td>0.20***</td>
<td>0.26***</td>
<td>0.24***</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>GDP Deviation from Trend, end (%) 1/2</td>
<td>-0.08</td>
<td>0.03</td>
<td>0.005</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(0.27)</td>
<td>(0.31)</td>
<td>(0.29)</td>
</tr>
<tr>
<td>Per Capita US$ GDP, end (thousand US$)</td>
<td>-1.87</td>
<td>-1.69</td>
<td>-0.48</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>(1.34)</td>
<td>(1.35)</td>
<td>(1.37)</td>
<td>(1.35)</td>
</tr>
<tr>
<td>External Debt/GDP Ratio, end (%)</td>
<td>0.22***</td>
<td>0.15***</td>
<td>0.19***</td>
<td>0.18***</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Export-to-debt Service Ratio, end (%)</td>
<td>0.69*</td>
<td>0.80*</td>
<td>0.95**</td>
<td>0.92**</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.41)</td>
<td>(0.43)</td>
<td>(0.44)</td>
</tr>
<tr>
<td>LIBOR 12-month, end (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.59)</td>
</tr>
<tr>
<td>Germany 1-year yield, end (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.93**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.77)</td>
</tr>
<tr>
<td>Constant</td>
<td>34.24***</td>
<td>28.95***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(6.79)</td>
<td>(6.03)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample 87 87 76 92
Adj-R² 0.48 0.47 0.88 0.86
Root MSE 19.1 19.4 21.0 21.3


Notes: All regression results are based on ordinary least square (OLS) estimation. Standard errors are in parentheses. ***, **, * show significance at 1, 5, and 10 percent levels, respectively.
1/ Levels at end of restructuring.
2/ GDP deviation from the trend and growth rate of GDP trend are a percentage deviation from the trend and an annual change in the trend obtained by applying a Hodrick-Prescott (H-P) filter to quarterly GDP series.
3 Theoretical Model

3.1 Summary of Theoretical Findings

Our theoretical model of sovereign debt embeds post-default multi-round renegotiations—negotiations only take place after sovereigns’ default, not preemptively—with a risk-averse sovereign and a risk-averse creditor and generates the aforementioned stylized facts. The current model is built for the purpose of shedding lights on the role of the creditor on restructuring outcomes and processes: How does the creditors’ business cycle influence haircuts and duration of restructurings?

First on the outcome of restructurings, we show that haircuts are smaller (recovery rates are higher) when the foreign creditor is facing high income. In this case, the creditor is less financially constrained and less eager to recoup losses on defaulted debt at the current round of negotiation. An outside option for the creditor, defined as the expected utility from the settlement with high expected recovery rates in the future period, remains high since his/her high income is anticipated to persist. The creditor only requests recovery rates high (haircuts low) enough to be comparable to high expected recovery rates. Otherwise, he/she simply opts to postpone an option of proposal. This is because in the next period the creditor, who remains patient due to his/her persistently high income, continues demanding high recovery rates. As a consequence, the sovereign has no option but to accept high recovery rates (low haircuts) if it prefers to settle the deal in the current period hoping to avoid further output costs and financial exclusion.

Second, on the process of restructurings, our model explains two mechanisms of delays, originating from two different drivers;

- **Recovery of the debtor’s income to its pre-default level takes time.** The first mechanism is explained by Benjamin and Wright (2009) and Bi (2008) who show that both the sovereign and the creditor prefer to “wait for a larger case,” i.e., recovery of the debtor’s income. High output costs of defaults undermine the debtor’s repayment capacity during negotiations. This reduces the proposed recovery rates, resulting in an increase in likelihood of postponement of the settlement.

- **The creditor with high income is reluctant to smooth consumption through recovered debt payments and requests high recovery rates.** Our model newly demonstrates the role of the consumption-smoothing motive for the creditor driven by his/her
income process. When the creditor’s income is high—with limited consumption smoothing motive by receiving recovered debt payments—he/she demands higher recovery rates that are at least comparable to the high, expected recovery rates in future periods, corresponding to the creditor’s value of postponing the negotiation. This makes it difficult to reach an agreement with the debtor, who suffers the cost of default in the current period resulting in delays.

Moreover, our model successfully replicates further delays when these two drivers interact through the aforementioned mechanisms.

3.2 General Points

Both the sovereign debtor and the creditor are assumed to be risk-averse. Their preferences are shown by following utility functions:

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

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 $t$, $u()$ and $v()$ are one-period utility functions, which are continuous, strictly increasing and strictly concave, and satisfy the Inada conditions. A discount factor of the sovereign reflects both pure time preference and probability that the current government will remain in power next period (myopia associated with political uncertainty), whereas a discount factor of the creditor captures only pure time preference. Our assumption of the risk-averse creditor is aligned with the investor behavior in emerging financial markets avoiding sovereign default risk excessively.\(^{24}\)

In each period, the sovereign has its credit record $h_t \in [0, 1]$ which indicates the sovereign has maintained access to the market, i.e., a good credit record ($h_t = 0$) or whether it has lost market access due to defaults, i.e., a bad credit record ($h_t = 1$). In addition, both the sovereign and the creditor receive stochastic endowment streams $y_t^h$ and $y_t^f$. We denote $y_t$, a

\(^{24}\)Lizarazo (2013) explains that assumption of risk-averse creditors 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 these agents 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.
column vector of two income processes: \( y_t = [y^h_t, y^f_t] \). It is stochastic, drawn from a compact set \( Y = [y^h_{\min}, y^h_{\max}] \times [y^f_{\min}, y^f_{\max}] \subset \mathbb{R}^2_+ \). \( \mu(y_{t+1}|y_t) \) is probability distribution of a vector of shocks \( y_{t+1} \) conditional on previous realization \( y_t \). These goods endowed in two countries are identical and tradable. The sovereign has current account deficit (surplus),—its consumption is larger (less) than endowment—when it repays debt and issues new debt (has new savings). On the contrary, its current account is balanced,—its consumption is equal to endowment—when it defaults its debt and loses market access (\( h_t = 1 \)). All information on income processes of two parties, the sovereign’s credit record and bond issuances of two parties is perfect and symmetric.

Both sovereign bond and risk-free bond markets are incomplete.\(^{25}\) On one hand, the sovereign can borrow and lend only via one-period, zero-coupon sovereign bonds.\(^{26}\) \( b_{t+1} \) denotes the amount of bonds to be repaid in the next period whose set is shown by \( B = [b_{\min}, b_{\max}] \subset \mathbb{R} \) where \( b_{\min} \leq b_{\max} \). On the other hand, the risk-averse creditor can smooth his/her consumption through borrowing and lending via both one-period, zero-coupon sovereign bonds and risk-free bonds. \( b^*_t \) and \( b^*_{f,t} \) express amounts of sovereign bonds and risk-free bonds to be repaid next period whose sets are shown by \( B^* = [b^*_{\min}, b^*_{\max}] \subset \mathbb{R} \) and \( B^{*f} = [b^{*f}_{\min}, b^{*f}_{\max}] \subset \mathbb{R} \) where \( b^*_{\min} \leq b^*_{\max} \) and \( b^{*f}_{\min} \leq b^{*f}_{\max} \). We set the lower bound for the sovereign’s bond holding (the upper bound for the creditor’s bond holding) at \( b_{\min} < -y^h_{\max}/\alpha^*(b^{*f}_{\max}) > -y^h_{\max}/\alpha^* \), which is the largest debt that the sovereign could repay. The upper bound \( b_{\max} \) is the high level of assets that the sovereign may accumulate.\(^{27}\)

We assume \( q(b_{t+1}, b^*_{f,t+1}, 0, y_t) \) and \( q^f(b_{t+1}, b^*_{f,t+1}, h_t, y_t) \) to be prices of sovereign bonds and risk-free bonds with sovereign’s asset position \( b_{t+1} \), creditors’ holding of risk-free bonds \( b^*_{f,t+1} \), credit record \( h_t \), and a vector of income shocks \( y_t \). Both bond prices are determined in equilibrium.

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 its status to issue bonds in the next period. On the contrary, if it chooses

\(^{25}\)Following a conventional sovereign debt model, we do not consider a credit default swap (CDS) contract which provides insurance against default. See Salomao (2014) for the role of CDS markets in sovereign debt.

\(^{26}\)Our model of debt restructuring with one-period bonds follows Benjamin and Wright (2009), Bi (2008), Yue (2010) and Asonuma and Trebesch (2016). Relaxing the model to include long-duration bonds does not provide additional insights but increase technical difficulty to track the model. See Hatchondo and Martinez (2000), Arellano and Ramanarayanan (2012), Chatterjee and Eyingungor (2012, 2015), and Hatchondo, et al. (2015) for long-duration bond models without debt restructurings.

\(^{27}\)\( b_{\max} \) exists when the interest rates on the sovereign’s savings are sufficiently low compared to the discount factor, which is satisfied as \((1 + \alpha^*)\beta < 1\)
not to pay its debt, it is then subject to both exclusion from the international capital market and direct output costs.\textsuperscript{28} When a default occurs, the country and foreign creditors negotiate a reduction of unpaid debt via a 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 its option. The other party decides whether to accept or reject the proposal. If the offer with haircuts (recovery rates) is proposed and accepted, then the sovereign regains access to the market in the next period ($h_{t+1} = 0$) and the creditor receives recovered debt payments. Otherwise, both parties continue the negotiation over debt in arrears in the next period.

In order to avoid permanent exclusion from the international capital market and direct costs, the country has an incentive to negotiate over haircuts (recovery rates). From the creditor’s point of view, it prefers to maximize the recovered debt payments, so they are also willing to negotiate over the reduction of unpaid debt.

### 3.3 Timing of the model

Figure 3 summarizes the timing of decisions within each period.

1. The sovereign starts the current period with initial assets/debt $b_t$ and the creditor’s risk-free assets $b_{t}^{sf}$. We are in node (A).

2. A vector of income $y_t$ realizes. The sovereign decides whether to pay its debt or to default after observing its income.

3. (a) In node (B) (payment node), if payment is chosen, we move to the upper branch of a tree. The sovereign maintains market access ($h_{t+1} = 0$) and chooses its consumption ($c_t$) and next-period assets/debt ($b_{t+1}$). Default risk is determined and the creditor also chooses next-period sovereign bonds ($b_{t+1}^{sf}$) and risk-free assets ($b_{t+1}^{sf}$). Bond prices are 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 on to the lower branch of a tree. The sovereign suffers output costs $\lambda d y_t h$ and also loses access to the international

\textsuperscript{28}There are several estimates for output loss at the time of defaults and restructurings. Sturzenegger (2004) estimates output loss as around 2% of GDP. Asonuma and Trebesch (2016) support his finding by reporting output costs of 2.4% of GDP for post-default restructuring episodes and also find lower costs for preemptive cases. On contrary, De Paoli, Hoggarth, and Saporta (2006) suggest that the output loss in the wake of sovereign default appears to be very large—around 7% a year on the median measure—as well as long lasting.
capital market ($h_{t+1} = 1$). The creditor chooses next-period risk-free assets $b_{t+1}^r$ and its price is determined in the market.

4. A vector of income $y_{t+1}$ realizes.

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 to the other party. The creditor chooses next-period risk-free assets $b_{t+1}^r$.

6. (a) In node (E) (propose node), if the proposer chooses to propose, the other party decides whether to accept or reject the offer. If the other party accepts the offer, the sovereign regains market access in the next period ($b_{t+2} = 0$). We move back to node (A) in the next period. On the contrary, if the other party rejects the offer, the sovereign remains autarky ($h_{t+2}=1$). We again move to node (D). The creditor chooses next-period risk-free assets $b_{t+1}^r$.

(b) In node (F) (wait node) if the proposer opts to wait proposing, the sovereign remains autarky ($h_{t+2} = 1$). We again move to node (D). The creditor chooses next-period
risk-free assets $b_{t+1}^{sf}$.

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. It makes its default/repayment choice and determines consumption ($c_t$) and next-period assets ($b_{t+1}$), given its asset position ($b_t$), the creditor’s risk-free assets ($b_{t}^{sf}$), credit record ($h_t$), and a vector of two income shocks ($y_t$), and the value function is denoted by $V(b_t, b_{t}^{sf}, h_t, y_t)$.

First, we start with its problem when the sovereign has a good credit record ($h_t = 0$). 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 pay its debt, it determines its next-period assets and consumption after repaying its debt. In contrast, if it chooses to default, it will be excluded from the international capital market and its credit record deteriorates to $h_{t+1} = 1$, with debt in arrears $b_{t+1} = (1 + r_t^*)b_t$ in the next period where $r_t^*$ is a risk-free interest rate. Given an option to default,

$$V(b_t, b_{t}^{sf}, 0, y_t) = \max \left[ V^R(b_t, b_{t}^{sf}, 0, y_t), V^D(b_t, b_{t}^{sf}, 0, y_t) \right]$$

(1)

where $V^R(b_t, b_{t}^{sf}, 0, y_t)$ is its value associated with paying debt:

$$V^R(b_t, b_{t}^{sf}, 0, y_t) = \max_{c_t, b_{t+1}} u(c_t) + \beta \int_Y V(b_{t+1}, b_{t+1}^{sf}, 0, y_{t+1}) d\mu(y_{t+1}|y_t)$$

s.t. $c_t + q(b_{t+1}, b_{t+1}^{sf}, 0, y_t)b_{t+1} = y_t^h + b_t$

(2)

where $V^D(b_t, b_{t}^{sf}, 0, y_t)$ is its value associated with default:

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

(3)

Next comes the sovereign’s problem with a bad credit history with unpaid debt arrears.

$^{29}$The case where the sovereign has strictly positive savings ($b > 0$) is not considered. This is because the creditor optimally chooses not to borrow ($b = 0$) from the creditor when he/she has an access to both (i) risk-free assets ($b^{sf}$) and (ii) debt to the sovereign ($b$) with its interest rate higher than that of the risk-free assets.
(h_t = 1 & b_t < 0). The country is currently excluded from the international market, suffering output cost and may settle on recovery rates through renegotiation with the creditor. The renegotiation process is a dynamic game that may last longer than one period. In equilibrium, this bargaining game pins down an endogenous recovery rate $\delta(b_t, b_t^{*f}, 1, y_t)$ and length of restructurings (financial autarky). Its value of staying financial autarky and continuing renegotiation, $V^D(b_t, b_t^{*f}, 1, y_t)$ is an expected payoff that the debtor obtains from the bargaining which starts from period $t$:

$$V^D(b_t, b_t^{*f}, 1, y_t) = \Gamma(b_t, b_t^{*f}, y_t)$$  \hspace{1cm} (4)

The sovereign’s default policy can be characterized by its default set $D(b_t, b_t^{*f}, 0)$, defined as a set of income vector $y_t$ which default is optimal given the sovereign’s debt $b_t$, the creditor’s risk-free assets $b_t^{*f}$ and good credit record ($h_t = 0$):

$$D(b_t, b_t^{*f}, 0) = \{ y_t \in Y : V^R(b_t, b_t^{*f}, 0, y_t) < V^D(b_t, b_t^{*f}, 0, y_t) \}$$  \hspace{1cm} (5)

### 4.2 Foreign creditor’s problem

We also start from the creditor’s problem under sovereign’s good credit record ($h_t = 0$). For $b_t \leq 0$ ($h_t = 0$) where the sovereign (the creditor) has debt (savings), the creditor optimally chooses its consumption ($c_t^*$), sovereign bonds ($b_t^{*f} < 0$), and risk-free assets ($b_t^{*f}$):

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

where $1_{Non-Default}$ is an indicator function showing 1 if sovereign does not default and 0 otherwise and $V^R(b_t, b_t^{*f}, 0, y_t)$ is the value when sovereign opts to repay its debt

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

s.t.  $c_t^* + q(b_{t+1}, b_{t+1}^{*f}, 0, y_t)b_t^{*f} + q^f(b_{t+1}, b_{t+1}^{*f}, 0, y_t)b_{t+1}^{*f} = y_t^{f} + b_t^{*f} + b_t^{*f}$  \hspace{1cm} (7)

$V^D(b_t, b_t^{*f}, 0, y_t)$ is the value when sovereign decides to default:
\[ V^{*D}(b_t, b_t^f, 0, y_t) = \max_{c_t^*, b_t^f} v(c_t^*) + \beta \int_Y \Gamma^*((1 + r_t^*)b_t, b_t^f, 1, y_{t+1})d\mu(y_{t+1}|y_t) \]

\[ s.t. \quad c_t^* + q^f(b_{t+1}, b_{t+1}^f, 0, y_t)b_{t+1}^f = y_t + b_t^f \] (8)

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

\[ q(b_{t+1}, b_{t+1}^f, 0, y_t) = \beta \int \left[ \frac{v'(c_{t+1}^*)}{v'(c_t^*)} \right] \left[ (1 - 1_{Non-Default}) \gamma(b_{t+1}, b_{t+1}^f, y_{t+1}) \right]d\mu(y_{t+1}|y_t) \] (9)

\[ q^f(b_{t+1}, b_{t+1}^f, 0, y_t) = \beta \int \frac{v'(c_{t+1}^*)}{v'(c_t^*)} d\mu(y_{t+1}|y_t) \] (10)

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’s had a bad credit record, the creditor’s value function is

\[ V^{*D}(b_t, b_t^f, 1, y_t) = \Gamma^*(b_t, b_t^f, y_t) \] (11)

Bond price function for the risk-free assets remains identical;

\[ q^f(b_{t+1}, b_{t+1}^f, 1, y_t) = \beta \int \frac{v'(c_{t+1}^*)}{v'(c_t^*)} d\mu(y_{t+1}|y_t) \] (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).\(^{30}\) It is a multi-round stochastic bargaining game in that both the endowment processes of two parties and the identity of the proposer are stochastic. To account time-variant outside option for the creditor during debt renegotiation in the real world, our model newly assumes the risk-averse creditor facing his/her stochastic income process. This assumption differentiates our paper from previous studies on a multi-round bargaining game such as Benjamin and Wright (2009) and Bi (2008); in their models, creditors who are

\(^{30}\)There could be other approaches of modeling a bargaining game between two parties. But we stick to the conventional bargaining game in Merlo and Wilson (1995) for their simplicity and tractability.
risk-neutral are totally independent on when the restructuring is settled and care only recovery rates in present value terms.\textsuperscript{31} Thus, creditors are willing to wait for recovery of the debtor’s capacity of repayment. In contrast, in our framework, the creditor’s income process influences not only outcomes, but also equally importantly timing of restructuring settlement: when the creditor’s income is high, he/she is reluctant to settle the deal and recoups losses in the current period and instead requests higher recovery rates anticipating that the settlement would be postponed and he/she would receive higher expected recovery rates in the future period. This results in delays in negotiations since the debtor suffering costs of defaults can not meet the requested recovery rates, but postpones the settlement.

In each round, a state is realized and the proposer is randomly selected. For simplicity, that each player has a constant probability of being selected as the proposer in each round throughout the negotiation. That is, the identity of the proposer is independent of both parties’ income processes. Let $\phi$ denote the probability that the borrower, B, can propose in a period, and $1 - \phi$ is the probability that the lender, L, proposes in each period. The probability with which a player 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 or pass. If he/she proposes, then the other party chooses to accept or to reject the proposal. If the proposal is accepted, then the sovereign debtor immediately repays its reduced debt arrears, and then resumes access to the market in the next period with an upgraded credit record $h_{t+1} = 0$ and no outstanding debt. If the proposal is rejected, a vector of income processes is realized and the game repeats until an agreement is reached. If the proposer opts to pass, both players proceed to the next period with a new income vector and continue the game.\textsuperscript{32}

First, we define some basic concepts of the game. A stochastic bargaining game may be denoted by $(C, \beta, \beta^*)$, 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. $\beta$ and $\beta^*$ are the discount factors for B and L, respectively.\textsuperscript{33} A payoff function is an element $\Delta(y) \in C(y)$, where $\Delta_i(y)$ is the

\textsuperscript{31}This is because debt arrears are accumulated with the risk-free interest rate during restructuring and the creditors’ discount rate is an inverse of the risk-free interest rate.

\textsuperscript{32}We assume that the proposer makes an offer that the respondent accepts when the value of proposing is higher or equal to the value of passing, and chooses to pass otherwise. This assumption can get rid of trivial source of multiplicity. See Merlo and Wilson (1995) and Ortner (2013) for the same treatment.

\textsuperscript{33}Merlo and Wilson (1995) assume that the players have the same discount factor. But they also mention that
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 other party would accept for sure and to postpone otherwise. In contrast, the other player’s strategy is to accept when a proposal is made and rejects otherwise. Therefore, we can denote the proposer $i$’s and the other party $j$’s equilibrium strategies (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 other party $j$ 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 other party $j$ rejects the offer.  

34 A stationary subgame perfect (SP) equilibrium is defined as the players’ equilibrium stationary strategies $\theta$ and $\theta^*$ and the payoff functions, $\Gamma$ and $\Gamma^*$, associated with these strategies for player B and L. The expected payoff for the borrower B and lender L in period $t$, shown as:

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

$$\Gamma^*(b_t, b_t^{*f}, y_t) = \phi \Gamma^B^*(b_t, b_t^{*f}, y_t) + (1 - \phi) \Gamma^L^*(b_t, b_t^{*f}, y_t)$$  \hspace{1cm} (13)$$

Here the superscript denotes the identity of the propose: $\Gamma^B$ ($\Gamma^B^*$) represents the borrower’s (lender’s) payoff when the borrower himself is the proposer and $\Gamma^L$ ($\Gamma^L^*$) refers to the borrower’s (lender’s) payoff when the lender is the proposer. First, we start from the case when the borrower B is the proposer. We denote the proposed debt recovery rate as $\delta_B^t$, the borrower’s values of proposing and passing as $V^{PRO}$ and $V^{PASS}$, and the creditor’s values of accepting offer and rejecting as $V^{*ACT}$ and $V^{*REJ}$. When B proposes and the proposal is accepted, the sovereign immediately pays agreed debt repayments $\delta_B^t b_t$ and resumes access to the market in the next period with a good credit record and no outstanding debt.

34Benjamin and Wright (2009) theoretically prove existence and uniqueness of the equilibrium in multi-round bargaining game over defaulted debt.
\[ V^{PRO}(b_t, b_t^{sf}, y_t) = u((1 - \lambda_d)y_t^h + \delta_t^B b_t) + \beta \int_Y V(0, b_{t+1}^{sf}, 0, y_{t+1})d\mu(y_{t+1}|y_t) \] (14)

\[ V^{*ACT}(b_t, b_t^{sf}, y_t) = \max_{c_t^*, b_{t+1}^{sf}} v(c_t^*) + \beta^* \int_Y V^*(0, b_{t+1}^{sf}, 0, y_{t+1})d\mu(y_{t+1}|y_t) \]

\[ \text{s.t.} \quad c_t^* + q_f(b_{t+1}, b_{t+1}^{sf}, 1, y_t)b_{t+1}^{sf} = y_t^f - \delta_t^B b_t + b_t^{sf} \] (15)

When B postpones offering, both parties proceed to the next period with accumulated arrears \((1 + r_t^*)b_t\).

\[ V^{PASS}(b_t, b_t^{sf}, y_t) = u((1 - \lambda_d)y_t^h) + \beta \int_Y \Gamma((1 + r_t^*)b_t, b_{t+1}^{sf}, y_{t+1})d\mu(y_{t+1}|y_t) \] (16)

\[ V^{*REJ}(b_t, b_t^{sf}, y_t) = \max_{c_t^*, b_{t+1}^{sf}} v(c_t^*) + \beta^* \int_Y \Gamma^*((1 + r_t^*)b_t, b_{t+1}^{sf}, y_{t+1})d\mu(y_{t+1}|y_t) \]

\[ \text{s.t.} \quad c_t^* + q_f(b_{t+1}, b_{t+1}^{sf}, 1, y_t)b_{t+1}^{sf} = y_t^f + b_t^{sf} \] (17)

In equilibrium, the agreed recovery rates \(\delta_t^B\) satisfy\(^{35}\)

\[ \delta_t^B = \arg\max_{c_t^*, b_{t+1}^{sf}} V^{PRO}(b_t, b_t^{sf}, y_t) \]

\[ V^{PRO}(b_t, b_t^{sf}, y_t) \geq V^{PASS}(b_t, b_t^{sf}, y_t) \]

\[ V^{*ACT}(b_t, b_t^{sf}, y_t) \geq V^{*REJ}(b_t, b_t^{sf}, y_t) \] (18)

If both parties reach an agreement, two parties’ payoffs are as follows:

\[ \Gamma^B(b_t, b_t^{sf}, y_t) = V^{PRO}(b_t, b_t^{sf}, y_t) \] (19)

\[ \Gamma^{B*}(b_t, b_t^{sf}, y_t) = V^{*ACT}(b_t, b_t^{sf}, y_t) \] (20)

Otherwise,

\[ \Gamma^B(b_t, b_t^{sf}, y_t) = V^{PASS}(b_t, b_t^{sf}, y_t) \] (19’)

\[ \Gamma^{B*}(b_t, b_t^{sf}, y_t) = V^{*REJ}(b_t, b_t^{sf}, y_t) \] (20’)

\(^{35}\)Off-equilibrium paths are eliminated in equilibrium.
The renegotiation settlement can be characterized by settlement set $R^B(b_t, b_t^f)$, defined as the set of vectors of income shocks $y_t$ which both parties agree on terms when the borrower is the proposer given the sovereign’s debt $b_t$, the creditor’s risk-free bonds $b_t^f$.

\[ R^B(b_t, b_t^f) = \left\{ y_t \in Y : V^{PRO}(b_t, b_t^f, y_t) \geq V^{PASS}(b_t, b_t^f, y_t) \right\}. \tag{21} \]

Similarly, the lender is a proposer and we refer the proposed debt recovery rate as $\delta_t^L$, the borrower’s value as $V^{ACT}$ and $V^{REJ}$ and the lender’s values as $V^{PRO}$ and $V^{PASS}$. When L proposes,

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

\[ s.t. \quad c_t^* + q^f(t_{t+1}, b_t^f, 1, y_t)b_{t+1}^f = y_t - \delta_t^L b_t + b_t^f \tag{22} \]

\[ V^{ACT}(b_t, b_t^f, y_t) = u((1 - \lambda_d)y_t^h + \delta_t^L b_t) + \beta \int_Y V(0, b_t^f, 0, y_{t+1})d\mu(y_{t+1}|y_t) \tag{23} \]

When L passes,

\[ V^{PASS}(b_t, b_t^f, y_t) = \max_{c_t^*, b_t^f} v(c_t^*) + \beta^* \int_Y V^*((1 + r_t^*b_t, b_t^f, y_{t+1})d\mu(y_{t+1}|y_t) \]

\[ s.t. \quad c_t^* + q^f(t_{t+1}, b_t^f, 1, y_t)b_{t+1}^f = y_t + b_t^f \tag{24} \]

\[ V^{REJ}(b_t, b_t^f, y_t) = u((1 - \lambda_d)y_t^h + \beta \int_Y V^*((1 + r_t^*)b_t^f, y_{t+1})d\mu(y_{t+1}|y_t) \tag{25} \]

In equilibrium, agreed recovery rates $\delta_t^{L*}$ satisfy

\[ \delta_t^{L*} = \arg\max V^{PRO}(b_t, b_t^f, y_t) \]

\[ V^{PRO}(b_t, b_t^f, y_t) \geq V^{PASS}(b_t, b_t^f, y_t) \]

\[ V^{ACT}(b_t, b_t^f, y_t) \geq V^{REJ}(b_t, b_t^f, y_t) \tag{26} \]

If both parties reach an agreement, two parties’ payoffs are as follows;

\[ \Gamma^L(b_t, b_t^f, y_t) = V^{PRO}(b_t, b_t^f, y_t) \tag{27} \]
\[ \Gamma^L(b_t, b_t^*, y_t) = V^{ACT}(b_t, b_t^*, y_t) \]  
\[ \text{otherwise,} \quad \Gamma^*(b_t, b_t^*, y_t) = V^{PASS}(b_t, b_t^*, y_t) \]

The renegotiation settlement can be characterized by settlement set \( R^L(b_t, b_t^*) \), defined as the set of vectors of income shocks \( y_t \) which both parties agree on terms when the lender is the proposer.

\[ R^L(b_t, b_t^*) = \left\{ y_t \in Y : V^{PRO}(b_t, b_t^*, y_t) \geq V^{PASS}(b_t, b_t^*, y_t) \right\} \]

### 4.4 Market Clearing Conditions

If the sovereign repays its debt in the current period, a market clearing condition for goods is

\[ c_t + c_t^* = y_t^h + y_t^f \]  

On the contrary, if the sovereign defaults, a market clearing condition for goods is

\[ c_t = (1 - \lambda_d)y_t^h, \quad c_t^* = y_t^f \]

A market clearing condition for sovereign bonds is

\[ \pi b_t + (1 - \pi)b_t^* = 0 \]

where \( \pi \) denotes the size of the sovereign debtor relative to the creditor.\(^{36}\)

### 4.5 Equilibrium

**Definition 4.1.** A recursive equilibrium is defined as a set of functions for (A) the sovereign’s value function, consumption, asset position, default set; (B) the creditor’s consumption, asset

\(^{36}\)A market clearing condition for the risk-free bonds specifies that total supply of the risk-free assets is zero. Relaxing zero-supply of risk-free assets does not change our qualitative implications, but a little change in quantitative results since the creditors continue to have a consumption smoothing motive.
position; (C) the sovereign’s and creditor’s decision functions, two sets of recovery rates (depend-
ing on who is the proposer), the payoffs; (D) bond price functions for sovereign bonds, and the risk-free bonds such that:

[1]. The sovereign’s value function, consumption, asset position, and default set satisfy the sovereign’s optimization problem (1)–(5).

[2]. The creditor’s consumption and asset position satisfy the creditor’s optimization problem (6)–(11).

[3]. Both parties’ decisions, recovery rates, and the payoffs solve the post-default renegotiation problem (12)–(29).

[4]. Market clearing conditions for goods and bonds (30)–(32) are satisfied.

In equilibrium, default probability \( p^*(b_{t+1}, b_{t+1}^{sf}, 0, y_t) \) is defined by using the sovereign’s default decision:

\[
p^D(b_{t+1}, b_{t+1}^{sf}, 0, y_t) = \int_{D(b_{t+1}, b_{t+1}^{sf})} d\mu(y_{t+1}|y_t),
\]

(33)

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

\[
p^R(b_{t+1}, b_{t+1}^{sf}, y_t) = \phi \int_{R^B(b_{t+1}, b_{t+1}^{sf})} d\mu(y_{t+1}|y_t) + (1 - \phi) \int_{R^L(b_{t+1}, b_{t+1}^{sf})} d\mu(y_{t+1}|y_t),
\]

(34)

Expected recovery rates conditional on default choice is shown as:

\[
\gamma(b_t, b_t^{sf}, y_t) = \int_Y \beta^* \frac{v'(c_t^{*+1})}{v'(c_t)} \left[ \phi \mathbb{1}_{y_{t+1} \in R^B(b_{t+1}, b_{t+1}^{sf})} \delta_t^B((1 + r_t^*)b_t, b_{t+1}^{sf}, y_{t+1}) \\
+ (1 - \phi) \mathbb{1}_{y_{t+1} \in R^L(b_{t+1}, b_{t+1}^{sf})} \delta_t^L((1 + r_t^*)b_t, b_{t+1}^{sf}, y_{t+1}) \\
+ (1 - \phi) \mathbb{1}_{y_{t+1} \notin R^B(b_{t+1}, b_{t+1}^{sf})} \gamma((1 + r_t^*)b_t, b_{t+1}^{sf}, y_{t+1}) \right] d\mu(y_{t+1}|y_t)
\]

(35)

The risk-free interest rate is defined as

\[
1 + r^*(b_{t+1}, b_{t+1}^{sf}, h_t, y_t) = \frac{1}{q^f(b_{t+1}, b_{t+1}^{sf}, h_t, y_t)}
\]

(36)
Spreads for sovereign bonds is defined as follow:

\[ s(b_{t+1}, b_{t+1}^*, 0, y_t) = \frac{1}{q(b_{t+1}, b_{t+1}^*, 0, y_t)} - 1 - r^* (b_{t+1}, b_{t+1}^*, 0, y_t) \] (37)

5 Quantitative Analysis

This section provides the quantitative analysis of model. Our major findings can be summarized as follows. At the steady state distribution, we find that when creditor’s income is high, (i) recovery rates agreed at restructuring are higher and (ii) the sovereign is more willing to delay negotiations than when the creditor’s income at mean level. Moreover, our model successfully replicates both longer delays in renegotiations than previous work on debt restructurings and high average debt-to-GDP ratio.

5.1 Parameters and Functional Forms

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

\[ u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}, \quad v(c_t^*) = \frac{c_t^*^{1-\alpha}}{1-\alpha} \] (38)

where \( \sigma \) and \( \alpha \) express degree of risk aversion of the sovereign and the creditor, respectively. We set both \( \sigma \) and \( \alpha \) equal to 2, which is commonly used in the real business cycle (RBC) literature for advanced and emerging market countries.\(^{37}\) The creditor’s discount factor is set to \( \beta^* = 0.98 \) in line with Lizarazo (2013). Output loss parameter \( \lambda_d \) is assumed to be 2% following Sturzenegger (2004)’s estimates.\(^{38}\)

The endowment processes are calibrated to match Argentine and the US quarterly GDP from the Ministry of Finance of Argentina (MECON) and the US Bureau of Economic Analysis.

\(^{37}\)See Lizarazo (2013) for the symmetric risk aversion assumption.

\(^{38}\)Asonuma and Trebesch (2016) confirm that output costs for post-default restructurings are similar to Sturzenegger (2004)’s estimates, while those for preemptive restructurings are substantially lower.
(BEA) over 1993Q1–2008Q2. As in previous studies (Yue 2010; Benjamin and Wright 2009; Hatchondo et al. 2015), we model the output growth rate of the borrower and the creditor as an AR(1) process:

\[
\log(g^i_t) = (1 - \rho^i_g) \log(1 + \mu^i_g) + \rho^i_g \log(g^i_{t-1}) + \epsilon^i_{g,t}, \quad \text{for} \quad i = h, f
\]  

(39)

where growth rate \(g^i_t = \frac{y^i_t}{y^i_{t-1}}\), growth shock \(\epsilon^i_g\) is i.i.d. N\((0, \sigma^i_g)^2\), and \(\log(1 + \mu^i_g)\) is the expected log gross growth rate of endowment. To maintain the stationary of the model, we assume the average growth rates for the borrower and the creditor are symmetric as in conventional international real business cycle literature: \(\mu^h_g = \mu^f_g = \bar{\mu}_g\). Appendix C.1. discusses the equilibrium properties for different average growth rates. Each shock is then discretized into a finite state Markov chain by using a quadrature procedure in Tauchen (1986) from their joint distribution. Through regressions applied separately to two countries, we obtain auto-correlation \(\rho^h_g = 0.65\) for Argentina and \(\rho^f_g = 0.89\) for the US, average endowment growth rate \(\bar{\mu}_g = 0.009\), and standard deviation of endowment growth shock \(\sigma^h_g = 0.054\) for Argentina and \(\sigma^f_g = 0.012\) for the US. Since output shocks permanently affect the level of endowment in a nonstationary model economy, we detrend the model by dividing by the lagged endowment level \(y_{t-1}\). The detrended counterpart of a variable \(x_t\) is thus \(\bar{x} = x_t / x_{t-1}\). The equilibrium value function, bond price functions, recovery rates, and interest spreads are all evaluated at detrended values. For remaining country-specific parameters, size of the sovereign relative to the creditor 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 IMF World Economic Outlook (WEO). Appendix C.2. explores the equilibrium properties for different country size. Sturzenegger and Zettelmeyer (2006) report that Argentina experienced 6 defaults in 1820–2004. We specify the sovereign’s discount factor \(\beta = 0.75\) and bargaining power \(\phi = 0.97\) (the debtor – Argentina) to replicate the average annual default frequency of 3.26% and a recovery rate of 25.0% (Argentina 2001–2005 restructuring). Table 5 summarizes the model parameters and our computation algorithm is reported in Appendix D.

### 5.2 Numerical Results on Equilibrium Properties

First, we provide the qualitative equilibrium properties of our theoretical model for the case when the sovereign proposes. Appendix E discusses the equilibrium properties for the case when the creditor proposes.
Table 5: Model parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk aversion</td>
<td>$\sigma = \alpha = 2$</td>
<td>RBC Literature, Lizarazo (2013)</td>
</tr>
<tr>
<td>Output cost</td>
<td>$\lambda_d = 0.02$</td>
<td>Sturzenegger (2004)</td>
</tr>
<tr>
<td>Bargaining power</td>
<td>$\phi = 0.97$</td>
<td>Computed</td>
</tr>
<tr>
<td>Average endowment growth</td>
<td>$\mu_g = 0.009$</td>
<td>Computed-MECON</td>
</tr>
<tr>
<td><strong>Creditor specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta^* = 0.98$</td>
<td>Lizarazo (2013)</td>
</tr>
<tr>
<td>Auto-correlation. of income</td>
<td>$\rho^I = 0.89$</td>
<td>Computed-US BEA</td>
</tr>
<tr>
<td>Std of endowment shock</td>
<td>$\sigma^I = 0.012$</td>
<td>Computed-US BEA</td>
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<tr>
<td><strong>Sovereign specific</strong></td>
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<tr>
<td>Discount factor</td>
<td>$\beta = 0.75$</td>
<td>Computed</td>
</tr>
<tr>
<td>Auto-correlation. of income</td>
<td>$\rho^h = 0.65$</td>
<td>Computed-MECON</td>
</tr>
<tr>
<td>Std of endowment shock</td>
<td>$\sigma^h = 0.054$</td>
<td>Computed-MECON</td>
</tr>
<tr>
<td>Relative size of sovereign</td>
<td>$\pi = 0.025$</td>
<td>Computed-IMF WEO</td>
</tr>
</tbody>
</table>

Figure 4 reports agreed recovery rates when the sovereign proposes. In all panel charts, a horizontal axis is sovereign’s assets and a vertical axis is sovereign’s (borrower’s) income. To demonstrate our new findings, three panel charts are classified according to the creditor’s income level: (i) mean (benchmark), (ii) low, and (iii) high. Our benchmark case of mean creditor’s income (panel i) replicates general patterns of recovery rates as in the previous work on debt restructurings, for instance Yue (2010), Bi (2008), Asonuma and Trebesch (2016), and Asonuma (2016a). Recovery rates are increasing respect to both sovereign’s assets and income: if the size of debt becomes smaller, the sovereign can pay higher portion of defaulted debt. If the sovereign’s capacity of repay is high (due to high income), it repays high recovered debt payments. The region where agreed recovery rates do not exist corresponds to either the region the sovereign opts to pay debt in full, i.e., no restructuring, or the region where the sovereign does not agree on the deal with the creditor, i.e., no settlement (Figure 5).

More importantly, our model discovers one new feature of recovery rates: agreed recovery rates are low (high) when the creditor is facing low (high) income. When the creditor’s income is low (panel ii), the creditor has a high degree of consumption smoothing motive by receiving recovered debt payments in the current period. Though it is not the first-best solution, the creditor ceteris paribus still accepts the lower proposed recovery rates than the benchmark case.
On the contrary, when the creditor enjoys high income (panel iii), he/she is more patient and is less eager to recoup losses on defaulted debt for consumption smoothing in the current period anticipating high expected recovery rates in the next period due to persistency in his/her income. Thus, he/she only accepts recovery rates proposed in the current period which are favorable to or at least equivalent to high expected recovery rates in the next period. As a result, agreed recovery rates are higher than those in the benchmark case.

Figure 4: Agreed Recovery Rates

(i) Mean creditor’s income

We then explore the sovereign’s choice of repayment, default/settlement and default/delay choice in Figure 5. We follow the same presentation approach as in Figure 4 regarding to axis and panel classifications. In our benchmark case (mean creditor’s income in panel i), we observe
the common trend of the sovereign’s choice as in previous studies on multi-round negotiation as in Benjamin and Wright (2009) and Bi (2008). When the sovereign’s debt is low, it pays its debt in full and maintains an access to the market shown in the green region. Otherwise, it opts to default and proceeds to a post-default renegotiation. During financial exclusion, when its current income is low, the sovereign’s repayment capacity has not fully recovered yet. In such a case, paying recovered debt is more costly for the sovereign than remaining excluded from the international market. As a consequence, the sovereign opts to postpone offering and waits for recovery of income corresponding to the red region. When its current income is high, the sovereign’s repayment capacity has fully repaired. In this case, the sovereign finds that costs of financial autarky combined with output costs in the future are higher than those of paying recovered debt payments. It proposes high recovery rates which attract the creditor and settles the deal highlighted in the blue region.

More importantly, what our model explains newly in addition to the aforementioned trend in the literature is that the sovereign ceteris paribus opts to delay (settle the deal) when the creditor’s income is high (low). In the case of low creditor’s income (panel ii), the sovereign proposes recovery rates and settles the deal even when the sovereign’s income is low as shown in the enlarged “settlement” region in blue color and the shrunk “delay” region in red color, respectively. The creditor who suffers low income is less patient due to his/her financial constraint and more eager to recoup losses to smooth consumption in the current period. As explained in Figure 4, the creditor accepts the lower proposed recovery rates than those when his/her income is at mean level. Therefore, it is more likely that both parties complete restructurings.

In contrast, in the case of high creditor’s income, the sovereign chooses passing when the sovereign’s income is moderate as highlighted in the enlarged “delay” region in red color and the shrunk “settlement” region in blue color, respectively. This is because, the creditor with high income is more patient and less reluctant to receive unfavorable recovered debt payments for current consumption given expectation of 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. The sovereign with low or moderate income finds that its repayment capacity has not been fully recovered and it decides to wait until full recovery of its income. Moreover, given high likelihood of delay (less likelihood of settlement), the sovereign finds defaulting more costly ex ante and is more willing to pay in full shown in the larger
“repayment” region in green color.

Figure 5: Repayment, Default/Settlement, Default/Delay Choice

(i) Mean creditor’s income

Moreover, the sovereign is more (less) willing to default shown in larger “settlement” region in blue color (smaller “settlement” region in blue) when the creditor’s income is low (high) as in conventional models with risk-averse creditors (Borri and Verdelhan 2011; Lizarazo 2013). However, a main driver of willingness to default differs between ours and these models; while time-variant outside option for the creditor influences costs of default in our model, how the creditor with time-variant risk aversion perceives the riskiness of sovereign bonds affects the default/repayment choice of the sovereign in their models.

Underlying mechanisms apply symmetrically to the case where the creditor proposes and
generate the identical equilibrium properties as shown in Appendix E.
5.3 Simulation Exercise

Next, we provide simulation results to show how precisely our theoretical model predicts the Argentine default and restructuring in 2001–2005. 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 samples, we withdraw 40 observations before and observations during the last default/restructuring event at the stationary distribution to compute key moment statistics.\footnote{See also Arellano (2008) and Yue (2010) for this treatment of simulation.}

For the Argentine data, output, consumption, and the trade balance are all seasonally adjusted from the MECON for 1993Q1–2001Q4 (prior to default) and 2002Q1–2005Q2 during default). The trade balance is measured in terms of percentage of GDP. Argentine external debt data are from the IMF World Economic Outlook (WEO) for 1993–2001 (prior to default) and 2002–2005 (during default/restructuring). Average external debt is also measured in terms of percentage of GDP.\footnote{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), Asonuma and Trebesch (2016).} 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 with those in Arellano (2008) and Yue (2010) which are commonly used as benchmark cases.

First, our theoretical model matches the business cycle statistics in data as reported in Part (A) in Table 6. For pre-default periods, our model replicates volatile consumption (of the same magnitude with output volatility) and volatility of trade balance-to-GDP. Both of them are prominent features of emerging economies RBC models. Volatile consumption is also proved to the case in the restructuring periods. In addition, during restructuring process, the country remains financial autarky and its trade balance is constant at zero (no volatility at all) in our model. However, the model fails to generate a negative correlation between trade balance and output in pre-default periods. This is because bond spreads in our model is limited relative to high level of debt to generate net borrowing due to time-variant stochastic discount rate of the creditor which is constrained by high auto-correlation of the creditor’s income. This is a common by-product in models with multi-round negotiations which successfully replicate high level debt for instance Bi (2008).

We also see that non-business cycle statistics of the model match with the data as shown...
Table 6: Simulated Business and Non-business Cycle Statistics of Model

(A) Business Cycle Statistics

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Default periods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption (std dev.)/Output (std dev.)</td>
<td>1.1</td>
<td>0.99</td>
<td>1.10</td>
<td>1.04</td>
</tr>
<tr>
<td>Trade Balance/Output (std dev.)</td>
<td>0.36</td>
<td>0.02</td>
<td>0.26</td>
<td>-</td>
</tr>
<tr>
<td>Corr.(Trade Balance, Output)</td>
<td>-0.87</td>
<td>0.22</td>
<td>-0.25</td>
<td>-0.16</td>
</tr>
<tr>
<td><strong>Renegotiation Periods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption (std dev.)/Output (std dev.)</td>
<td>1.17</td>
<td>1.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Trade Balance/Output (std dev.)</td>
<td>0.45</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Corr.(Trade Balance, Output)</td>
<td>-0.97</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Sources: Arellano (2008), Datastream, IMF WEO, MECON, Yue (2010).

(B) Non-business Cycle Statistics

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target Statistics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Default Probability (%)</td>
<td>3.26</td>
<td>3.25</td>
<td>3.00</td>
<td>2.67</td>
</tr>
<tr>
<td>Average Recovery Rate (%)</td>
<td>25.0</td>
<td>41.8</td>
<td>-</td>
<td>27.3</td>
</tr>
<tr>
<td><strong>Pre-Default Periods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Debt/GDP ratio (%)</td>
<td>45.4</td>
<td>49.7</td>
<td>5.95</td>
<td>10.10</td>
</tr>
<tr>
<td>Bonds Spreads: average (%)</td>
<td>9.4</td>
<td>3.6</td>
<td>3.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Bonds Spreads: std dev. (%)</td>
<td>7.6</td>
<td>2.1</td>
<td>6.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Corr.(Spreads, Output)</td>
<td>-0.88</td>
<td>-0.61</td>
<td>-0.29</td>
<td>-0.11</td>
</tr>
<tr>
<td>Corr.(Debt/GDP, Spreads)</td>
<td>0.92</td>
<td>0.12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Corr.(Debt/GDP, Output)</td>
<td>-0.97</td>
<td>-0.07</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Risk-free Interest Rate (%)</td>
<td>1.3</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Renegotiation Periods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Debt/GDP ratio (%)</td>
<td>130.5</td>
<td>50.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Duration of Renegotiation (quarter)</td>
<td>14.0</td>
<td>5.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Debtor Output Dev. (diff. btw start &amp; end, %)</td>
<td>8.7</td>
<td>15.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Creditor Output Dev. (diff. btw start &amp; end, %)</td>
<td>1.5</td>
<td>1.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Corr.(Debt/GDP, Recovery Rates)</td>
<td>0.3</td>
<td>0.4</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Corr.(Debt/GDP, Output)</td>
<td>-0.95</td>
<td>-0.17</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Sources: Arellano (2008), Datastream, IMF WEO, MECON, Yue (2010).

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in Part (B) in Table 6. First in pre-default periods, the model successfully replicates high level of debt close to the data in pre-default periods (45 percent of GDP v.s. 50 percent) and restructuring periods (131 percent v.s. 50 percent).\textsuperscript{41} This is one of the advantages of models with multi-round renegotiations, that models with one-round negotiations (Yue 2010) or models without negotiations (Arellano 2008; Aguair and Gopinath 2006) fail to explain. Contrary to models with one-round negotiations (Yue 2010), costs of defaults in models with multi-round negotiations are larger due to longer periods of financial exclusion. Therefore, the sovereign finds itself optimal to default only at the high level of debt around 50 percent of GDP. Both average bond spreads of 3.6 percent and bond spread volatility (2.1 percent) in our model—similar to those in Yue (2010)—are lower than those in the data due to limited variation of time-variant stochastic discount rate of the creditor. Our model accords for observed relationships among bond spreads, debt and output.

More importantly, the model generates average restructuring duration of 5.9 quarters, substantially longer than that of models with one-round negotiations (Yue 2010) but still shorter than that of the data (14 quarters). This is the other merit of multi-round negotiations and driven by both recovery in repayment capacity (Benjamin and Wright 2009; Bi 2008) and the creditor’s outside option. These two drivers match with the data: the debtor’s income is higher at the end of restructuring than one at the start (8.7 percent in the data v.s. 15.7 percent), while the creditor’s income is higher at the end than one at the start (1.5 percent in the data v.s. 1.4 percent).

\textsuperscript{41}High average debt-to-GDP ratio (130 percent of GDP) during the 2001–2005 restructuring in Argentina was also influenced by sharp exchange rate depreciations.
5.4 Comparison with Models of Multi-round Negotiations

Table 7 contrasts selected moments in our model with those in existing models of multi-round negotiations. We consider two cases: (A) risk-neutral creditors in line with Benjamin and Wright (2009) and Bi (2008), and (B) small open economy model with risk-averse creditors as in Borri and Verdelhan (2011). To generate moments comparable to ours, we embed two assumptions of risk-neutral creditors and fixed income for case (A) and one assumption of creditors’ consumption relying only on income, not on recovered debt repayments ($\pi = 0$) for case (B) in our model leaving all other parameters unchanged.

In comparison of our model with case (A), the most crucial is a substantial difference in duration of restructurings between our model and models with risk-neutral creditors (5.9 quarters v.s. 4.8 quarters). While recovery in repayment capacity drives delays in negotiations symmetrically in two models shown by positive change in debtor output deviation (15.7 percent v.s. 12.5 percent), the time-variant creditors’ consumption smoothing motive driven by improvement in creditors’ income (1.4 percent) is present only in our model generating further delays (1.4 percent). Higher bond spreads and standard deviation of spreads in our model than those in the models with risk-neutral creditors (3.6 & 2.1 percent v.s. 0.4 & 0.4 percent) are driven by creditors’ time-variant risk appetite with volatile income as in Lizarazo (2013).

Next, when we contrast our model with case (B), the difference in duration of restructurings becomes more severe (5.9 quarters in our model v.s. 2.0 quarters). A conventional small open economy model with risk-averse creditors does not generate any delays as in models with one-round negotiations (Yue 2010; Asonuma 2016a)—2 quarters are minimum length of negotiation in the current set-up. This is because the creditors’ business cycle influences only indirectly and marginally through its stochastic discount rate, but not directly through their current recovery rates and outside options. In a small open economy model, the risk-averse creditors’ surplus at the bargaining game does not reflect the debtor’s capacity of repayments changing over the debtor’s income realization and the random selection of proposers. Appendix F reports that there are no delay regions at any levels of the creditors’ income. A further and equally important consideration is low average debt-to-GDP ratio in pre-default periods (17.0 percent), similar to that in models with one-round negotiations. As it is less costly to default due to no delays in negotiations, the debtor is willing to default at low level of debt (Figure A4 in Appendix F). Clearly, a small open economy model eliminates advantages of multi-round negotiations and
Table 7: Comparison of Our Model with Models of Multi-round Negotiations

<table>
<thead>
<tr>
<th></th>
<th>Our Model</th>
<th>Risk-neutral Creditors</th>
<th>Small Open Economy with Risk-averse Creditors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Default periods</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Debt/Output ratio (%)</td>
<td>49.7</td>
<td>58.8</td>
<td>17.0</td>
</tr>
<tr>
<td>Bonds Spreads: average (%)</td>
<td>3.6</td>
<td>0.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Bonds Spreads: std dev. (%)</td>
<td>2.1</td>
<td>0.4</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Renegotiation periods</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Debt/GDP ratio (%)</td>
<td>50.0</td>
<td>60.0</td>
<td>17.1</td>
</tr>
<tr>
<td>Duration of Renegotiation (quarter)</td>
<td>5.9</td>
<td>4.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Debtor Output Dev. (diff. btw start &amp; end, %)</td>
<td>15.7</td>
<td>12.5</td>
<td>8.8</td>
</tr>
<tr>
<td>Creditor Output Dev. (diff. btw start &amp; end, %)</td>
<td>1.4</td>
<td>-</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Sources: authors’ computation

brings the results similar to those in the models with one-round negotiations.

5.5 Robustness Check

The creditor’s output volatility and persistency, output costs and bargaining power are key parameters pinning down the debt restructuring process and outcomes. Table 8 reports how changes in these parameter values keeping other parameter values constant influence the main statistics. A decrease in the creditor output volatility from the benchmark case reduces duration of restructurings (3.7 quarters). As the creditor’s income process becomes less volatile (more certain), the creditors are more willing to settle the deals with lower recovery rates (39.3 percent). This case resembles to that of models with risk-neutral creditors and no income uncertainty. In contrast, an increase in volatility also leads to shorter duration of restructurings (2.5 quarters). Though it seems counter-intuitive, what plays behind is the creditor’s precautionary motive to reach an agreement quickly given high uncertainty on their income process.

When the creditor’s income becomes more persistent (more mean-reverting), duration of restructurings gets longer (shorter) and recovery rates get higher (lower). The creditor has less (more) consumption smoothing motive through receiving recovered debt payments.

An increase in output costs leads to shorter duration of restructurings (5.7 quarters). Despite high level of debt at restructurings, the debtor is more willing to reach an agreement with lower recovery rates as the financial exclusion is more costly. When the debtor (the creditor) is less likely (high likely) to be selected to be a proposer, restructurings become longer (6.2 quarters). The creditor’s state-dependent consumption-smoothing motive plays a larger role resulting in
delays in negotiations.

Table 8: Sensitivity Analysis

<table>
<thead>
<tr>
<th></th>
<th>Creditor output volatility</th>
<th>Creditor output persistency</th>
<th>Output cost</th>
<th>Bargaining power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default probability</td>
<td>0.005 0.012 0.02</td>
<td>0.80 0.89 0.91</td>
<td>0.015 0.02 0.025</td>
<td>0.95 0.97</td>
</tr>
<tr>
<td>Average Recovery Rate</td>
<td>3.27 3.25 3.54</td>
<td>3.24 3.25 3.27</td>
<td>3.28 3.25 3.24</td>
<td>3.21 3.25</td>
</tr>
</tbody>
</table>

Before default/renegotiation

<table>
<thead>
<tr>
<th></th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Debt/Output ratio (%)</td>
<td>46.3</td>
<td>49.7</td>
<td>42.4</td>
<td>44.5</td>
<td>49.7</td>
<td>49.5</td>
<td>35.7</td>
<td>49.7</td>
<td>60.2</td>
<td>62.5</td>
</tr>
<tr>
<td>Bonds Spreads: average (%)</td>
<td>1.2</td>
<td>3.6</td>
<td>8.5</td>
<td>4.9</td>
<td>3.6</td>
<td>2.7</td>
<td>3.6</td>
<td>3.6</td>
<td>2.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Bonds Spreads: std dev. (%)</td>
<td>0.7</td>
<td>2.1</td>
<td>2.7</td>
<td>2.3</td>
<td>2.1</td>
<td>1.7</td>
<td>2.0</td>
<td>2.1</td>
<td>1.5</td>
<td>1.7</td>
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</table>

During debt renegotiation

<table>
<thead>
<tr>
<th></th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
<th>(% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of Renegotiation (quarter)</td>
<td>3.7</td>
<td>5.9</td>
<td>2.5</td>
<td>4.1</td>
<td>5.9</td>
<td>6.0</td>
<td>4.2</td>
<td>5.9</td>
<td>5.7</td>
<td>6.2</td>
</tr>
<tr>
<td>Debtor Output Dev. (%)</td>
<td>3.7</td>
<td>5.9</td>
<td>2.5</td>
<td>4.1</td>
<td>5.9</td>
<td>6.0</td>
<td>10.6</td>
<td>15.7</td>
<td>3.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Creditor Output Dev. (%)</td>
<td>1.3</td>
<td>1.4</td>
<td>1.4</td>
<td>1.3</td>
<td>1.4</td>
<td>0.9</td>
<td>1.0</td>
<td>1.4</td>
<td>1.3</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Sources: authors’ computation

6 Empirical Analysis: Testing Theoretical Findings

Lastly, we conduct an empirical analysis to explore whether the data support our findings in the theoretical model. Our dataset is an unbalanced panel comprised of 111 post-default restructuring episodes in 60 countries (both emerging markets and low-income countries) for the duration for each episode from the start of restructurings to the completion of exchanges, as explained in Section 2. Following the original classification in Asonuma and Trebesch (2016), we treat two restructuring events separately when the sovereign debtor is negotiating with different creditors. In this regard, our panel data includes the overlapping periods of one sovereign debtor.

As in empirical works by Asonuma and Trebesch (2016), we construct our data in annual frequency, due to data availability for GDP and debt for the defaulting countries. Our dependent variable is a binary variable for the completion of restructurings: 1 for completion, 0 otherwise. To be consistent with our theoretical model, the set of explanatory variables comprises the current real GDP growth rate of the sovereign debtor, external debt-to-GDP ratio, and current real GDP growth rates of the US and Germany and term premia of the US and German Treasury bonds. We use the external debt-to-GDP ratio from the IMF’s World Economic Outlook (WEO), which provides a larger coverage than the public external debt-to-GDP data available from the World Bank Global Financial Development Database. To control for liquidity and the creditors’ risk aversion in the global market, our specification includes term premia of the US and German
Treasury bonds.

Table 9 summarizes our pooled panel regression results. As predicted from the theoretical findings, the regression results show that high creditors’ GDP growth rates (the US and Germany) decrease the likelihood of completion of restructurings (columns 3 and 4): a one-percentage increase in the GDP growth rates in the US or Germany reduces the probability of completion by 12–13 percent. Moreover, consistent with the theoretical model, restructurings are likely to be settled when the debt remains at a low level (columns 3 and 4) or the debtor is experiencing high GDP growth (column 3). An increase in the market participants’ risk aversion, proxied by the term premia on treasury bonds, enters as a counter-intuitive sign possibly due to high correlation with the GDP growth rates (column 3).

In summary, our panel regression results confirm the main prediction from the theoretical model: debt restructurings are protracted when creditors’ GDP growth rates are high.

Table 9: Probit Regression Results – Annual Frequency

<table>
<thead>
<tr>
<th>Dependent variable: Completion of Restructurings</th>
<th>(1) US GDP Growth Rate</th>
<th>(2) German GDP Growth Rate</th>
<th>(3) Full model- US GDP Growth</th>
<th>(4) Full model- German GDP Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP Growth Rate - Debtor (%)⁵/</td>
<td>-</td>
<td>-</td>
<td>0.02*</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Debt/GDP Ratio (%)</td>
<td>-0.64***</td>
<td>-0.67***</td>
<td>-0.35***</td>
<td>-0.66***</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.09)</td>
<td>(0.10)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Real GDP Growth Rate US, annual (%)⁶/</td>
<td>-0.13***</td>
<td>-0.12***</td>
<td>-0.11***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>Real GDP Growth Rate German, annual (%)⁶/</td>
<td>-</td>
<td>-0.12***</td>
<td>-</td>
<td>-0.12***</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td></td>
<td>(0.03)</td>
</tr>
<tr>
<td>Term Premium (%)*²/</td>
<td>-</td>
<td>-</td>
<td>-0.30***</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.04)</td>
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<table>
<thead>
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<th>Number of observations</th>
<th>582</th>
<th>582</th>
<th>578</th>
<th>578</th>
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<td>Wald $\chi^2$</td>
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<td>184.6</td>
<td>213.1</td>
<td>183.6</td>
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<td>Prob.$&gt; \chi^2$</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Sources: Board of Governors of the Federal Reserve System, Bureau of Economic Analysis (US), Federal Statistical Office (Germany), IMF WEO.

Notes: All regressions are pooled probit regressions. Standard errors are in parentheses. ***, **, * show significance at 1, 5, and 10 percent levels, respectively.

⁵/ Annual growth rate.

²/ Term premium on the government bonds is a difference between 1-year and 10-year bond yields.
7 Conclusion

The current paper explores the role of foreign creditors at sovereign debt restructurings. We newly code two datasets on the creditor committees and on creditors’ business cycles during restructurings. Our compiled data show that when foreign creditors are facing high GDP growth rates, restructurings are protracted and settled with smaller NPV haircuts and face value reductions. We embed multi-round debt negotiations 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 of restructuring and smaller haircuts. Our theoretical findings are also confirmed by the data through an empirical analysis.

On the basis of better understanding of how foreign creditors react at the debt restructurings, we will potentially explore additional restructuring options (proposals) contingent on the creditors’ business cycles for sovereign debtors. With these restructuring options, sovereign could attract foreign creditors and facilitate smooth negotiations avoiding lengthy delays which have been costly for the debtors. This in turn, might potentially be beneficial for the creditors: creditors might welcome the debtors’ proposals which meet their demand and be more willing to engage with the debtors.
References


[38] Gu, G., 2016, “A Tale of Two Countries: Sovereign Default, Trade and Terms of Trade,” manuscript, UC Santa Cruz.


## Appendix A  Selected Debt Restructuring Episodes

Table A1: Selected Debt Restructuring Episodes with Creditor Committees

<table>
<thead>
<tr>
<th>Country</th>
<th>Restructuring Periods</th>
<th>Creditor Committee</th>
<th>Committee Chairmen</th>
<th>Institution</th>
<th>Nationality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start (Announcement/Default)</td>
<td>End (Final exchange)</td>
<td>Yes/No</td>
<td>Institution</td>
<td>Nationality</td>
</tr>
<tr>
<td>Albania</td>
<td>Nov-1991</td>
<td>Aug-1995</td>
<td>Yes</td>
<td>Creditanstalt-Bankverein</td>
<td>Austria</td>
</tr>
<tr>
<td>Algeria</td>
<td>Oct-1990</td>
<td>Mar-1992</td>
<td>Yes</td>
<td>Credit Lyonnais</td>
<td>France</td>
</tr>
<tr>
<td>Algeria</td>
<td>Dec-1993</td>
<td>Jul-1996</td>
<td>Yes</td>
<td>Societe General, Sakura Bank (deputy)</td>
<td>Japan</td>
</tr>
<tr>
<td>Argentina</td>
<td>Jul-1982</td>
<td>Aug-1985</td>
<td>Yes</td>
<td>Citibank</td>
<td>US</td>
</tr>
<tr>
<td>Argentina</td>
<td>Aug-1985</td>
<td>Aug-1987</td>
<td>Yes</td>
<td>Citibank</td>
<td>US</td>
</tr>
<tr>
<td>Brazil</td>
<td>Dec-1982</td>
<td>Feb-1983</td>
<td>Yes</td>
<td>Morgan Guaranty (deputy), Lloyds Bank (deputy)</td>
<td>US (deputy)</td>
</tr>
<tr>
<td>Brazil</td>
<td>Dec-1983</td>
<td>Feb-1984</td>
<td>Yes</td>
<td>Morgan Guaranty (deputy), Lloyds Bank (deputy)</td>
<td>US (deputy)</td>
</tr>
<tr>
<td>Brazil</td>
<td>Sep-1986</td>
<td>Nov-1988</td>
<td>Yes</td>
<td>Morgan Guaranty (deputy), Lloyds Bank (deputy)</td>
<td>US (deputy)</td>
</tr>
<tr>
<td>Brazil</td>
<td>Jun-1989</td>
<td>Apr-1994</td>
<td>Yes</td>
<td>Morgan Guaranty (deputy), Lloyds Bank (deputy)</td>
<td>US (deputy)</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Mar-1990</td>
<td>Jun-1994</td>
<td>Yes</td>
<td>Deutsche Bank</td>
<td>Germany</td>
</tr>
<tr>
<td>Cote d'Ivoire</td>
<td>Jun-1983</td>
<td>Mar-1998</td>
<td>Yes</td>
<td>BNP</td>
<td>France</td>
</tr>
<tr>
<td>Cote d'Ivoire</td>
<td>Mar-2000</td>
<td>Apr-2010</td>
<td>No</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cameroon</td>
<td>Jun-1985</td>
<td>Aug-2003</td>
<td>No</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Appendix B  Further Empirical Analysis on Sovereign Debt Restructurings and Creditors’ Income

B.1 Face Value Reductions and Creditors’ Income for Restructurings

Panel A and B in Figure A1 show that face value reductions are small when the creditors’ growth rates at end of restructurings are high. The same logic in the case of NPV haircuts also applies to face value reductions: when creditors’ growth rates are high (low), the creditors request low (high) face value reductions to settle the deal as they are less (more) financially constrained.

Our cross-sectional regression results show that face value reductions are reduced significantly when the US or German GDP growth rates increase (columns 1 and 2 of Table A2): Creditors receiving high income demand lower face value reductions, while accept higher face value reduction when their income is low. In addition, when creditors are less risk-averse (inversely correlated with creditors’ GDP growth rates), they request smaller face value reductions (column 3 and 4 in Table A2). Similar to regression results on NPV haircuts, face value reductions are larger if external debt is high and export-to-debt service ratio is high: sovereigns cannot afford to or might not be willing to repay high recovered debt payments when they have large debt burden and high liquidity (from export earnings). Though insignificant, face value reductions are smaller when per capital US dollar GDP is high indicating higher capacity to repay. Again, sovereigns’ GDP deviation from trend at restructurings results in a counter-intuitive sign and insignificance. Most likely, it is highly related to the completion of restructurings rather than the term of restructurings.
Figure A1: Face Value Reductions and Creditors' GDP Growth Rates for Restructurings in 1978–2010

(i) US GDP Growth Rate

(ii) German GDP Growth Rate
Table A2: Regression Results on Face Value Reductions

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(1) US GDP Growth Rate</th>
<th>(2) German GDP Growth Rate</th>
<th>(3) US Credit Spreads (GZ)</th>
<th>(4) German Term Premia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Value Reductions (%)</td>
<td>US GDP Growth Rate, end (%)$^{1/}$</td>
<td>-3.16*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>German GDP Growth Rate, end (%)$^{1/}$</td>
<td>-</td>
<td>-4.38***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>US Credit Spreads (GZ), end (%)$^{1/}$</td>
<td>-</td>
<td>-</td>
<td>9.63**</td>
</tr>
<tr>
<td></td>
<td>German Term Premia, end (%)$^{1/}$</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Length of Restructurings (years)</td>
<td>0.32***</td>
<td>0.30***</td>
<td>0.29***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td></td>
<td>GDP Deviation from Trend, end (%)$^{1/2/}$</td>
<td>-0.13</td>
<td>0.02</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.38)</td>
<td>(0.37)</td>
<td>(0.39)</td>
</tr>
<tr>
<td></td>
<td>Per Capita US $GDP, end (thousand US$)$^{1/}$</td>
<td>-0.28</td>
<td>-0.36</td>
<td>-1.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.87)</td>
<td>(1.82)</td>
<td>(1.72)</td>
</tr>
<tr>
<td></td>
<td>External Debt/GDP Ratio, end (%)$^{1/}$</td>
<td>0.22***</td>
<td>0.23***</td>
<td>0.26***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
</tr>
<tr>
<td></td>
<td>Export-to-debt Service Ratio, end$^{1/}$</td>
<td>0.90</td>
<td>1.30*</td>
<td>0.94*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.56)</td>
<td>(0.55)</td>
<td>(0.55)</td>
</tr>
<tr>
<td></td>
<td>LIBOR 12-month, end (%)$^{1/}$</td>
<td>-</td>
<td>-</td>
<td>-3.30***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>(0.83)</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>-2.89</td>
<td>-4.38</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.58)</td>
<td>(8.11)</td>
<td>-</td>
</tr>
<tr>
<td>Sample</td>
<td>87</td>
<td>87</td>
<td>76</td>
<td>87</td>
</tr>
<tr>
<td>Adj-R$^2$</td>
<td>0.48</td>
<td>0.50</td>
<td>0.72</td>
<td>0.70</td>
</tr>
<tr>
<td>Root MSE</td>
<td>26.7</td>
<td>26.1</td>
<td>26.4</td>
<td>25.8</td>
</tr>
</tbody>
</table>


Notes: Standard errors are in parentheses. *** *, **, * show significance at 1, 5, and 10 percent levels, respectively. All regression results are based on least square estimations.

$^{1/}$ Levels at end of restructuring.

$^{2/}$ GDP deviation from the trend and growth rate of GDP trend are a percentage deviation from the trend and an annual change in the trend obtained by applying a Hodrick-Prescott (H-P) filter to quarterly GDP series.
B.2 Robustness Check

For both duration and NPV haircut regressions, we account for whether the debtor countries engage on an IMF-supported program and receive official financing during restructurings, and for outliers. Duration regression results are robust when we control for an IMF-supported program engagement (columns 1 and 2 in Table A3) and outliers (columns 3 and 4 in Table A3). Similarly, controlling for an IMF-supported program (columns 1 and 2 in Table A4) and outliers (columns 3 and 4 in Table A4) indicates the validity of our NPV haircut regression results.

We use other proxies for creditors’ income: (a) growth rate of US domestic commercial banks’ assets, and (b) growth rate of US equity price (New York Stock Exchange Composite Index). Similar to the baseline specification (column 1 in Table A5), NPV haircuts are substantially reduced by an increase in growth rate of both US commercial banks’ assets or US equity price at the end of restructurings (columns 2 and 3 in Table A5). We also try (a’) growth rate of US commercial banks (including located abroad) and (b’) US equity price (SP 500 composite index) and confirm that our results remain unchanged.
Table A3: Robustness Check on Regression Results for Duration of Restructurings

<table>
<thead>
<tr>
<th>Duration of Restructurings (year)</th>
<th>(1) US GDP Growth Rate - IMF Program</th>
<th>(2) German GDP Growth Rate - IMF Program</th>
<th>(3) Dropping Outliers - Durations</th>
<th>(4) Dropping Outliers - GDP growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>US GDP Growth Rate, average (%) ≈</td>
<td>7.22** (3.19)</td>
<td>-</td>
<td>6.59** (2.90)</td>
<td>6.14* (3.67)</td>
</tr>
<tr>
<td>German GDP Growth Rate, average (%) ≈</td>
<td>-</td>
<td>7.55* (3.85)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GDP Deviation from Trend, end (%) ≈</td>
<td>1.66** (0.61)</td>
<td>1.62** (0.61)</td>
<td>1.64*** (0.55)</td>
<td>1.68*** (0.61)</td>
</tr>
<tr>
<td>Growth Rate of GDP Trend, end (%) ≈</td>
<td>10.11*** (2.86)</td>
<td>9.69*** (2.92)</td>
<td>8.55*** (2.63)</td>
<td>10.13*** (2.89)</td>
</tr>
<tr>
<td>External Debt/GDP Ratio, end (%) ≈</td>
<td>0.20** (0.10)</td>
<td>0.22** (0.10)</td>
<td>0.20** (0.09)</td>
<td>0.20* (0.10)</td>
</tr>
<tr>
<td>Export-to-debt Service Ratio, end (%) ≈</td>
<td>2.15** (0.92)</td>
<td>2.14*** (0.93)</td>
<td>1.65* (0.86)</td>
<td>2.09** (0.94)</td>
</tr>
<tr>
<td>LIBOR 12-month, average (%) ≈</td>
<td>10.05*** (2.44)</td>
<td>5.98** (3.04)</td>
<td>9.80*** (2.58)</td>
<td>9.29*** (3.00)</td>
</tr>
<tr>
<td>LIBOR 12-month, end (%) ≈</td>
<td>-11.98*** (2.44)</td>
<td>-10.06*** (2.38)</td>
<td>-11.49*** (2.24)</td>
<td>-11.78*** (2.48)</td>
</tr>
<tr>
<td>IMF-supported programs, start 4/</td>
<td>-23.56** (10.56)</td>
<td>-22.19** (10.82)</td>
<td>-22.36** (9.60)</td>
<td>-22.06** (10.75)</td>
</tr>
<tr>
<td>Contant</td>
<td>3.94 (25.08)</td>
<td>32.90 (24.67)</td>
<td>7.00 (22.79)</td>
<td>12.33 (28.58)</td>
</tr>
</tbody>
</table>

Sample: 89 89 87 88
Adj-R²: 0.47 0.46 0.47 0.46
Root MSE: 43.5 44.0 39.5 43.8


Notes: Standard errors are in parentheses. ***, **, * show significance at 1, 5, and 10 percent levels, respectively.
1/ Monthly average over duration of restructurings.
2/ Levels at end of restructurings.
3/ GDP deviation from the trend and growth rate of GDP trend are a percentage deviation from the trend and annual change in the trend obtained by applying a Hodrick-Prescott (H-P) filter to quarterly GDP series.
4/ IMF-supported program dummy is set to 1 when an IMF-supported program starts at the year of completion of debt restructuring and 0 otherwise.
Table A4: Robustness Check on Regression Results for Haircuts

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(1) US GDP Growth Rate - IMF Program</th>
<th>(2) German GDP Growth Rate - IMF Program</th>
<th>(3) Dropping Outliers - Durations</th>
<th>(4) Dropping Outliers - GDP growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of Restructurings (year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US GDP Growth Rate, average (%)&lt;sup&gt;1/&lt;/sup&gt;</td>
<td>-2.88**</td>
<td>-</td>
<td>-2.86**</td>
<td>-2.25**</td>
</tr>
<tr>
<td></td>
<td>(1.18)</td>
<td></td>
<td>(1.16)</td>
<td>(1.30)</td>
</tr>
<tr>
<td>German GDP Growth Rate, average (%)&lt;sup&gt;1/&lt;/sup&gt;</td>
<td>-</td>
<td>-2.06*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.22)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Restructurings (years)</td>
<td>0.20***</td>
<td>0.19***</td>
<td>0.18***</td>
<td>0.20***</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>GDP Deviation from Trend, end (%)&lt;sup&gt;2/3/&lt;/sup&gt;</td>
<td>-0.02**</td>
<td>0.07**</td>
<td>0.08***</td>
<td>-0.02***</td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(0.27)</td>
<td>(0.27)</td>
<td>(0.27)</td>
</tr>
<tr>
<td>Per Capita US$ GDP, end (thousand US$)&lt;sup&gt;1/&lt;/sup&gt;</td>
<td>-2.27</td>
<td>-2.01</td>
<td>-2.11</td>
<td>-2.36</td>
</tr>
<tr>
<td></td>
<td>(1.34)</td>
<td>(1.36)</td>
<td>(1.32)</td>
<td>(1.34)</td>
</tr>
<tr>
<td>External Debt/GDP Ratio, end (%)&lt;sup&gt;2/&lt;/sup&gt;</td>
<td>0.15***</td>
<td>0.19***</td>
<td>0.16***</td>
<td>0.15***</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Export-to-debt Service Ratio, end (%)&lt;sup&gt;2/&lt;/sup&gt;</td>
<td>0.62</td>
<td>0.72*</td>
<td>0.64</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.941)</td>
<td>(0.40)</td>
<td>(0.40)</td>
</tr>
<tr>
<td>IMF-supported programs, start &lt;sup&gt;4/&lt;/sup&gt;</td>
<td>-8.48**</td>
<td>-7.48</td>
<td>-10.62**</td>
<td>-8.10*</td>
</tr>
<tr>
<td></td>
<td>(4.78)</td>
<td>(5.01)</td>
<td>(4.75)</td>
<td>(4.78)</td>
</tr>
<tr>
<td>Constant</td>
<td>34.24***</td>
<td>32.99***</td>
<td>39.72***</td>
<td>36.41***</td>
</tr>
<tr>
<td></td>
<td>(6.79)</td>
<td>(6.57)</td>
<td>(7.10)</td>
<td>(7.67)</td>
</tr>
<tr>
<td>Sample</td>
<td>87</td>
<td>87</td>
<td>85</td>
<td>86</td>
</tr>
<tr>
<td>Adj-R&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.48</td>
<td>0.48</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Root MSE</td>
<td>19.1</td>
<td>19.1</td>
<td>18.42</td>
<td>18.84</td>
</tr>
</tbody>
</table>


Notes: Standard errors are in parentheses. ***, **, * show significance at 1, 5, and 10 percent levels, respectively.
<sup>1/</sup> Levels at end of restructurings.
<sup>2/</sup> GDP deviation from the trend and growth rate of GDP trend are a percentage deviation from the trend and annual change in the trend obtained by applying a Hodrick-Prescott (H-P) filter to quarterly GDP series.
<sup>3/</sup> IMF-supported program dummy is set to 1 when an IMF-supported program starts at the year of completion of debt restructuring and 0 otherwise.
Table A5: Regression Results on Haircut using Other Proxies for Creditors’ Income

<table>
<thead>
<tr>
<th>Dependent variable: Haircuts (%)</th>
<th>(1) Baseline-US GDP Growth Rate</th>
<th>(2) Growth Rate of US Bank’s Assets</th>
<th>(3) Growth Rate of US Equity Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>US GDP Growth Rate, end (%)¼</td>
<td>-3.20***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.96)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Rate of US Dom. Com. Banks’ Assets, end (%)¼</td>
<td>-</td>
<td>-2.70***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(2.77)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Rate of US Equity Price (NYSE), end (%)¼</td>
<td>-</td>
<td>-</td>
<td>-0.54***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.17)</td>
</tr>
<tr>
<td>GDP Deviation from Trend, end (%)¼/½</td>
<td>0.22</td>
<td>0.52**</td>
<td>0.51**</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
<td>(0.24)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>Per Capita US$ GDP, end (thousand US$)¼</td>
<td>-1.52</td>
<td>-2.84**</td>
<td>-3.43***</td>
</tr>
<tr>
<td></td>
<td>(1.32)</td>
<td>(1.28)</td>
<td>(1.30)</td>
</tr>
<tr>
<td>External Debt/GDP Ratio, end (%)¼</td>
<td>0.26***</td>
<td>0.20***</td>
<td>0.321***</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Export-to-debt Service Ratio, end¼</td>
<td>2.26***</td>
<td>1.30***</td>
<td>1.61***</td>
</tr>
<tr>
<td></td>
<td>(0.42)</td>
<td>(0.42)</td>
<td>(0.42)</td>
</tr>
<tr>
<td>LIBOR 12-month, end (%)¼</td>
<td>-</td>
<td>-</td>
<td>-2.99***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.62)</td>
</tr>
<tr>
<td>Constant</td>
<td>23.72***</td>
<td>66.14***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(6.35)</td>
<td>(10.10)</td>
<td></td>
</tr>
</tbody>
</table>

Sample 148 148 148
Adj-R² 0.23 0.43 0.42
Root MSE 22.6 21.0 24.0


Notes: Standard errors are in parentheses. ***, **, * show significance at 1, 5, and 10 percent levels, respectively. All regression results are based on least square estimations.

Ⅰ/ Levels at end of restructuring.

Ⅱ/ GDP deviation from the trend and growth rate of GDP trend are a percentage deviation from the trend and an annual change in the trend obtained by applying a Hodrick-Prescott (H-P) filter to quarterly GDP series.
Appendix C

Figure A2: Average Growth Rate

(i) Baseline ($\mu=0.009$)

(ii) $\mu=0.006$

(iii) $\mu=0.0075$
Figure A3: Size of Country

(i) Baseline ($\pi=0.025$)

(ii) Extremely small ($\pi=0.0001$)

(iii) Equal size ($\pi=0.5$)
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 by \( B = [b_{\text{min}}, 0] \), \( B^f = [b^f_{\text{min}}, b^f_{\text{max}}] \), \( Y^h = [y^h_{\text{min}}, y^h_{\text{max}}] \), and \( Y^f = [y^f_{\text{min}}, y^f_{\text{max}}] \). The limits of the asset space are set to ensure that limits do not bind in equilibrium. Limits on 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 (40) 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 two sets of recovery rates (\( \delta^B_t \) and \( \delta^L_t \)) corresponding to two cases where either the sovereign or the creditor is the proposer. Limits of both sets of recovery rates are to ensure that they do not bind in equilibrium.

3. Third, we set the initial values for equilibrium bond prices and two sets of recovery rates.
   We use the average risk-free bond price \( q^0 = q^f, 0 = (1.01)^{-1} \) for the baseline value of equilibrium bond price. We set \( \delta^B_0 = \delta^L_0 = 0.5 \) for the baseline recovery rates.

4. Fourth, given the baseline equilibrium bond price and two sets of recovery rates, we solve for the sovereign’s optimization problem for good and bad credit records \( (h_t = 0, 1) \). This procedure finds the value function as well as the default decisions. We first guess the value functions \( (V^0, V^{R,0}, V^{D,0}) \) and iterate it using the Bellman equation to find the fixed value \( (V^1, V^{R,1}, V^{D,1}) \). By iterating the Bellman function, we also derive the optimal asset functions for each state \( (b^1, b^{R,1}, b^{D,1}) \). We obtain the default choice, which requires a comparison of the values of defaulting and non-defaulting. By comparing these two values, we calculate the corresponding default set. Based on the default set, we also evaluate the default probability using the transition matrix.

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

6. Sixth, given the value functions for the sovereign and the creditor, we solve the bargaining problem and compute the new recovery schedule for two cases either the debtor or creditor is the proposer \((\delta_t^{R, 1} \text{ and } \delta_t^{L, 1})\). Then we iterate step 4 and 5 to have the fixed optimal recovery rates.
Appendix E  Equilibrium Properties in the Case the Creditor Proposes

Proposition 1. When the lender is the proposer and both parties settle on a deal, agreed recovery rates are weakly increasing respect to the creditor’s income: If $y_1 = (\bar{y}_1', y_1^f) \in p^f(B, B^f)$ and $y_2 = (\bar{y}_2', y_2^f) \in p^f(B, B^f)$ for $i = B, L$, then $\delta^{L*}(y_2) \geq \delta^{L*}(y_1)$. (note that $P^i(b, b^f)$ is the delay region where $P^i(b, b^f) \cap R^i(b, b^f) = \emptyset$.

Proof. Assume that $\delta^{L*}(y_1) > \delta^{L*}(y_2)$ (agreed recovery rates are lower). Since $y_1 = (\bar{y}_1', y_1^f) \in P^i(b, b^f)$, then from equation (29) with $\delta^{L*}(y_1)$

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

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

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

Similarly, since $y_2 = (\bar{y}_2', y_2^f) \in P^i(b, b^f)$ then from equation (29) with $\delta^{L*}(y_2)$

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

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

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

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

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

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

And also $V^{*PRO}(b_t, b_t^f, y_2; \delta^{L*'}(y_2)) > V^{*PRO}(b_t, b_t^f, y_2; \delta^{L*'}(y_2))$. Then it contradicts to the definition of $\delta^{L*}(y_2)$.

$\square$

Figure A2 reports agreed recovery rates when the creditor proposes. Similar to the case where
the debtor proposes, our benchmark case of mean creditor’s income clearly shows the common feature in existing studies on debt restructurings (panel i); recovery rates are increasing respect to both the sovereign’s assets and income. The creditor demands higher recovery rates when the debtor’s debt burden is limited and capacity to repay is high. Agreed recovery rates when the creditor proposes are slightly higher than those when the debtor proposes (Figure 4) as in the previous work on multi-round negotiations (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 other party would accept, while the counterpart can only choose to accept or reject the offer. Therefore, he/she is willing to offer more favorable term for him/her than the term of the offer he/she receives from the alternative party.

In both cases of low and high creditor’s income (panel ii and iii), the same logic applies as in the case where the debtor proposes: In the case of low (high) creditor’s income, the creditor proposes low (high) recovery rates at least equivalent to the low (high) expected recovery rates in the next period hoping that the debtor accepts the offer for sure.

We show the sovereign’s choice of repayment, default/settlement and default/delay when the creditor proposes in Figure A3. The sovereign’s choice when the creditor proposes is exactly identical to that when the sovereign proposes (Figure 4). This is aligned to a finding in the literature of multi-round negotiations (Bi 2008); whether an agreement on restructuring can be reached in the current period does not depend on the identity of the proposer.42 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. Similar to the case where the sovereign proposes, the benchmark mean creditor income case (panel i) shows that when the sovereign’s debt is low, it pays its debt in full (the green region). Otherwise, it defaults and proceeds to a post-default renegotiation. When the current income is low with limited capacity of repayment, the sovereign has no option other than reject the proposed recovery rates, i.e., delay (shown in the red region). In contrast, when the current income is high, the sovereign opts to accept the proposed recovery rates and settles the deal (the blue region). In both cases of low and high creditor’s income (panel ii and iii), the same logic applies here as in the case where the debtor proposes: The creditor opts to delay (settle the deal) when the creditor’s income is high (low).

42Bi (2008) provides a theoretical proof of this statement. More general theoretical proof is shown in Merlo and Wilson (1995).
Figure A4: Agreed Recovery Rates

(i) Mean creditor’s income

(ii) Low creditor’s income

(iii) High creditor’s income
Figure A5: Repayment, Default/Settlement, Default/Delay Choice

(i) Mean creditor’s income

(ii) Low creditor’s income

(iii) High creditor’s income
Appendix F    Small Open Economy Model with risk-averse Creditors

Figure A6: Repayment, Default/Settlement, Default/Delay Choice

(i) Mean creditor’s income

(ii) Low creditor’s income

(iii) High creditor’s income