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FISCAL AUSTERITY AND SOVEREIGN DEBT RESTRUCTURINGS

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Fiscal Austerity and Sovereign Debt Restructurings*

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Abstract

Sovereigns implement fiscal austerity, i.e., expenditure consolidation around debt crises. We compile data on fiscal expenditure consolidation around debt restructurings with private external creditors in 1975–2020. We find that expenditure consolidation precedes preemptive restructurings or prevents restructurings—"*ex ante*"—, while occurs upon defaults/post-default restructurings—"*ex post*". We build sovereign long-term debt model with endogenous choice of preemptive and post-default renegotiations and public capital accumulation. The model quantitatively shows when both public capital and debt are high, the sovereign implements ex ante fiscal expenditure consolidation which, in turn, results in preemptive restructurings or avoiding restructurings. Data support theoretical predictions.

JEL Classification Codes: F34, F41, H63

Key words: Fiscal Austerity; Expenditure Consolidation; Sovereign Debt; Sovereign Default; Public Investment;

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1 Introduction

Sovereigns implement fiscal austerity, i.e., expenditure consolidation around debt crises.[1] We compile data on fiscal expenditure consolidation around sovereign debt restructurings with private external creditors in 1975–2020. We find that fiscal expenditure consolidation precedes preemptive restructurings or prevents any restructurings—"*ex ante (pre-crisis)*"—, while occurs upon defaults/post-default restructurings—"*ex post (post-crisis)*". To explain the stylized facts, we build a theoretical model of defaultable long-term debt with endogenous choice of preemptive and post-default renegotiations and public capital accumulation. The model quantitatively shows when both public capital and debt are high, the sovereign implements ex ante fiscal expenditure consolidation which, in turn, results in preemptive restructurings or avoiding restructurings. Data support our theoretical predictions.

We first present two new datasets on (i) non-restructuring debt distress episodes and (ii) fiscal expenditure consolidation around sovereign debt restructurings for 75 countries that have experienced sovereign debt restructurings with private external creditors in 1975–2020. On the former, we define non-restructuring debt distress satisfying three criteria consistent with a debt restructuring and compile 25 episodes. On the latter, we apply fiscal consolidation criteria in Alesina and Perotti (1997) specifically on public expenditure and compile fiscal expenditure consolidation episodes. We merge fiscal expenditure consolidation episodes with three types of sovereign debt crises, i.e., a post-default restructuring, a preemptive restructuring—that takes place preemptively without missing payments and going into a default—and non-restructuring debt distress in Asonuma and Trebesch (2016) and our new dataset. We classify eight joint strategies of fiscal expenditure consolidation and debt restructurings differentiated by timing of fiscal expenditure consolidation and debt restructuring strategies.

Our comprehensive datasets show five new stylized facts. First, post-default restructurings are associated with ex post fiscal expenditure consolidation, while preemptive restructurings and non-restructuring debt distress are associated with ex ante fiscal expenditure consolidation. Second, public investment declines sharply prior to the start of preemptive restructurings, while upon the start of post-default restructurings i.e., defaults. Third, debt settlement is quick and prior to recoveries in public investment in preemptive cases, while protracted and after recoveries in public investment in post-default cases. Fourth, recoveries in public investment are quicker in preemptive cases than in post-default cases. Fifth, public consumption and transfers decline temporarily and recover quickly in both types of restructurings.

These stylized facts uncover a new aspect of fiscal austerity and sovereign debt, which the literature has not explored fully yet. These facts pose one question: What determines the sovereign's choice between ex ante and ex post fiscal expenditure consolidation and how its fiscal expenditure consolidation choice interacts with its debt restructuring choice? By answering

[1]Fiscal austerity usually has a broader definition including fiscal revenue expansion. Our focus on fiscal expenditure consolidation episodes is due to a lack of comprehensive dataset on fiscal primary balance and revenues. Ongoing work Asonuma, Joo and Zhang (2022) compile a new dataset on fiscal primary balance, revenues, and expenditure and code revenues-based and expenditure-based consolidation episodes.

this question, we pose a more fundamental question in the literature: How can the sovereign avoid a default (and post-default restructuring) and even more a sovereign debt crisis (i.e., debt restructuring) at all? Despite of its importance, the literature has not yet fully explored this question. This is because the literature conventionally acknowledges that the sovereign in EMs implements (ex post) fiscal expenditure consolidation only after it defaults, loses market access (no borrowing) and is constrained to balance fiscal budget.

To our knowledge, our paper is the first to explore the sovereign's choice between ex ante and ex post fiscal expenditure consolidation which is jointly determined with debt restructuring choice. To answer these questions, we build a theoretical model of sovereign long-term debt that embeds endogenous public capital accumulation, expenditure composition, production and choice of preemptive and post-default renegotiations. In line with recent quantitative work on sovereign debt, our model follows a traditional framework of Eaton and Gersovitz (1981).[2] We follow closely two modeling approaches in the literature: (i) one with a critical role for fiscal policy—in a setup with distinct private and public sectors, distortional tax and two types of consumption (Cuadra et al. 2010; Arellano and Bai 2017) and (ii) one with multi-round debt renegotiations with foreign creditors (Benjamin and Wright 2013; Asonuma and Joo 2020).[3]

Our theoretical innovation is to newly introduce an endogenous interaction between the sovereign's choice of preemptive and post-default restructurings—made at different points in time (i.e., prior to and after productivity realization)—and public capital accumulation. In this regard, our model is different from (i) Asonuma and Trebesch (2016) with endogenous choice of preemptive and post-default restructurings and exogenous income and (ii) Gordon and Guerron-Quintana (2018) with endogenous choice of default and private capital accumulation. The sovereign's choice of two types of restructurings and public capital accumulation mutually interact to newly account for (b) ex ante fiscal expenditure consolidation and a preemptive restructuring, and (c) fiscal expenditure consolidation and no restructuring (debt distress) as observed in data. This differentiates our model from previous studies on sovereign debt and fiscal policy (e.g., Cuadra et al. 2010) which account for only (a) ex post fiscal expenditure consolidation and a default/post-default restructuring.

Our model presents two main theoretical predictions. First, our model shows predictions on the sovereign's choice of fiscal expenditure consolidation and debt restructurings, especially (b) ex ante fiscal expenditure consolidation and a preemptive restructuring and (c) fiscal expenditure consolidation and no restructuring (debt distress). When debt is high, public capital is high and productivity is moderate/high, the sovereign repays debt in full, issues less new debt (i.e., debt reduction), and implements ex ante fiscal expenditure consolidation (i.e., reduction in public investment). This is because marginal cost of public investment (high borrowing costs) due to high debt is higher than marginal return of public investment (low marginal product of capital) due to both high debt and high public capital. In subsequent periods, when debt remains high, before productivity materializes, the sovereign opts a preemptive restructuring—"ex

[2]See Arellano (2008) and other studies covered in Aguiar and Amador (2014) and Aguiar et al. (2016).

[3]See also Bai and Zhang (2012) and Bi (2008).

ante fiscal expenditure consolidation and a preemptive restructuring". When debt is moderate, after moderate/high productivity materializes, the sovereign repays debt in full (i.e., preventing any type of debt restructuring)—"fiscal expenditure consolidation and no restructuring (debt distress)".

In addition, the model also accounts for (a) ex post fiscal expenditure consolidation and a default/post-default restructuring as in previous studies (e.g., Asonuma and Joo 2024). When debt is moderate, public capital is low, and productivity is moderate/high, the sovereign does not implement ex ante fiscal expenditure consolidation. This is because marginal return of public investment (high marginal product of capital) due to low public capital are higher than marginal costs of public investment (low borrowing costs) due to moderate debt. In subsequent periods, when debt is moderate, after low productivity materializes, the sovereign opts a default, and has no option but to reduce public investment due to both prohibition of external borrowing and the sovereign's consumption-smoothing motive—"ex post fiscal expenditure consolidation and a default/post-default restructuring".

Second, our model makes predictions on the role of public capital (investment) determining the timing of fiscal expenditure consolidation and associated debt crisis resolution. High public capital allows the sovereign to implement ex ante fiscal expenditure consolidation through reduction in public investment ("fiscal consolidation channel"). After ex ante fiscal expenditure consolidation, it results in low level of public capital. The sovereign is more willing to take a preemptive restructuring in subsequent periods because it opts to avoid larger costs associated with a default/post-default restructuring—longer financial exclusion and larger output costs—when public capital is low. Under a preemptive restructuring, it achieves quick debt settlement due to smaller output costs, and in turn, quick public investment recovery due to market re-access.

On the contrary, when debt is moderate and public capital is low, the sovereign refrains ex ante fiscal expenditure consolidation. After low productivity materializes and it opts to default, it has no choice other than reducing public investment given loss in market access and larger output costs. Under a post-default restructuring, public investment recovery is prolonged (i.e., slow recovery) due to a combination of slow recovery in productivity, prohibition of external borrowing and the sovereign's consumption-smoothing motive. Debt settlement is more protracted (i.e., longer delays) because it is achieved only after public investment recovery. The sovereign benefits from high public capital through the fiscal consolidation channel by choosing desirable timing of fiscal expenditure consolidation (i.e., ex ante or ex post). This differs from three conventional channels of public capital. The sovereign benefits from high public capital by improving its capacity of repayment ("smoothing channel"). It also benefits from high public capital through smoothing household consumption in financial autarky ("autarky channel") and quick debt settlement ("renegotiation channel").

Our theoretical predictions are supported by data: the sovereign's choice of fiscal expenditure consolidation and debt restructurings. The quantitative analysis of our model is calibrated to three episodes: (a) Argentine post-default restructuring in 2001–05; (b) Uruguayan preemptive restructuring in 2003; and (c) Argentine non-restructuring debt distress in 1995. Our quanti-

tative analysis successfully replicates moment statistics, likelihood of ex ante fiscal expenditure consolidation and a preemptive restructuring, and the five stylized facts: (i) three main strategies of fiscal expenditure consolidation and debt restructurings; (ii) a sharp decline in public investment prior to a preemptive restructuring and that upon a default/post-default restructuring, (iii) quick public investment recovery after quick settlement in preemptive restructurings, and gradual public investment recovery leading to protracted settlement in post-default restructurings; (iv) a quicker public investment recovery in preemptive restructurings than in post-default restructurings; and (v) a temporal decline and a quick recovery in public consumption and transfers in both types of restructurings.

There are three important differences between our baseline model of endogenous public capital and a model of endogenous *aggregate* capital with no separation between private and public sectors (Gordon and Guerron-Quintana 2018; Park 2017). First, our baseline model of endogenous public capital accounts for (b) ex ante fiscal expenditure consolidation and a preemptive restructuring and (c) fiscal expenditure consolidation and no restructuring (debt distress), while the model of endogenous aggregate capital accounts for none of these two. Second, public capital plays a role in the sovereign's choice of ex ante fiscal expenditure consolidation in our baseline model of endogenous public capital. However, aggregate capital plays almost no role on its choice of ex ante *aggregate* consolidation in the model of endogenous aggregate capital. In the model of endogenous aggregate capital, due to the sovereign's ability to extract resources without distortion from private sector, it achieves both quick aggregate capital recovery and quick debt settlement. As a result, effective costs of a default/post-default restructuring are low and the sovereign has a low and almost no incentive to take a preemptive restructuring. This, in turn, reduces merits of ex ante *aggregate* consolidation prior to a preemptive restructuring. Third, our baseline model of endogenous public capital accounts for five facts, but the model of endogenous aggregate capital accounts for only a fifth fact—a temporal decline and a quick recovery in aggregate consumption.

Literature Review First, current paper contributes to empirical literature on fiscal austerity. Using an enrich dataset of austerity (consolidation) plans in advanced economies. Guajardo et al. (2014) find that fiscal consolidation has contractionary effects on private demand and GDP. Alesina et al. (2019) show larger negative effects of tax-based austerity on GDP growth than those of expenditure-based austerity. Our paper fills a gap in the literature by showing new empirical facts on different consequences of two types of fiscal expenditure consolidation (i.e., ex ante vs. ex post) on sovereign debt crises and resolution.

Second, a theoretical strand of literature explores the sovereign's interdependent choice of debt (foreign borrowing), defaults, and fiscal policy.[4] Recent studies, e.g., Cuadra et al. (2010), Arellano and Bai (2017), Bianchi et al. (2023) and Hatchondo et al. (2022) embed fiscal policy instrument (i.e., expenditure and taxation) in a model wtih endogenous default and

[4]See also Leeper et al. (2010) and Ramey (2021) for the role of public investment on business cycles.

production.[5,6] Our paper contributes to the literature in that we newly explain fiscal expenditure consolidation prior to debt restructurings, i.e., ex ante fiscal expenditure consolidation.

Lastly, the theoretical work on sovereign debt restructuring explains different types of sovereign defaults in the context of a bargaining between a sovereign debtor and its creditors.[7] Arellano et al. (2023) explain both "partial default" and "full default" in that these are differentiated by debt repayment amount, (i.e., partial or no) upon the sovereign's choice of default, i.e., missing payments. Hatchondo et al. (2014) show both "voluntary debt exchange" and default that both occur at the same time upon income realization, i.e., ex post. On the contrary, Asonuma and Trebesch (2016) explain both preemptive and post-default debt restructurings that occur at different point of times, prior to and after income realization. We newly find how the sovereign's restructuring choice is jointly determined with fiscal expenditure consolidation choice and both have consequences to sovereign debt crises and resolution.

2 Dataset and Stylized Facts

2.1 New Dataset on Non-Restructuring Debt Distress Episodes

Table 1: Non-restructuring Debt Distress Episodes in 1975–2020

	Observation	Country	Duration (years, average)	EMBIG Bond Spreads (basis points, average)	Expected Restructuring Probability[1/] (percent, average)
Non-restructuring Debt Distress	25	19	1.4		
EMBIG bond spreads	8	6	1.5	1287	
Estimated restructuring probability	18	15	1.3		21.1/38.8
Debt Restructuring	197	75	3.4	1098	14.2/36.4

Sources: Asonuma and Trebesch (2016), Datastream, and our calculation
Note: [1/] Estimated probability for post-default (left) and preemptive restructurings (right).

First, we compile a new dataset on non-restructuring debt distress episodes in 1975–2020. To have these episodes as a complement to debt restructuring episodes, we classify these episodes based on three criteria: (i) high expected restructuring probability—prior to the event, sovereigns anticipate that a restructuring is highly likely as in actual restructuring events—; (ii) no overlap with restructurings—duration of debt distress and debt restructuring does not overlap—; (iii) being cured—there is an interval of at least 2 years (i,e., non-distressed period) prior to a new restructuring or debt distress.

For criterion (i), we use bond spreads from the J.P. Morgan Emerging Market Bond Index Global (EMBIG) in 1993–2020 for 40 countries with debt restructurings. Average bond spreads

[5]Aguiar et al. (2009) and Mendoza et al. (2014) explore interactions between fiscal policy, i.e., different taxation method and external borrowing choice without the sovereign's default choice.

[6]See also Roch and Uhlig (2018), Pouzo and Presno (2022), D'Erasmo and Mendoza (2016, 2021), Goncalves and Guimaraes (2015), Fink and Scholl (2016), Conesa and Kehoe (2024), Espino et al. (forthcoming), and Karantounias (2018). For empirical work on sovereign debt and fiscal policy, see Kaminsky et al. (2005), Ilzetzki (2011), Ilzetzki et al. (2013), and Frankel et al. (2013).

[7]See also Bulow and Rogoff (1989), Kovrijnykh and Szentes (2007), Arellano et al. (2023), D'Erasmo (2011), Pitchford and Wright (2012) and Dvorkin et al. (2021).

over 12 months prior to the start of debt restructurings in the same sample period are 1098 basis points. We set this as a threshold for annual bond spreads. To complement both limited coverage of time and countries, we follow Asonuma et al. (2024) to apply a probit regression for preemptive and post-default restructurings for 75 countries in 1975–2020. Average expected probability of these restructurings is 36.4 and 14.2 and we set this as a threshold for expected restructuring probability. For criteria (ii) and (iii), we use monthly debt crisis (i.e., duration) dataset in Asonuma and Trebesch (2016).

We find 25 non-restructuring debt distress episodes in 19 countries. Duration of non-restructuring debt distress is 1.4 years on average. Table A1 in Appendix A.1 report all non-restructuring debt distress episodes events and the underlying criteria met.

2.2 New Dataset on Fiscal Expenditure Consolidation

Second, we code a new dataset on fiscal expenditure consolidation around debt restructurings, non-restructuring debt distress and non-debt crisis recessions in 1975–2020 for 75 countries.[8] Following classification of a tight fiscal policy in Alesina and Perotti (1997), we define fiscal expenditure consolidation:

- ***Definition 1***: Fiscal expenditure consolidation is a year in which a *cyclical adjusted* fiscal expenditure-to-GDP ratio falls by more than 1.5 percent or two sequential years in which a *cyclical adjusted* fiscal expenditure-to-GDP ratio falls by at least 1.25 percent a year.

We complement the conventional definition of fiscal consolidation with an alternative classification based on fiscal expenditure-to-potential GDP which is less influenced by business cycles.

- ***Definition 1'***: Fiscal expenditure consolidation is a year in which a fiscal expenditure-to-*potential* GDP ratio falls by more than 1.5 percent or two sequential years in which a fiscal expenditure-to-*potential* GDP ratio falls by at least 1.25 percent a year.

Our fiscal expenditure consolidation is based on actual public expenditure series which includes a sovereign government's fiscal policy response to business cycles (i.e., "endogenous" response). This is different from fiscal consolidation in the literature of fiscal multiplier which is based on the sovereign government's planned fiscal consolidation independent from business cycles (e.g., Alesina et al. 2019).

We compile 148, 14, and 194 fiscal expenditure consolidation episodes around debt restructurings, non-restructuring debt distress and non-debt crisis recessions—from 3 years before each event to the end of event duration. Fiscal expenditure consolidation is more frequent (75 percent of events) around debt restructurings than around non-restructuring debt distress and non-debt crisis recessions (57 or 60 percent). Table A2 in Appendix A.2 reports examples of fiscal expenditure consolidation episodes.

We distinguish two types of fiscal expenditure consolidation by timing:

[8] Asonuma and Joo (2024) define a non-debt crisis recession based on four criteria and code 325 non-debt crisis recession episodes in the same set of 75 countries.

Table 2: Fiscal Expenditure Consolidation Episodes around Debt Restructurings, Non-restructuring Debt Distress and Non-debt Crisis Recessions in 1975–2020

	Event Observation	Fiscal Expenditure Consolidation Observation	Share (% of event)
Debt Restructuring	197	148	75.1
Non-restructuring Debt Distress	25	14	57.0
Non-debt Crisis Recession	325	194	59.7

- ***Definition 2***: Ex ante fiscal expenditure consolidation is one which occurs prior to the start of a debt crisis (i.e., either a start of debt restructuring or a default). Ex post fiscal expenditure consolidation is one which occurs up or after the start of a debt crisis.

We use monthly debt crisis dataset (i.e., duration) in Asonuma and Trebesch (2016) and our non-restructuring debt distress episodes, and compile two types of fiscal expenditure consolidation. In the case of non-restructuring debt distress, all fiscal expenditure consolidation around the event is implemented independently with a debt crisis event and its timing. We merge fiscal expenditure consolidation episodes with the dataset on restructuring strategies in Asonuma and Trebesch (2016). Asonuma and Trebesch (2016) define a preemptive restructuring as a restructuring without missed payments, and a post-default restructuring as a restructuring that a sovereign unilaterally defaults on its payments. Our consolidated datasets provide eight joint strategies of fiscal expenditure consolidation and debt restructurings distinguished by timing and restructuring strategies in Appendix A.3.

2.3 Empirical Findings: Five Stylized Facts

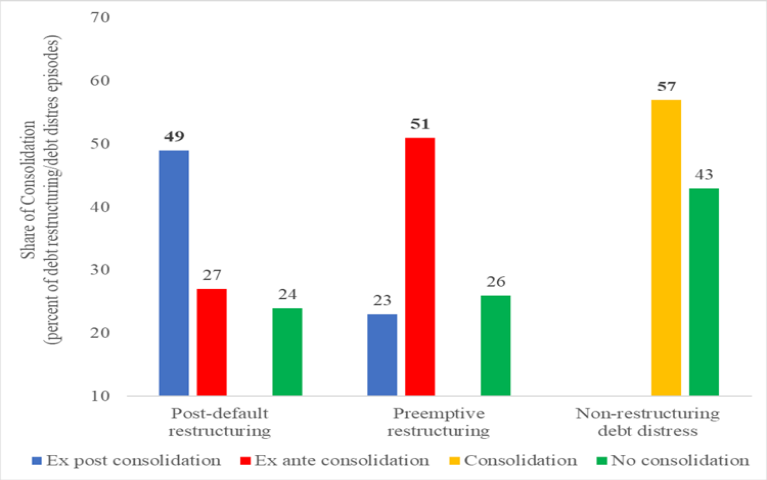
Our findings for fiscal expenditure consolidation and debt restructurings in 1975–2020 can be summarized in five main stylized facts.[9]

- ***Stylized fact 1: Post-default restructurings are associated with ex post fiscal expenditure consolidation, while preemptive restructurings and non-restructuring debt distress are associated with ex ante fiscal expenditure consolidation.***

Figure 1 reports share of fiscal expenditure consolidation choice for each restructuring choice—adds up to 100 percent for post-default, preemptive and no restructuring (debt distress) choice. Ex post expenditure consolidation is the most frequent accounting for 49 percent of 111 post-default restructurings (left section). On the contrary, ex ante expenditure consolidation is the most frequent accounting for 51 percent of 75 preemptive restructurings (center section). Fiscal expenditure consolidation is the most frequent accounting for 57 percent of 25 non-restructuring debt distress episodes (right section). Figure B1 in Appendix B confirms that the observed

[9]For empirical literature on sovereign debt defaults and restructurings, see also Reinhart and Rogoff (2009, 2012).

Figure 1: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings in 1975–2020



pattern remains the same when we apply an alternative classification of fiscal expenditure consolidation using expenditure-to-potential GDP ratio. Figure B2 in Appendix B reports choice of fiscal expenditure around non-debt crisis recessions.[10]

- ***Stylized fact 2: Public investment declines sharply prior to a restructuring in preemptive cases, while upon a default and post-default restructuring in post-default cases.***

- ***Stylized fact 3: Debt settlement takes place before recoveries in public investment in preemptive cases, while after in post-default cases.***

Figure 2 shows the dynamics of public investment around post-default and preemptive debt restructuring, and non-restructuring debt distress episodes.[11] In three panels, the start and end of the debt restructurings and debt distress are marked by gray and orange vertical bars, respectively. Public investment is in real and level terms and is normalized at levels at the start of debt restructurings and debt distress. The blue, red, and purple solid lines show an average for all post-default and preemptive restructuring, and non-restructuring debt distress episodes for which public investment data are available. The green dotted and brown dashed lines show average public investment during the pre-restructuring (pre-debt distress) and restructuring (debt distress) periods.

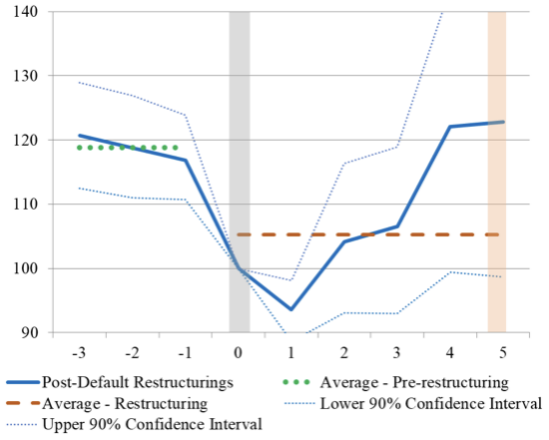
Public investment declines markedly prior to preemptive restructurings i.e., from year -3 to year -1 (panel ii), while at the onset of post-default restructuring i.e., from year -1 to year 1

[10] Ando et al. (2024) empirically show that with using a comprehensive dataset of sovereign debt restructurings covering official external (Paris Club and China), private external and domestic restructuring episodes, debt restructuring combined with fiscal consolidation successfully reduces public debt-to-GDP ratio.

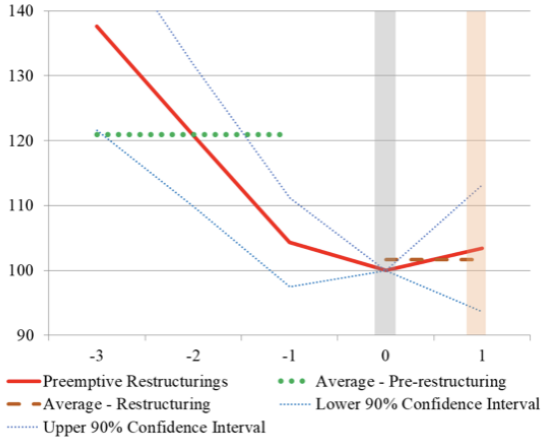
[11] Izquierdo et al. (2019) empirically show that some European EMs with low initial stock of public capital have signicantly high public investment multipliers.

Figure 2: Public Investment

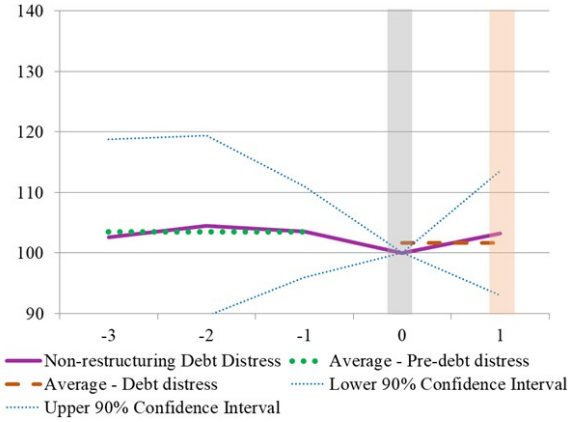
(i) Post-default Restructurings



(ii) Preemptive Restructurings



(iii) Non-restructuring Debt Distress



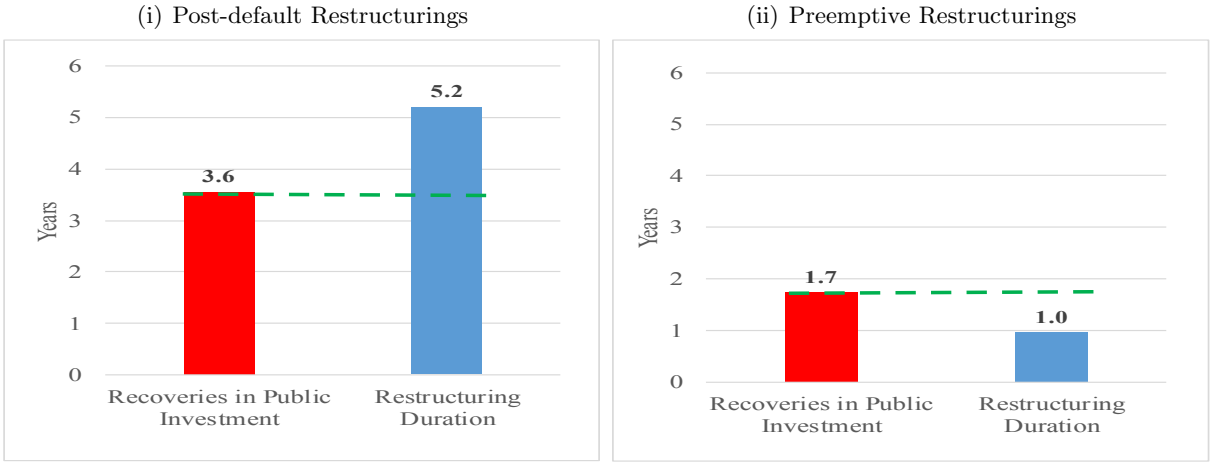
(panel i). On the contrary, public investment reduces temporarily and marginally upon non-restructuring debt distress (panel iii).

In preemptive restructurings, public investment recovers only partially in year 1 and debt settlement takes place in year 1 leading to full recoveries in public investment afterwards (panel ii)—debt settlement precedes recoveries in public investment in 54 percent of preemptive restructurings. In post-default restructurings, public investment recovers to the pre-restructuring level in year 4 and debt settlement follows in year 5 (panel i)—recoveries in public investment precede debt settlement in 70 percent of post-default restructurings. On the contrary, in non-restructuring debt distress, public investment recovers to pre-debt distress level and non-restructuring debt distress ends in year 1. When we measure public investment as percent of GDP, we also find the identical dynamics of public investment-to-GDP ratio for two types of debt restructurings and non-restructuring debt distress (Figure B3 in Appendix B). Figure B4 in Appendix B reports public investment dynamics around non-debt crisis recessions.

- ***Stylized fact 4: Recoveries in public investment are faster in preemptive cases than in post-default cases.***

Figure 3 contrasts length of recoveries in public investment between two types of restructurings. Recoveries in public investment are faster in preemptive cases than in post-default cases (1.7 years vs. 3.6 years). In preemptive restructurings, public investment recovers to the pre-restructuring level immediately after debt settlement (1.7 years vs. 1.0 year in panel ii) taking benefits of quick re-access to the international capital market. On the contrary, in post-default restructurings, public investment recovers to the pre-restructuring level before debt settlement (3.6 years vs. 5.2 years in panel i).

Figure 3: Recoveries in Public Investment and Duration of Restructurings



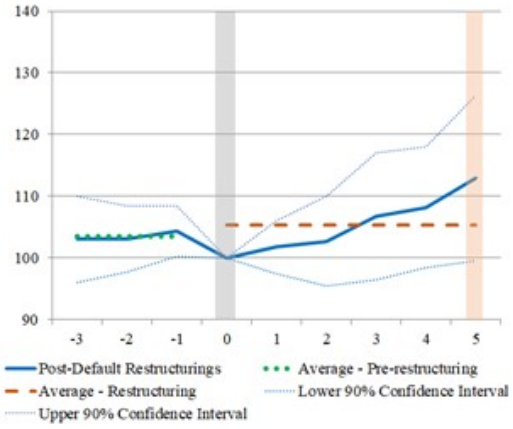
- ***Stylized fact 5: Public consumption and transfers decline temporarily upon a debt restructuring and recover quickly in both types of restructurings.***

Figure 4 shows the dynamics of public consumption and transfers around post-default and preemptive restructurings, and non-restructuring debt distress. We follow the same presentation approach as in Figure 2 in terms of time horizon, timing of events, scale (real and level), normalization of the series at level of the start of restructurings and debt distress (=100), and average in the two periods. Public consumption and transfers fall temporarily at the onset of post-default and preemptive restructurings (year 0) and recover quickly and reach the pre-restructuring level in years 1 or 2 (panels i-ii). Public consumption and transfers continue an upward trend around non-restructuring debt distress (panel iii). When we measure public consumption and transfers as percent of GDP, we also find the identical dynamics of public consumption and transfers-to-GDP ratio for two types of debt restructurings and non-restructuring debt distress (Figure B5 in Appendix B). Figure B6 in Appendix B reports dynamics of public consumption and transfers around non-debt crisis recessions.

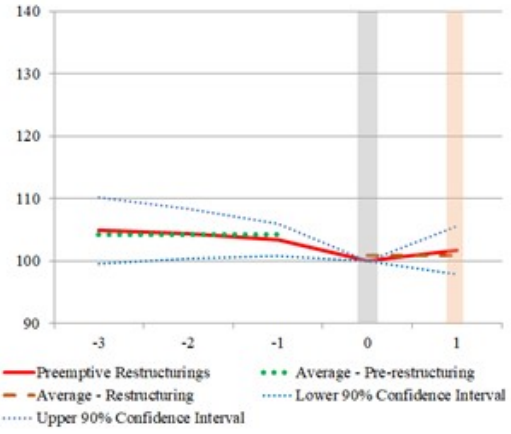
A contrast between Figures 2 and 4 shows a difference in the dynamics between public consumption and transfers, and investment. In preemptive restructurings, public investment

Figure 4: Public Consumption and Transfers

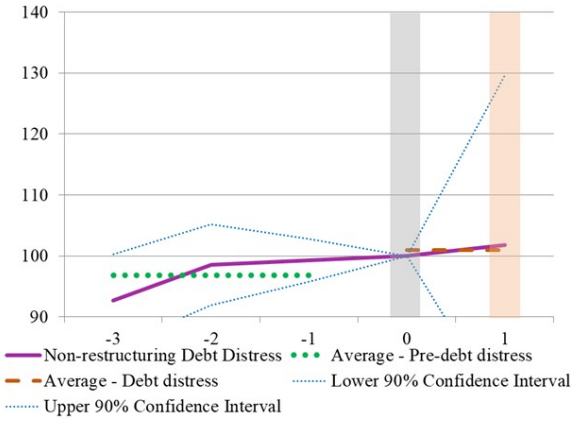
(i) Post-default Restructurings



(ii) Preemptive Restructurings



(iii) Non-restructuring Debt Distress



experiences a severe decline prior to restructurings, but public consumption and transfers do not. In post-default restructurings, public investment experiences a severe decline at the onset of restructurings, but public consumption and transfers experience a small decline. As a result, public expenditure skews heavily towards consumption and transfers under fiscal expenditure consolidation in both preemptive and post-default cases.

To support our stylized facts, we provide logit regression results following the conventional approach in the literature (Asonuma and Joo 2020; 2024). We explore main drivers of both ex ante fiscal expenditure consolidation and preemptive debt restructurings. We use an unbalanced panel covering 197 sovereign debt restructurings (both preemptive and post-default). Each sovereign debt restructuring episode covers both the pre-restructuring and restructuring periods, i.e., from 3 years before the start year of debt restructurings to 3 years after the start year of debt restructurings. We follow two conventional approaches in empirical literature on debt restructurings (e.g., Struzenegger 2004, Asonuma and Trebesch 2016). First, we set our panel

dataset at an annual frequency because both our fiscal and public debt datasets are at an annual frequency. Second, each restructuring episode is treated as a separate episode when both exchanged debt instruments and dates of announcement and of settlement in one restructuring episode are different from those in other episodes. We have overlapping observations at an annual frequency in our panel.

Table 3: Logit regression results on ex ante fiscal expenditure consolidation and preemptive debt restructurings

	Ex ante fiscal expenditure consolidation (binary)		Preemptive debt restructuring (binary)	
	(1)	(1')	(2)	(2')
	coef/se	dy/dx / Delta-method se	coef/se	dy/dx / Delta-method se
Public capital (lagged, percent of GDP)	0.005***	0.001***	-	-
	(0.002)	(0.0002)		
Ex ante fiscal expenditure consolidation (lagged, binary)	-	-	1.16***	0.12***
			(0.24)	(0.03)
Ex ante fiscal expenditure consolidation (2- year lagged, binary)	-	-	1.46***	0.14***
			(0.29)	(0.03)
Public investment (lagged, percent of GDP)	-	-	-0.06**	-0.006*
			(0.03)	(0.003)
Public capital (2-year lagged, percent of GDP)	-	-	-0.0003	-0.00003
			(0.002)	(0.0002)
PPG external debt (lagged change, percent of GDP)	0.02***	0.003***	-0.009	-0.0009
	(0.01)	(0.001)	(0.009)	(0.0009)
GDP deviation from the trend (current, percent)	-0.003	-0.0005	-0.05**	-0.005*
	(0.02)	(0.004)	(0.03)	(0.003)
Constant	-1.83***	-	-1.56***	-
	(0.17)		(0.21)	
Episode-specific fixed effects	No		No	
Number of restructuring episodes	117		125	
Number of observations	533		539	
χ^2	17.47		55.49	
p-value	0.001		0.000	
Log-likelihood ratio	-161.48		-100.91	

The table shows results from random effects logit regressions. The dependent variables are ex ante fiscal expenditure consolidation (binary) and preemptive debt restructurings. For a regression on ex ante fiscal expenditure consolidation choice, main explanatory variables are lagged public capital (in percent of GDP) and lagged percentage change in public extenral debt-to-GDP ratio. For a regression for preemptive debt restructurings, main explanatory variables are both ex ante fiscal expenditure consolidation choice over the last two years (binary), lagged public investment (in percent of GDP), lagged percentage change in public external debt-to-GDP ratio. Both robust standard errors and Delta-method standard errors are are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Our dependent variables are binary for fiscal expenditure consolidation and preemptive debt restructurings: these are defined as whether the sovereign implements ex ante fiscal expenditure consolidation and/or a preemptive debt restructuring or not in the current year: 1 for implementation and 0 otherwise. For regression on ex ante fiscal expenditure consolidation, our main explanatory variables are lagged public capital (in percent of GDP) and lagged percentage

change in public external debt-to-GDP ratio. For regression on preemptive debt restructurings, our main explanatory variables are ex ante fiscal expenditure consolidation over the last two years (binary), lagged public investment (percent of GDP), and lagged percentage change in public external debt-to-GDP ratio. GDP deviation from the HP filtered trend is included as a proxy for productivity shocks.

We report two main logit regression results in Table 3. First, we find that when the public capital is at a higher level and public external debt increases sharply in the previous year, the sovereign is more likely to implement ex ante fiscal expenditure consolidation in the current year. Quantitatively, both an increase in the public capital by 5 percent of GDP and an increase in the public external debt by 5 percent of GDP in the previous year increases the probability of ex ante fiscal expenditure consolidation by 0.5 percent and 1.5 percent, respectively. Second, when ex ante fiscal expenditure consolidation is implemented over the last two years and the public investment decreases in the previous year, the sovereign is more likely to implement a preemptive debt restructuring in the current year. Quantitatively, implementation of ex ante fiscal expenditure consolidation over the last two years and a 5-percent decrease in the public investment-to-GDP ratio in the previous year increase the likelihood of a preemptive debt restructuring by 13 and 3 percent, respectively. When public external debt decreases independently or associated with fiscal expenditure consolidation in the previous year, the sovereign is more likely to implement a preemptive debt restructuring in the current year but not significantly. This is because in the previous year, the sovereign responded by implementing ex ante fiscal expenditure consolidation to a sharp increase in public external debt in the run-up to a preemptive debt restructuring. Furthermore, the sovereign is more likely to implement both ex ante fiscal expenditure consolidation and a preemptive debt restructuring in the current year when GDP deviation from the Hodrick–Prescott (HP) filtered trend is low, but only significantly for preemptive restructuring choice.

3 Theoretical Model

3.1 Summary of Theoretical Findings

Our theoretical model sheds light on the sovereign's choice of fiscal expenditure consolidation and debt restructurings. Specifically, our model newly introduces an interaction between the sovereign's endogenous choice of preemptive and post-default restructurings and endogenous public capital (investment) accumulation. To reflect different economic circumstances which sovereign debtors face, we proceed in two steps. At the first step, we use a conventional sovereign debt model with fiscal policy (Cuadra et al. 2010; Arellano and Bai 2017) as baseline model and show key results in Sections 3, 4, and 5. At the second step, we include different assumptions used in the previous studies in our baseline model and show that our baseline model remains robust in Appendix C.2.

We have two main theoretical predictions. Our first predictions are on the sovereign's choice of fiscal expenditure consolidation and debt restructurings, importantly, (b) ex ante fiscal ex-

penditure consolidation and a preemptive restructuring and (c) fiscal expenditure consolidation and no restructuring (debt distress). When debt is high, public capital is high and productivity is moderate/high, the sovereign repays debt in full, borrows less new debt, and implements ex ante fiscal expenditure consolidation. Under high public capital, reducing debt and default risk through public investment cut is more beneficial than maintaining public investment. After implementing ex ante fiscal expenditure consolidation, when debt is high, before productivity materializes, the sovereign takes a preemptive restructuring. When debt is moderate, after moderate/high productivity materializes, it repays debt in full.

Moreover, the model shows (a) ex post fiscal expenditure consolidation and a default/post-default restructuring. When debt is moderate, public capital is low and productivity is moderate/high, the sovereign does not implement ex ante fiscal consolidation. After choosing no ex ante fiscal expenditure consolidation, when debt is moderate, after low productivity materializes, it chooses to default and implement ex post fiscal expenditure consolidation.

Our second predictions are on the role of public capital (investment dynamics) determining the timing of fiscal expenditure consolidation and associated debt crisis resolution. When public capital is high, the sovereign implements ex ante fiscal expenditure consolidation through public investment cut. The consolidation results in low public capital. When public capital is low, it finds a preemptive restructuring optimal in later periods in order to avoid larger costs associated with a default/post-default restructuring. Under a preemptive restructuring, it reaches debt settlement quickly due to smaller costs (than those under a post-default case), and public investment recovers quickly afterwards due to re-access to the international market. Contrary, when debt is moderate and public capital is low, it does not implement ex ante fiscal expenditure consolidation. After low productivity materializes, it defaults and reduces public investment due to loss in market access and larger costs associated with a default/post-default restructuring. Under a post-default restructuring, public investment recovers slowly due to financial exclusion and larger costs, and as a result, debt settlement is delayed further.

3.2 Assumptions in the Model

There are four agents in the model: a household, a firm, a sovereign (government), and foreign creditors.[12] The sovereign is risk averse and cannot affect the global risk-free interest rate (r^*). Foreign creditors are risk-neutral. They can borrow or lend as much as needed at the constant risk-free interest rate in the international capital market.

In each period, a stochastic productivity shock a_t materializes. It is stochastic, drawn from a compact set $A = [a_{min}, a_{max}] \subset R$. $\mu(a_{t+1}|a_t)$ is a probability distribution of a shock a_{t+1} conditional on its previous realization a_t. In addition, the sovereign's credit record $h_t \in [0, 1, 2]$, denotes "good" when it maintains access to the international market ($h_t = 0$), "intermediate" when it has partial access due to a preemptive restructuring ($h_t = 1$), or "bad" when it loses access due to a default/post-default restructuring ($h_t = 2$). The credit record keeps track of where we are in the decision tree, in particular, timing of both decisions and debt renegotiations.

[12] In this theoretical and quantitative analysis, the term sovereign corresponds to the government.

The information on the sovereign's debt, public capital, credit record, and productivity shock is symmetric and perfect for all parties.[13]

Decisions by the sovereign, household and firm are made at two points in time depending the sovereign's credit record; (i) before realization of current productivity when the credit record is intermediate, (i.e., preemptive renegotiation), or (ii) after realization of current productivity when credit record is good or bad, (i.e., repayment or post-default renegotiation).

The sovereign receives consumption tax revenues and decides expenditure composition—public consumption, investment and transfers—together with its choice of repayment and default (settlement and delay), and of external borrowing. Consumption tax revenues are determined by the household's optimal choice of private consumption given a constant consumption tax rate—Appendix C.2 assumes two-stage taxation method i.e., higher consumption tax rate during preemptive and post-default restructurings than that during normal market access periods. Public consumption and transfers are provided to the household to improve his utility directly or indirectly by smoothing private consumption, respectively. Public capital rented to the firm is accumulated through net investment and is subject to both depreciation and adjustment costs.

The households receives public consumption and transfers from the sovereign and dividends from the firm, pays taxes on consumption goods to the sovereign, decides private consumption and labor. The firm receives public capital from the sovereign and decides labor demand, produces goods, and pays dividends to the household.

The sovereign bond market is incomplete. The sovereign can borrow and lend only via long-term sovereign bonds, while neither the household nor firm can. As in Hatchondo and Martinez (2009) and Chatterjee and Eyigungor (2012), current outstanding debt (b_t) matures with probability λ and if it does mature, it provides a coupon payment z.[14] Its set is shown by $B = [b_{min}, 0] \subset R$ where $b_{min} \leq 0$. We set the lower bound for the sovereign's bond holding at $b_{min} > -y_{max}/r^*$ which is the largest debt that the sovereign could repay. New debt issuance in the current period is shown by $-b_{t+1} + (1-\lambda)b_t$. We assume $q(b_{t+1}, k^g_{t+1}, 0, a_t)$ to be price of sovereign bonds with its debt b_{t+1}, public capital k^g_{t+1}, good credit record ($h_t = 0$), and a productivity shock a_t. The bond price is determined in equilibrium.

We assume that the creditors always commit to repay their debt. However, the sovereign is free to decide whether to repay its debt or to default. If the sovereign chooses to repay its debt, it will preserve access to the international capital market in the next period. If it chooses to default, it is then subject to full loss in market access, larger productivity loss, and accumulation

[13]Our model does not assume any ex ante information asymmetries among four agents or disincentives of the sovereign government that make a default unavoidable. In the reality, a sovereign government could have private information. See Amador and Phelan (2021) and D'Erasmo (2011).

[14]Sanchez et al. (2018) explore endogenous choice of sovereign debt maturity.

of arrears.[15,16] If it chooses a preemptive restructuring (no default), it suffers partial loss in market access and smaller productivity loss, but no accumulation of arrears. The assumption of two types of productivity loss is consistent with different output dynamics between preemptive and post-default restructurings in empirical literature (e.g., Asonuma et al. 2024).

Debt renegotiations also take place at two different points in time: (i) before realization of current productivity, (i.e., preemptively), or (ii) after realization of current productivity and the sovereign chooses to default, (i.e., post-default). In both renegotiations, the sovereign and creditors negotiate a reduction of debt via multi-round bargaining.[17] One party is randomly selected as a proposer with exogenous and constant probability. The proposer chooses among proposing an offer with haircuts (recovery rates), passing, and quitting the renegotiations in preemptive restructurings, while only between proposing and passing in post-default restructurings. The other party chooses among accepting, rejecting, and quitting the renegotiations in preemptive restructurings, while only between accepting and rejecting in post-default restructurings. In preemptive restructurings, if one party quits the renegotiations, both parties move back to the sovereign's choice of passing preemptive option. In both types of restructurings, if the offer with haircuts is proposed and accepted, then the sovereign regains full access to the international capital market in the next period and the creditors receive recovered debt payments. Otherwise, both parties continue the negotiation over a reduction of debt in the next period.

The sovereign is willing to settle on haircuts in both preemptive and post-default restructurings. In preemptive restructurings, it prefers avoiding partial exclusion from the international market and smaller productivity loss while paying large recovered debt payments. In post-default restructurings, it prefers avoiding permanent exclusion from the international market and larger productivity loss while paying small recovered debt payments.

The creditors are also willing to settle on recovery rates (haircuts) in both preemptive and post-default restructurings. In preemptive restructurings, they accept when the recovery rates are at least higher than the expected return on bonds accounting for both probability of full repayment and the recovery rates conditional on a default. In post-default restructurings, they accept because debt settlement is the only option to recoup losses om the debt in arrears.

[15]The productivity loss assumption in our production model is conceptually equivalent to "output costs" assumption in the conventional endowment model (e.g., Arellano 2008; Aguiar and Gopinath 2006; Yue 2010). In this regard, the direct production loss is widely accepted in the sovereign debt literature with endogenous production (Cuadra et al. 2010; Arellano and Bai 2017; Gordon and Guerron-Quintana 2018). Both assumptions are broadly in line with empirical estimates of output loss at default in general (Sturzenegger 2004; Tomz and Wright 2007; Levy-Yeyati and Panizza 2011) and those at both preemptive and post-default restructurings (Asonuma and Trebesch 2016; Trebesch and Zabel 2017; Asonuma et al. 2024).

[16]Mendoza and Yue (2012) provide micro-foundation of this conventional assumption that exclusion from the international capital market leads to losses in production efficiency due to a lack of imported inputs and labor reallocation away from final goods production.

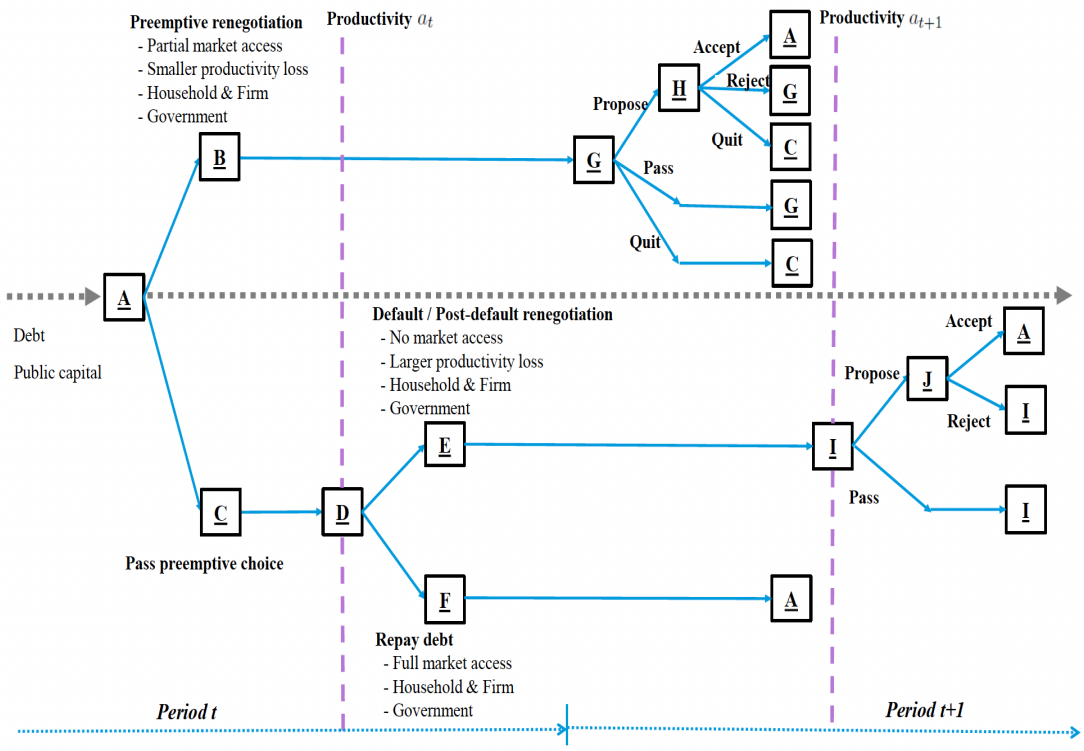
[17]As in previous studies on sovereign debt restructuring (Benjamin and Wright 2013; Yue 2010), we assume no change in maturity of debt during debt renegotiations. Dvorkin et al. (2021) explore a change in maturity of debt (i.e., maturity extension) during debt renegotiations.

3.3 Timing of the Model

Figure 5 summarizes the timing of decisions within each period.

1. The sovereign starts the current period with debt and public capital. We are in node (A).
2. The sovereign decides whether to initiate a preemptive restructuring or not.
   (a) If the sovereign opts a preemptive restructuring, we move to the upper branch of the tree and are in node (B). The sovereign has partial access to the market, suffers smaller productivity loss, and chooses public expenditure. The household and firm make their decision. We move to node (G) in the next period.
   (b) If the sovereign passes the preemptive option, we move to the lower branch of the tree and are in node (C).
3. A productivity shock (a_t) realizes. The sovereign decides whether to repay debt in full or to default.
   (a) In node (E) (default node), if it defaults, we move to the middle-upper branch of the tree. It fully loses access to the market, suffers larger productivity loss, and chooses public expenditure. The household and firm make their decision. We proceed to node (I) in the next period.
   (b) In node (F) (repayment node), the sovereign repay debt in full, we move to the lower branch of the tree. It maintains full market access and chooses debt and public expenditure. Foreign creditors choose sovereign bonds in the next period. The household and firm make their decision. We proceed to node (A) in the next period.
4. In node (G) (preemptive renegotiation), the proposer decides whether to propose an offer, pass or quit the preemptive renegotiation.
   (a) In node (H) (propose node), if the proposer proposes an offer, the counterpart decides whether to accept, reject, or quit the preemptive renegotiation. If the counterpart accepts the offer, the sovereign regains market access and we move to node (A) in the next period. If the counterpart rejects the offer, the sovereign's market access remains partial and we move back to node (G) in the next period. If the counterpart quits the preemptive renegotiation, we proceed to node (C) in the current period.
   (b) If the proposer passes, the sovereign's market access remains partial and we move back to node (G) in the next period.
   (c) If the proposer quits the preemptive renegotiation, we proceed to node (C) in the current period.
5. A productivity shock (a_{t+1}) realizes.

Figure 5: Timing of Model



6. In node (I) (post-default renegotiation), the propose decides whether to propose an offer or pass.

7. (a) In node (J) (propose node), if the proposer chooses to propose an offer, the counterpart decides whether to accept or reject. If the counterpart accepts the offer, the sovereign regains market access and we move to node (A) in the next period. If the counterpart rejects, the sovereign remains in financial autarky and we move back to node (I) in the next period.

   (b) If the proposer chooses to pass, the sovereign remains in financial autarky and we move back to node (I) in the next period.

4 Recursive Equilibrium

4.1 Household's Problem

This section defines the stationary recursive equilibrium of our model. A representative household's utility function is defined as:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t [(1-\omega)u(c_t, l_t) + \omega v(g_t)]$$

where $0 < \beta < 1$ is the discount factor and c_t, l_t, g_t denote private consumption, labor supply and public consumption in period t, respectively. His period utility function is separable between a multiple of private consumption and labor supply, and public consumption. Both $u(\cdot)$ and $v(\cdot)$ are continuous, strictly increasing, strictly concave, and satisfy the Inada conditions. ω denotes the weight on public consumption in the household's utility function.

The household takes as given the wage rate w_t, dividends paid by the firm π_t^F, public transfers T_t, public consumption g_t and a consumption tax rate τ, and chooses private consumption and labor supply. He does not borrow directly from abroad, but the sovereign borrows, provides public consumption and transfers, and makes restructuring/repayment choice internalizing the household's utility. The household's optimization problem is written as

$$\begin{aligned} &\max E_0 \sum_{t=0}^{\infty} \beta^t [(1-\omega)u(c_t, l_t) + \omega v(g_t)] \\ &s.t. \quad (1+\tau)c_t = w_t l_t + \pi_t^F + T_t \end{aligned} \tag{1}$$

The consumption tax rate is assumed to be constant (Arellano and Bai 2017; Alfaro and Kanczuk 2017)—also supported by empirical findings on value-added taxes in developing countries in Gunter et al. (2021). The optimality condition of the household is shown as follows:

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{w_t}{1+\tau} \tag{2}$$

4.2 Firm's Problem

A representative firm chooses labor l_t for goods production given a productivity shock a_t, public capital stock k_t^g, and fixed private capital stock $k^p (= 1)$. The production function is Cobb-Douglas:

$$y_t = a_t (l_t)^{\alpha_l} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k} \tag{3}$$

where $0 < \alpha_l, \alpha_k < 1$. The fixed private capital stock assumption follows closely Mendoza and Yue (2012) and Azzimonti (2015). The firm's optimization problem is written as:

$$\max_{l_t} \pi_t^F = a_t (l_t)^{\alpha_l} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k} - w_t l_t \tag{4}$$

The optimality condition of the firm is shown as follows:

$$w_t = \alpha_l a_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k} \tag{5}$$

4.3 Sovereign's (Government's) Problem

The sovereign's problem is to maximize expected lifetime utility. We start the sovereign's problem with a good credit record ($h_t = 0$), i.e., full access to the international market.

Prior to realization of current productivity, the sovereign decides whether to initiate a preemptive restructuring or not and its ex ante value function is defined as follows:

$$V^{EXANTE}(b_t, k_t^g, 0, a_{t-1}) = \max\left[V^{PRE}(b_t, k_t^g, 0, a_{t-1}), V^{NON\_PRE}(b_t, k_t^g, 0, a_{t-1})\right] \tag{6}$$

$V^{PRE}(b_t, k_t^g, 0, a_{t-1})$ is the ex ante value function of a preemptive restructuring:

$$V^{PRE}(b_t, k_t^g, 0, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t} \int_A [(1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta V((1-\lambda)b_t, k_{t+1}^g, 1, a_t)]d\mu(a_t|a_{t-1}) \tag{7}$$

$$s.t. \quad g_t + k_{t+1}^g + T_t = \tau c_t + (\lambda + (1-\lambda)z)b_t + (1-\delta^k)k_t^g - \frac{\Omega}{2}(\frac{k_{t+1}^g - k_t^g}{k_t^g})^2 k_t^g \tag{8}$$

$$T_t \geq 0 \tag{9}$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha \hat{a}_l (l_t)^{\alpha_l - 1}(k_t^g)^{\alpha_k}(\bar{k^p})^{1-\alpha_l-\alpha_k}}{1+\tau} \tag{10}$$

$$(1+\tau)c_t = \hat{y}_t + T_t \tag{11}$$

where $\hat{y}_t = \hat{a}_t(l_t)^{\alpha_l}(k_t^g)^{\alpha_k}(\bar{k^p})^{1-\alpha_l-\alpha_k}$ is output with smaller productivity loss due to a preemptive restructuring. Equation (8) is the budget constraint for the sovereign where it receives consumption tax revenues τc_t and public capital stock net of depreciation and adjustment costs (shown as the second and third terms of the right hand side)—non-linear adjustment costs are assumed and δ^k is the depreciation rate of public capital. It allocates resources to public consumption g_t, capital k_{t+1}^g, transfers T_t. Equation (9) is the "non-lump sum taxation constraint" indicating a limitation of the sovereign from transferring resources from the private sector. While the sovereign can allocates any resources to the household as a form of transfers, it is restricted to extract resources from the household only by the distortionary consumption tax. Equations (10) and (11) correspond to the combined optimality condition and budget constraint for the private sector.

$V^{NON\_PRE}(b_t, k_t^g, 0, a_{t-1})$ is the sovereign's ex ante value function of not choosing a preemptive restructuring, based on its ex post value function $V(b_t, k_t^g, 0, a_t)$ as follows:

$$V^{NON\_PRE}(b_t, k_t^g, 0, a_{t-1}) = \int_A V(b_t, k_t^g, 0, a_t)d\mu(a_t|a_{t-1}) \tag{12}$$

The sovereign's preemptive restructuring choice can be characterized by a preemptive restructuring set $PRE(b_t, k_t^g, 0) \subset A$. It is a set of productivity shocks a_{t-1} at which the sovereign finds preemptive restructuring choice optimal:

$$PRE(b_t, k_t^g, 0) = \{a_{t-1} \in A : V^{PRE}(b_t, k_t^g, 0, a_{t-1}) \geq V^{NON\_PRE}(b_t, k_t^g, 0, a_{t-1})\} \tag{13}$$

After realization of current productivity, the sovereign chooses whether to repay the debt or to default and its ex post value function is defined as follows:

$$V(b_t, k_t^g, 0, a_t) = \max\left[V^R(b_t, k_t^g, 0, a_t), V^D(b_t, k_t^g, 0, a_t)\right] \tag{14}$$

$V^R(b_t, k_t^g, 0, a_t)$ is its value function of repayment:

$$V^R(b_t, k_t^g, 0, a_t) = \max_{g_t, b_{t+1}, k_{t+1}^g, T_t} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta \int_A V(b_{t+1}, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{15}$$

$$\begin{aligned} s.t.\ (9)\ and\ & g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 0, a_t)(b_{t+1} - (1-\lambda)b_t) \\ & = \tau c_t + (1-\delta^k)k_t^g - \frac{\Omega}{2}\left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g + (\lambda + (1-\lambda)z)b_t \end{aligned} \tag{8a}$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l a_t (l_t)^{\alpha_l - 1}(k_t^g)^{\alpha_k}(\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \tag{10a}$$

$$(1+\tau)c_t = y_t + T_t \tag{11a}$$

where $(\lambda + (1-\lambda)z)b_t$ is debt payments due in the current period and $q(b_{t+1}, k_{t+1}^g, 0, a_t)(b_{t+1} - (1-\lambda)b_t)$ is new debt issued in the current period.
$V^D(b_t, k_t^g, 0, a_t)$ is its value function of a default/post-default restructuring:

$$V^D(b_t, k_t^g, 0, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta \int_A V((1+r^*)b_t, k_{t+1}^g, 1, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{16}$$

$$s.t. \quad (8), \quad (9) \text{ and}$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l \tilde{a}_t (l_t)^{\alpha_l - 1}(k_t^g)^{\alpha_k}(\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \tag{10b}$$

$$(1+\tau)c_t = \tilde{y}_t + T_t \tag{11b}$$

where $\tilde{y}_t = \tilde{a}_t (l_t)^{\alpha_l}(k_t^g)^{\alpha_k}(\bar{k_t^p})^{1-\alpha_l-\alpha_k}$ is output with larger productivity loss due to a default/post-default restructuring.

The sovereign's default/post-default restructuring choice can be characterized by a default/post-default restructuring set $D(b_t, k_t^g, 0) \subset A$. It is a set of productivity shocks a_t at which the sovereign finds a default and post-default restructuring optimal.

$$D(b_t, k_t^g, 0) = \{a_t \in A : V^R(b_t, k_t^g, 0, a_t) < V^D(b_t, k_t^g, 0, a_t)\} \tag{17}$$

Next comes the sovereign's problems with intermediate ($h_t = 1$) and bad ($h_t = 2$) credit records, i.e., partial or no access to the international market. Value functions for intermediate and bad credit records are expected payoffs for preemptive and post-default debt renegotiations for the sovereign:

$$V(b_t, k_t^g, 1, a_{t-1}) = \Psi(b_t, k_t^g, a_{t-1}) \tag{18}$$

$$V(b_t, k_t^g, 2, a_t) = \Gamma(b_t, k_t^g, a_t) \tag{19}$$

4.4 Foreign Creditors' Problem

Foreign creditors are risk-neutral and can borrow from the international market with the risk-free rate (r^*). When the sovereign has a good credit record ($h_t = 0$), given the sovereign bond price, the foreign creditors choose the amount of debt in the next period (b_{t+1}) to maximize their expected profit:

$$\pi^c(b_{t+1}, k_{t+1}^g, 0, a_t) = \begin{cases} \frac{\delta(b_{t+1}, k_{t+1}^g, 1, a_t)}{1+r^*}(-b_{t+1}) - q(b_{t+1}, k_{t+1}^g, 0, a_t) b_{t+1} & \text{if } a_{t-1} \in PRE(b_t, k_t^g, 0) \\ \left[\frac{(1-p^D(b_{t+1}, k_{t+1}^g, 0, a_t))\{\lambda + (1-\lambda)[z + q(b_{t+2}, k_{t+2}^g, 0, a_{t+1})\}}{1+r^*} \right. & \\ \left. + \frac{p^D(b_{t+1}, k_{t+1}^g, 0, a_t) \int_A \gamma(b_{t+1}, k_{t+1}^g, 2, a_{t+1}) d\mu(a_{t+1}|a_t)}{1+r^*} \right] \times (-b_{t+1}) & \\ -q(b_{t+1}, k_{t+1}^g, 0, a_t)(-b_{t+1}) & otherwise \end{cases} \tag{20}$$

where $\delta(b_{t+1}, k_{t+1}^g, 0, a_t)$ and $\alpha(b_{t+1}, k_{t+1}^g, 0, a_t)$ are expected recovery rates at preemptive and post-default restructurings, respectively. $p^D(b_{t+1}, k_{t+1}^g, 0, a_t)$ is expected default probability. Since we assume that the market for new sovereign bonds is completely competitive, foreign creditors' expected profit is zero in equilibrium. From the zero expected profit condition, we obtain the bond price function:

$$q(b_{t+1}, k_{t+1}^g, 1, a_t) = \begin{cases} \frac{\delta(b_{t+1}, k_{t+1}^g, 1, a_t)}{1+r^*} & \text{if } a_{t-1} \in PRE(b_t, k_t^g, 0) \\ \frac{(1-p^D(b_{t+1}, k_{t+1}^g, 0, a_t))\{\lambda + (1-\lambda)[z + q(b_{t+2}, k_{t+2}^g, 0, a_{t+1})\}}{1+r^*} & \\ + \frac{p^D(b_{t+1}, k_{t+1}^g, 0, a_t) \int_A \gamma(b_{t+1}, k_{t+1}^g, 2, a_{t+1}) d\mu(a_{t+1}|a_t)}{1+r^*} & otherwise \end{cases} \tag{21}$$

The foreign creditors face either the risk of a default/post-default restructuring with expected recovery rates, or the risk of a preemptive restructuring with expected recovery rates. The sovereign bond is priced to compensate the foreign creditors for these two types of risks. Since $0 \leq \delta(b_{t+1}, k^g_{t+1}, 1, a_t) \leq 1$ and $0 \leq \alpha(b_{t+1}, k^g_{t+1}, 0, a_t) \leq 1$, the bond price $q(b_{t+1}, k^g_{t+1}, 0, a_t)$ lies in $[0, \frac{1}{(1+r^*)}]$.

4.5 Debt Renegotiation

Two types of debt renegotiations (preemptive and post-default) are symmetric in bargaining game and power. Both renegotiations take the form of a two-player stochastic bargaining game with complete information as in Merlo and Wilson (1995).[18] It is a multi-round stochastic bargaining game in that both the productivity process of the sovereign and the identity of the proposer are stochastic. For simplicity, each player has a constant probability of being selected as the proposer in each round of the negotiation. That is, the identity of the proposer is independent of the sovereign's productivity process. Let ϕ denote the probability that the borrower, B, can propose and $1 - \phi$ is the probability that the lender, L, can propose. The probability which one of the players is selected as the proposer is a parsimonious way to reflect the bargaining power obtained through one's ability to enjoy the first-mover advantage.

Two types of debt renegotiations differ in three aspects: (i) timing, (ii) strategies, and (iii) outside options for two parties. Preemptive renegotiation takes place before realization of current productivity, while post-default renegotiation after realization of current productivity and the sovereign's default choice. Quitting the renegotiation is included in strategies for both parties under preemptive renegotiations, while not under post-default renegotiations. Outside options under preemptive case are passing preemptive option for the sovereign and ex ante expected return on bonds for the creditors, while those under post-default case are permanent autarky for the sovereign and no recovered debt payments for the creditors.

In every round, the proposer may either propose recovery rates (haircuts), pass, or quit the renegotiation—only available for preemptive case. If he proposes, then the other party chooses to accept, reject the proposal, or quit the renegotiation.[19] If the offer with recovery rates (haircuts) is proposed and accepted, the sovereign repays the recovered debt payments and resumes full access to the international market in the next period. If the proposer or the counterpart quit the renegotiation, both parties move back to the sovereign's choice of passing preemptive option. Otherwise (i.e. when the proposer proposes and the counterpart rejects, or the proposer passes), both parties repeat the bargaining game in the next period.

[18] While there could be other approaches of modeling a bargaining game between two parties, we follow the conventional bargaining game in Merlo and Wilson (1995) for their simplicity and tractability.

[19] 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.

We define some basic concepts of the game. A stochastic bargaining game may be denoted by $(C, \beta, 1/(1+r^*))$ where for each productivity process $a \in A$, $C(a)$ is the set of feasible utility vectors that may be agreed upon in that state. β and $1/(1+r^*)$ are the discount factors for B and L, respectively.[20] A payoff function is an element $\Delta(a) \in C(a)$, where $\Delta_i(a)$ is the utility to player i for $i = B, L$.

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 $(b_t, k_t^g, h_t, a_t/a_{t-1})$ where $h_t = 1, 2$ and the current offer. We denote the proposer i's and the other party j's equilibrium strategies as follows: for $h_t = 1, 2$, (a) $\theta_i(b_t, k_t^g, h_t, a_t/a_{t-1}) = 1$ (propose) when the proposer i proposes and $\theta_j(b_t, k_t^g, h_t, a_t/a_{t-1}) = 1$ (accept) when the other party j accepts the offer, (b) $\theta_i(b_t, k_t^g, h_t, a_t/a_{t-1}) = 0$ (pass) when the proposer i passes and $\theta_j(b_t, k_t^g, h_t, a_t/a_{t-1}) = 0$ (reject) when the other party j rejects the offer. In addition, only when $h_t = 1$ (preemptive restructuring), (a) $\theta_i(b_t, k_t^g, 1, a_{t-1}) = -1$ (quit) when the proposer i quits the renegotiation and $\theta_j(b_t, k_t^g, 1, a_{t-1}) = -1$ (quit) when the other party j quits.

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

$$\begin{aligned}\Gamma(b_t, k_t^g, 2, a_t) &= \phi\Gamma^B(b_t, k_t^g, 2, a_t) + (1-\phi)\Gamma^L(b_t, k_t^g, 2, a_t)\\ \Gamma^*(b_t, k_t^g, 2, a_t) &= \phi\Gamma^{*B}(b_t, k_t^g, 2, a_t) + (1-\phi)\Gamma^{*L}(b_t, k_t^g, 2, a_t)\end{aligned} \tag{22}$$

$$\begin{aligned}\Psi(b_t, k_t^g, 1, a_{t-1}) &= \phi\Psi^B(b_t, k_t^g, 1, a_{t-1}) + (1-\phi)\Psi^L(b_t, k_t^g, 1, a_{t-1})\\ \Psi^*(b_t, k_t^g, 1, a_{t-1}) &= \phi\Psi^{*B}(b_t, k_t^g, 1, a_{t-1}) + (1-\phi)\Psi^{*L}(b_t, k_t^g, 1, a_{t-1})\end{aligned} \tag{23}$$

Here the superscript denotes the identity of the proposer: $\Gamma^B(\Gamma^{*B})$ represents the borrower's (lender's) payoff when the borrower proposes, and $\Gamma^L(\Gamma^{*L})$ refers to the borrower's (lender's) payoff when the lender proposes. We consider the case when the borrower proposes. The case when the lender proposes is identical to the case the borrower proposes and is explained in Appendix C.1.

First, we start with post-default debt renegotiations. We denote the offered recovery rates as α_t^B, the borrower's values of proposing and passing as V^{PRO} and V^{PASS}, and the creditors' values of accepting and rejecting as V^{*ACT} and V^{*REJ}, respectively. When the borrower B proposes and the offer is accepted, the sovereign repays reduced debt arrears $-\alpha_t^B b_t$ and resumes access to the international market in the next period with outstanding debt, i.e., net issuance

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

at the settlement as in Benjamin and Wright (2013).

$$V^{PRO}(b_t, k_t^g, 2, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta \int_A V(b_{t+1}, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{24}$$

$$s.t. \quad (9),\ (10b),\ (11b),\ \text{and}$$

$$g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 2, a_t) b_{t+1} = \tau c_t + (1-\delta^k) k_t^g - \frac{\Omega}{2}(\frac{k_{t+1}^g - k_t^g}{k_t^g})^2 k_t^g + \alpha_t^B b_t \tag{8b}$$

$$V^{*ACT}(b_t, k_t^g, 2, a_t) = -\alpha_t^B b_t \tag{25}$$

When the borrower B passes, both parties proceed to the next period and continue post-default renegotiations with accumulated arrears.

$$V^{PASS}(b_t, k_t^g, 2, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta \int_A V((1+r^*)b_t, k_{t+1}^g, 2, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{26}$$

$$s.t. \quad (8),\ (9),\ (10b),\ \text{and}\ (11b)$$

$$V^{*REJ}(b_t, k_t^g, 2, a_t) = \frac{1}{1+r^*} \int_A \Gamma^*((1+r^*)b_t, k_{t+1}^g, 2, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{27}$$

In equilibrium, the agreed recovery rates α_t^{B*} satisfy the following:[21]

$$\begin{aligned} \alpha_t^{B*} &= argmax V^{PRO}(b_t, k_t^g, 2, a_t) \\ s.t. \quad V^{PRO}(b_t, k_t^g, 2, a_t) &\geq V^{PASS}(b_t, k_t^g, 2, a_t) \\ V^{*ACT}(b_t, k_t^g, 2, a_t) &\geq V^{*REJ}(b_t, k_t^g, 2, a_t) \end{aligned} \tag{28}$$

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

$$\Gamma^B(b_t, k_t^g, 2, a_t) = V^{PRO}(b_t, k_t^g, 2, a_t)$$

$$\Gamma^{B*}(b_t, k_t^g, 2, a_t) = V^{*ACT}(b_t, k_t^g, 2, a_t) \tag{29}$$

Otherwise,

$$\Gamma^B(b_t, k_t^g, 2, a_t) = V^{PASS}(b_t, k_t^g, 2, a_t)$$

[21] Off-equilibrium paths are eliminated in equilibrium.

$$\Gamma^{B*}(b_t, k_t^g, 2, a_t) = V^{*REJ}(b_t, k_t^g, 2, a_t) \tag{29a}$$

The renegotiation settlement can be characterized by a settlement set $R^B(b_t, k_t^g, 2) \subset A$. It is a set of productivity shocks a_t at which both parties reach an agreement:

$$R^B(b_t, k_t^g, 2) = \left\{ \begin{array}{c} a_t \in A : V^{PRO}(b_t, k_t^g, 2, a_t) \geq V^{PASS}(b_t, k_t^g, 2, a_t) \\ V^{*ACT}(b_t, k_t^g, 2, a_t) \geq V^{*REJ}(b_t, k_t^g, 2, a_t) \end{array} \right\} \tag{30}$$

Second, we consider preemptive debt renegotiations. We denote the offered recovery rates as δ_t^B, the borrower's values of proposing, passing, and quitting as V^{PRO}, V^{PASS}, and V^{QUIT}, the lender's values of accepting, rejecting, and quitting as V^{*ACT}, V^{*REJ}, and V^{*QUIT}, respectively. When the borrower B proposes and the offer is accepted, the sovereign repays agreed debt repayments $-\delta_t^B b_t$ and resumes access to the international market in the next period with outstanding debt:

$$V^{PRO}(b_t, k_t^g, 1, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t, b_{t+1}} \int_A \left[\begin{array}{c} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \\ \beta V^{EXANTE}(b_{t+1}, k_{t+1}^g, 0, a_t) \end{array} \right] d\mu(a_t|a_{t-1}) \tag{31}$$

$$s.t. \quad (9),\ (10),\ (11),\ \text{and}$$

$$g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 1, a_{t-1}) b_{t+1} = \tau c_t + (1-\delta^k) k_t^g - \frac{\Omega}{2} \left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g + \delta_t^B (1-\lambda) b_t + (\lambda + (1-\lambda) z) b_t \tag{8c}$$

$$V^{*ACT}(b_t, k_t^g, 1, a_{t-1}) = -\delta_t^B (1-\lambda) b_t - (\lambda + (1-\lambda) z) b_t \tag{32}$$

When the borrower B passes, both parties proceed to the next period and continue preemptive renegotiations with the same level of debt (i.e., no accumulation of arrears).

$$V^{PASS}(b_t, k_t^g, 1, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t} \int_A \left[\begin{array}{c} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \\ \beta \Psi(b_t, k_{t+1}^g, 1, a_t) \end{array} \right] d\mu(a_t|a_{t-1}) \tag{33}$$

$$s.t. \quad (8),\ (9),\ (10),\ \text{and}\ (11)$$

$$V^{*REJ}(b_t, k_t^g, 1, a_{t-1}) = -(\lambda + (1-\lambda) z) b_t + \frac{1}{1+r^*} \int_A \Psi^*((1-\lambda) b_t, k_{t+1}^g, 1, a_t) d\mu(a_t|a_{t-1}) \tag{34}$$

When the borrower B quits the preemptive debt renegotiations, the sovereign proceeds to its choice between repayment and default without any debt treatment and the foreign creditors

receive expected return on sovereign bonds:

$$V^{QUIT}(b_t, k_t^g, 1, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t} \int_A \left[\begin{array}{c} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \\ \beta \int_A V((1-\lambda)b_t, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \end{array} \right] d\mu(a_t|a_{t-1}) \tag{35}$$

$$s.t. \quad (8),\ (9),\ (10),\ \text{and}\ (11)$$

$$V^{*QUIT}(b_t, k_t^g, 1, a_{t-1}) = \Big[(1 - p^D(b_t, k_t^g, 0, a_{t-1})) + p^D(b_t, k_t^g, 0, a_{t-1})\alpha(b_t, k_t^g, 0, a_{t-1})\Big] b_t \tag{36}$$

In equilibrium, the agreed recovery rates δ_t^{B*} satisfy the following:[22]

$$\begin{aligned} \delta_t^{B*} &= argmax V^{PRO}(b_t, k_t^g, 1, a_{t-1}) \\ s.t. \quad V^{PRO}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{PASS}(b_t, k_t^g, 1, a_{t-1}) \\ V^{PRO}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{QUIT}(b_t, k_t^g, 1, a_{t-1}) \\ V^{*ACT}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{*REJ}(b_t, k_t^g, 1, a_{t-1}) \\ V^{*ACT}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{*QUIT}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \tag{37}$$

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

$$\begin{aligned} \Psi^B(b_t, k_t^g, 1, a_{t-1}) &= V^{PRO}(b_t, k_t^g, 1, a_{t-1}) \\ \Psi^{*B}(b_t, k_t^g, 1, a_{t-1}) &= V^{*ACT}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \tag{38}$$

Otherwise,

$$\begin{aligned} \Psi^B(b_t, k_t^g, 1, a_{t-1}) &= V^{PASS}(b_t, k_t^g, 1, a_{t-1}) \\ \Psi^{*B}(b_t, k_t^g, 1, a_{t-1}) &= V^{*REJ}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \tag{39}$$

or

$$\begin{aligned} \Psi^B(b_t, k_t^g, 1, a_{t-1}) &= V^{QUIT}(b_t, k_t^g, 1, a_{t-1}) \\ \Psi^{*B}(b_t, k_t^g, 1, a_{t-1}) &= V^{*QUIT}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \tag{39a}$$

The renegotiation settlement can be characterized by a settlement set $R^B(b_t, k_t^g, 1) \subset A$. It is the set of productivity shocks a_{t-1} which both parties agree on settlements:

$$R^B(b_t, k_t^g, 1) = \left\{ \begin{array}{c} a_{t-1} \in A : V^{PRO}(b_t, k_t^g, 1, a_{t-1}) \geq V^{PASS}(b_t, k_t^g, 1, a_{t-1}) \\ V^{*ACT}(b_t, k_t^g, 1, a_{t-1}) \geq V^{*REJ}(b_t, k_t^g, 1, a_{t-1}) \end{array} \right\} \tag{40}$$

[22] Off-equilibrium paths are eliminated in equilibrium.

4.6 Equilibrium

A recursive equilibrium is defined as a set of functions for (a) the sovereign's ex ante and ex post value functions, public consumption, capital, transfers, debt, sets of preemptive restructuring and default/post-default restructuring, (b) the household's private consumption and labor supply, (c) the firm's labor demand, (d) the sovereign's and the foreign creditors' decision functions, payoffs, recovery rates, settlement sets (all depending on who is the proposer), (e) sovereign bond price and wage such that

[1]. sovereign's value function, public consumption, capital, transfers, debt, sets of preemptive restructuring and default/post-default restructuring satisfy its optimization problem (6)–(19);

[2]. the household's private consumption and labor supply satisfy his optimization problem (1)–(2);

[3]. the firm's labor demand satisfies his optimization problem (3)–(5);

[4]. the foreign creditors' assets and bond prices satisfy their optimization problem (20)–(21);

[5]. both parties' decisions, payoffs and recovery rates solve the multi-round preemptive and post-default debt renegotiation problems (22)–(40).

In equilibrium, default probability and settlement probability are defined by the sovereign's default/post-default restructuring set and settlement set for two types of restructurings:

$$p^D(b_{t+1}, k^g_{t+1}, 0, a_t) = \int_{D(b_{t+1}, k^g_{t+1}, 0)} d\mu(a_{t+1}|a_t) \tag{41}$$

$$p^{POST}(b_{t+1}, k^g_{t+1}, a_t) = \phi \int_{R^B(b_{t+1}, k^g_{t+1}, 2)} d\mu(a_{t+1}|a_t) + (1-\phi) \int_{R^L(b_{t+1}, k^g_{t+1}, 2)} d\mu(a_{t+1}|a_t)$$

$$p^{PRE}(b_{t+1}, k^g_{t+1}, a_t) = \phi \int_{R^B(b_{t+1}, k^g_{t+1}, 1)} d\mu(a_{t+1}|a_t) + (1-\phi) \int_{R^L(b_{t+1}, k^g_{t+1}, 1)} d\mu(a_{t+1}|a_t) \tag{42}$$

Expected recovery rates conditional on the sovereign's preemptive and post-default restructuring choice are shown as:

$$\delta(b_{t+1}, k^g_{t+1}, 1, a_t) = \int_A \left[\begin{array}{c} \phi \mathbb{1}_{a_{t+1} \in R^B(b_{t+1}, k^g_{t+2}, 1)} \delta^{B*}(b_{t+1}, k^g_{t+2}, a_{t+1}) \\ +(1-\phi) \mathbb{1}_{a_{t+1} \in R^L(b_{t+1}, k^g_{t+2}, 1)} \delta^{L*}(b_{t+1}, k^g_{t+2}, a_{t+1}) \\ + \left(\begin{array}{c} \phi \mathbb{1}_{a_{t+1} \notin R^B(b_{t+1}, k^g_{t+2}, 1)} \\ +(1-\phi) \mathbb{1}_{a_{t+1} \notin R^L(b_{t+1}, k^g_{t+2}, 1)} \end{array} \right) \delta(b_{t+1}, k^g_{t+2}, 1, a_{t+1}) \end{array} \right] d\mu(a_{t+1}|a_t)$$

$$\alpha(b_{t+1}, k^g_{t+1}, 2, a_{t+1}) = \int_A \begin{bmatrix} \phi \mathbb{1}_{a_{t+2} \in R^B(b_{t+2}, k^g_{t+2}, 2)} \alpha^{B*}((1+r^*)b_{t+1}, k^g_{t+2}, a_{t+2}) \\ +(1-\phi)\mathbb{1}_{a_{t+2} \in R^L(b_{t+2}, k^g_{t+2}, 2)} \alpha^{L*}((1+r^*)b_{t+1}, k^g_{t+2}, a_{t+2}) \\ + \begin{pmatrix} \phi \mathbb{1}_{a_{t+2} \notin R^B(b_{t+2}, k^g_{t+2}, 2)} \\ +(1-\phi)\mathbb{1}_{a_{t+2} \notin R^L(b_{t+2}, k^g_{t+2}, 2)} \end{pmatrix} \alpha((1+r^*)b_{t+1}, k^g_{t+2}, 2, a_{t+2}) \end{bmatrix} d\mu(a_{t+2}|a_{t+1}) \tag{43}$$

Following Chatterjee and Eyigungor (2012), sovereign's bond spread is defined as the difference between an annualized "internal rate of return"—an $\tilde{r}$ satisfying $q(b_{t+1}, k^g_{t+1}, 0, a_t) = (\lambda + (1-\lambda)z)/(\lambda + \tilde{r}(b_{t+1}, k^g_{t+1}, 0, a_t))$—and the annualized global risk-free interest rate.

$$s(b_{t+1}, k^g_{t+1}, 0, a_t) = (1 + \tilde{r}(b_{t+1}, k^g_{t+1}, 0, a_t))^4 - (1+r^*)^4$$

4.7 Implication: Ex Ante Fiscal Consolidation and Preemptive Debt Restructuring

Following Cuadra et al. (2010) and Gordon and Guerron-Quintana (2018), we explore the sovereign's choice of both ex ante fiscal consolidation and a preemptive debt restructuring. In this subsection, for simplicity, we assume (i) no change in leisure and transfers (neither of these being evaluated), (ii) no adjustment costs of public capital, (iii) short-term bonds ($\lambda = 1$), and (iv) immediate settlement at preemptive debt restructuring (no delays).

First, we explore how both public capital and debt play a role on the sovereign's choice of ex ante fiscal consolidation. Reflecting the sovereign's preemptive restructuring choice and repayment choice conditional on passing the preemptive option, value of repayment (equation 15) can be written as follows. For simplicity, we assume that the sovereign repays its debt after it passes its preemptive option.

$$V^R(b_t, k^g_t, 0, a_t) = (1-\omega)u(c_t, l_t) + \omega \upsilon(g_t) + \beta \begin{bmatrix} \mathbb{1}_{a_t \in PRE(b_{t+1}, k^g_{t+1}, 0)} V^{PRE}(b_{t+1}, k^g_{t+1}, 0, a_t) + \\ (1 - \mathbb{1}_{a_t \in PRE(b_{t+1}, k^g_{t+1}, 0)}) \int_A V^R(b_{t+1}, k^g_{t+1}, 0, a_{t+1}) \mu(a_{t+1}|a_t) \end{bmatrix}$$

$$s.t.\ c_t + g_t + k^g_{t+1} + q(b_{t+1}, k^g_{t+1}, 0, a_t) b_{t+1} = y_t + (1-\delta^k)k^g_t + b_t \tag{15a}$$

where $\mathbb{1}_{a_t \in PRE(b_{t+1}, k^g_{t+1}, 0)}$ denotes an index function which is equal to 1 if the sovereign opts preemptive restructuring choice and 0 otherwise. We derive a first derivative for equation (15') with respect to debt in the next period (b_{t+1}) and obtain the following first-order condition. The first order condition is evaluated at private consumption in the current period under repayment c^R_t and output in the next period with an intermediate credit record $\hat{y}_{t+1}$ and with a good credit record y_{t+1}. We consider the case when the sovereign reduces debt by a reduction in public capital (and keeping public consumption constant), i.e., $\Delta b_{t+1} > 0$, Δk_{t+1}, $\Delta g_t = 0$).

$$\frac{\partial u(c_t^R, l_t)}{\partial c_t^R}\left\{q(b_{t+1}, k_{t+1}^g, 0, a_t) + \frac{\partial q(b_{t+1}, k_{t+1}^g, 0, a_t)}{\partial b_{t+1}} b_{t+1} + \frac{\partial k_{t+1}^g}{\partial b_{t+1}}\right\}$$

$$= \begin{bmatrix} \mathbb{1}_{a_t \in PRE(b_{t+1}, k_{t+1}^g, 0)} \int_A \frac{\partial u(c_{t+1}^{PRE}, l_{t+1})}{\partial c_{t+1}^{PRE}} \left\{ \left(\frac{\partial \hat{y}_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right) \frac{\partial k_{t+1}^g}{\partial b_{t+1}} + \delta(b_{t+1}, k_{t+1}^g, 0) \right\} \mu(a_{t+1}|a_t) \\ + (1 - \mathbb{1}_{a_t \in PRE(b_{t+1}, k_{t+1}^g, 0)}) \int_A \frac{\partial u(c_{t+1}^R, l_{t+1})}{\partial c_{t+1}^R} \left\{ \left(\frac{\partial y_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right) \frac{\partial k_{t+1}^g}{\partial b_{t+1}} + 1 \right\} \mu(a_{t+1}|a_t) \end{bmatrix} \tag{50}$$

The left- and right-hand sides of equation (50) correspond to marginal net costs and benefits of reducing debt by one unit due to a reduction in public capital (keeping public consumption constant), respectively. For net costs, a reduction of debt generates two components of costs in the current period. First, the sovereign loses resources to allocate to its expenditure by $q(b_{t+1}, k_{t+1}^g, 0, a_t)$ units, but given the high current debt, the debt reduction simultaneously reduces default risk, and in turn, increases sovereign bond price. The increase in sovereign bond price reflects that the sovereign does not lose full amount of resources with fixed sovereign bond price. An adjustment due to an increase in sovereign bond price is denoted by $\frac{\partial q(b_{t+1}, k_{t+1}^g, 0, a_t)}{\partial b_{t+1}} b_{t+1}$ (note that $b_{t+1} < 0$). Second, the sovereign reduces public capital with keeping public transfers constant shown by $\frac{\partial k_{t+1}^g}{\partial b_{t+1}} < 0$. It minimizes the negative impacts on the current utility by keeping public consumption. This is the role of public capital to smooth the sovereign's utility under repayment—i.e., "fiscal consolidation channel of public capital". In sum, the sovereign suffers net costs (evaluated by private consumption) but simultaneously smooths the household's utility through both constant public transfers and public consumption.

For net benefits, the reduction of both debt and public capital in the current period generates two opposing effects in the next period. On the one hand, by the reduction in debt, the sovereign has available resources of 1 unit under repayment, and $\delta(b_{t+1}, k_{t+1}^g, 0)$ units under a preemptive restructuring in the next period (evaluated by private consumption in the next period). On the other hand, by the reduction in public capital, the sovereign loses expected returns of public capital of $\left(\frac{\partial y_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k)\right) \frac{\partial k_{t+1}^g}{\partial b_{t+1}}$ units under repayment and $\left(\frac{\partial \hat{y}_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k)\right) \frac{\partial k_{t+1}^g}{\partial b_{t+1}}$ units under a preemptive restructuring in the next period (note that $\frac{\partial k_{t+1}^g}{\partial y_{t+1}} < 0$). When public capital is high, marginal product of public capital is low both under repayment and a preemptive restructuring, resulting in small reduction in expected return of public capital. This also corresponds to the role of public capital to smooth the sovereign's utility under repayment, i.e., reducing the net benefits in the next period. In sum, the sovereign receives net benefits as reduction in expected return of public capital is low.

Second, we explore how public capital plays the role on the sovereign's choice of a preemptive debt restructuring or passing the option. On the sovereign's ex ante value function of not choosing a preemptive restructuring, we express equation (12) using ex post value functions of repayment and default (equations 14–16).

$$V^{NON\_PRE}(b_t, k_t^g, 0, a_{t-1}) = P(a_t \geq \bar{a})V^R(b_t, k_t^g, 0, a_t) + (1 - P(a_t \geq \bar{a}))V^D(b_t, k_t^g, 0, a_t) \quad (12a)$$

We derive a first derivative for ex ante value functions of opting for a preemptive debt restructuring and not choosing a preemptive restructuring (equations 7 and 12') with respect to public capital in the next period (k_{t+1}^g). These ex ante value functions are evaluated at different levels of output in the next period $y_{t+1} > \hat{y}_{t+1} > \tilde{y}_{t+1}$ (productivity loss $a_{t+1} > \hat{a}_{t+1} > \tilde{a}_{t+1}$) and private consumption in the current period $c_t^R < c_t^D < c_t^{PRE}$. We obtain the following expressions (after dividing both sides by $(1-\omega)$).

$$\frac{\frac{\partial V^{PRE}(b_t, k_t^g, 0, a_{t-1})}{\partial k_{t+1}^g}}{(1-\omega)} = (-1)\frac{\partial u(c_t^{PRE}, l_t)}{\partial c_t^{PRE}} + \beta \int_A \frac{\partial u(c_{t+1}^{PRE}, l_{t+1})}{\partial c_{t+1}^{PRE}} \left\{ \frac{\partial \hat{y}_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right\} d\mu(a_{t+1}|a_t)$$

$$\begin{aligned}\frac{\frac{\partial V^{NON\_PRE}(b_t, k_t^g, 0, a_{t-1})}{\partial k_{t+1}^g}}{(1-\omega)} = {} & P(a_t \geq \bar{a}) \left[(-1)\frac{\partial u(c_t^R, l_t)}{\partial c_t^R} + \beta \int_A \frac{\partial u(c_{t+1}^R, l_{t+1})}{\partial c_{t+1}^R} \left\{ \frac{\partial y_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right\} d\mu(a_{t+1}|a_t) \right] \\ & + (1 - P(a_t \geq \bar{a})) \left[(-1)\frac{\partial u(c_t^D, l_t)}{\partial c_t^D} + \beta \int_A \frac{\partial u(c_{t+1}^D, l_{t+1})}{\partial c_{t+1}^D} \left\{ \frac{\partial \tilde{y}_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right\} d\mu(a_{t+1}|a_t) \right]\end{aligned}$$

A difference between the two expressions can be expressed as follows:

$$\begin{aligned}& (-1)\left[\frac{\partial u(c_t^{PRE}, l_t)}{\partial c_t^{PRE}} - \left\{ P(a_t \geq \bar{a})\frac{\partial u(c_t^R, l_t)}{\partial c_t^R} + (1 - P(a_t \geq \bar{a}))\frac{\partial u(c_t^D, l_t)}{\partial c_t^D} \right\} \right] \\ & + \beta \int_A \left[\frac{\partial u(c_t^{PRE}, l_{t+1})}{\partial c_{t+1}^{PRE}} \left\{ \frac{\partial \hat{y}_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right\} - \left\{ \begin{array}{l} P(a_t \geq \bar{a})\frac{\partial u(c_{t+1}^R, l_t)}{\partial c_{t+1}^R} \left\{ \frac{\partial y_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right\} \\ + (1 - P(a_t \geq \bar{a}))\frac{\partial u(c_{t+1}^D, l_t)}{\partial c_{t+1}^D} \left\{ \frac{\partial \tilde{y}_{t+1}}{\partial k_{t+1}^g} + (1-\delta^k) \right\} \end{array} \right\} d\mu(a_{t+1}|a_t) \right]\end{aligned} \quad (51)$$

The first term on expression (51) corresponds to a difference in marginal cost of allocating one unit of resource to public capital between opting a preemptive debt restructuring and not choosing a preemptive debt restructuring. The second term on the expression (51) corresponds to a difference in marginal benefit of allocating one unit of resource to public capital between opting a preemptive debt restructuring and not choosing a preemptive debt restructuring. Therefore, the first and second terms can be interpreted as cost and benefit of opting a preemptive debt restructuring in the current period (both evaluated by one-unit investment of public capital).

When the current public capital is high, the current output after repayment is high but that after a default/post-default restructuring with larger productivity loss is moderate. With ample resource available for public expenditure, public capital in the next period continues to

be high and in turn, output in the next period after repayment y_{t+1} is high and that after a default/post-default restructuring with larger productivity loss $\tilde{y}_{t+1}$ is moderate. There is a difference in output and public capital in the next period between when the sovereign repays debt in full and when it defaults in the current period due to larger productivity loss. Net benefits of not choosing a preemptive restructuring exceed net benefits of opting a preemptive restructuring. Therefore, the sovereign has a high incentive for "gamble for resurrection".

On the contrary, when public capital is low, both output in the current period after repayment and that after a default/post-default restructuring with larger productivity loss remains low. With limited resource available for public expenditure, public capital in the next period continues to be low and in turn, both output in the next period after repayment y_{t+1} and that after a default/post-default restructuring with larger productivity loss $\tilde{y}_{t+1}$ remains low. A difference in output and public capital in the next period between when the sovereign repays debt in full and when it defaults in the current period due to low. Net benefits of opting a preemptive debt restructuring exceed net benefits of not choosing a preemptive restructuring. Therefore, the sovereign has a high incentive for opting a preemptive restructuring avoiding a default.

5 Quantitative Analysis

We apply the quantitative analysis of our model to three episodes: (i) Argentine default and post-default restructuring in 2001–05, (ii) Uruguayan preemptive restructuring in 2003; and (iii) Argentine non-restructuring debt distress in 1995. We have three key findings. First, we predict the sovereign's choice of fiscal expenditure consolidation and debt restructurings, especially (b) ex ante fiscal expenditure consolidation and a preemptive restructuring, and (c) fiscal expenditure consolidation and no restructuring (debt distress). Second, we also predict the role of public capital (investment) determining the timing of fiscal expenditure consolidation and associated debt crisis resolution. Third, our quantitative analysis of the model successfully replicates five stylized facts.

5.1 Parameters and Functional Forms

For our quantitative analysis, we take a conventional approach and follow parameter values and functional forms used in the literature of sovereign debt and fiscal policy. The household utility is constant relative risk aversion (CRRA) and follows Greenwood et al. (1998) function with no wealth effects on labor supply—the marginal rate of substitution between labor and private consumption does not change depending on the size of private consumption:

$$u(c_t, l_t) = \frac{(c_t - \frac{l_t^{1+\psi}}{1+\psi})^{1-\sigma}}{1-\sigma}, \qquad v(g_t) = \frac{g_t^{1-\sigma_g}}{1-\sigma_g} \tag{44}$$

Risk aversion for private and public consumption is identical $\sigma = \sigma_g = 3$ (Cuadra et al. 2010, Arellano and Bai 2017; Hatchondo et al. 2022). The sovereign's appetite to smooth utility

Table 4: Model Parameters

Parameter	Value	Source
Risk aversion for private consumption	$\sigma = 3$	Hatchondo et al. (2022)
Risk aversion for public consumption	$\sigma_g = 3$	Hatchondo et al. (2022)
Labor elasticity	$\psi = 0.48$	Mendoza (1991)
Risk-free interest rate	$r^* = 0.01$	Aguiar et al. (2016) - US Treasury bill rate
Public capital depreciation rate	$\delta^k = 0.04$	US BEA (1999)
Bargaining power	$\phi = 0.73$	Yue (2010) - Argentina 2001-05 restructuring
Coupon payment	$z = 0.03$	Chatterjee and Eyigungor (2012)
Probability of maturity (long-term debt)	$\lambda = 0.05$	Chatterjee and Eyigungor (2012)
Country-specific parameters		
Weight on public consumption	$\omega = 0.80$ (ARG)/0.80 (URY)	Calibrated to match (ARG/URY)
Labor income share	$\alpha^l = 0.64$ (ARG)/0.58 (URY)	Gordon and Guerron-Quintana (2018) (ARG)/Estimated (URY)
Public capital income share	$\alpha^k = 0.058$ (ARG)/0.11 (URY)	Estimated (ARG/URY)
Effective consumption tax rate	$\tau = 0.33$ (ARG)/0.33 (URY)	Estimated - Asonuma et al. (2024) (ARG/URY)
Public capital adjustment costs	$\Omega = 10$ (ARG)/10 (URY)	Calibrated to match (ARG/URY)
Discount rate	$\beta = 0.95$ (ARG)/0.95 (URY)	Calibrated to match (ARG/URY)
Productivity loss (preemptive)	$\tilde{\kappa}_0 = -0.15, \tilde{\kappa}_1 = 0.20$	Calibrated to match (ARG/URY)
Productivity loss (post-default)	$\tilde{\kappa}_0 = -0.15, \tilde{\kappa}_1 = 0.22$	Calibrated to match (ARG/URY)
Auto-correlation of productivity shock	$\rho = 0.85$ (ARG) /0.95 (URY)	Estimated - MECON/INDEC (ARG)/ BCU (URY)
Standard deviation of productivity shock	$\sigma^{a,2} = 0.022$ (ARG) /0.017 (URY)	Estimated - MECON/INDEC (ARG)/ BCU (URY)

through two types of consumption remain the identical.[23] We set the risk-free interest as quarterly interest rate on the 3-month US Treasury bills $r^* = 0.01$ as in Aguiar et al. (2016). Labor elasticity is assumed as 0.48 as in Mendoza (1991). Labor and public capital income share is set as 0.64 and 0.058 for Argentina in 1993–2020 and 0.58 and 0.11 for Uruguay in 1993–2020. We assume depreciation rate on public capital as 0.04 as in US BEA (1999). Tax on consumption goods reflects effective rate computed based on total tax revenues for Argentina and Uruguay in 1993–2020 provided by the IMF WEO dataset as 0.33 (Argentina) and 0.33 (Uruguay).

The productivity is assumed to follow a log normal AR(1) process and its shock takes $i.i.d.$ $N(0, \sigma^{a,2})$ as in Gordon and Guerron-Quintana (2018):

$$\log(a_t) = \rho \log(a_{t-1}) + \epsilon_{a,t} \tag{45}$$

We calibrate the productivity to replicate closely quarterly seasonally adjusted GDP data from the Ministry of Economy and Production (MECON) and the National Institute of Statistics and Censuses (INDEC) in Argentina, and the Banco Central del Uruguay (BCU). Calibrated auto-correlation and standard deviation of the productivity shock are $\rho = 0.85$ and $\sigma^{a,2} = 0.022$ for Argentina and $\rho = 0.95$ and $\sigma^{a,2} = 0.017$ for Uruguay, respectively. Calibrated stochastic process is approximated as a discrete Markov chain of equally spaced grids by applying Tauchen (1989)'s quadrature approach.

Productivity loss due to a default/post-default restructuring and a preemptive restructuring follows a functional form in Chatterjee and Eyigungor (2012) and Gordon and Guerron-Quintana (2018) and both moments for bond spreads and output dynamics match with data. This func-

[23] In a sovereign debt model with public transfers, in order to have both public consumption and transfers to improve the household utility, the same degree of risk aversion needs to be assigned to two types of consumption (Cuadra et al. 2010; Arellano and Bai 2017).

tional form resembles the "output cost" function in Arellano (2008).[24]

$$\hat{a}_t = (1 - \hat{\kappa}(a))a_t,\ \tilde{a}_t = (1 - \tilde{\kappa}(a))a_t \tag{46}$$

$$where\ \ \hat{\kappa}(a) = \min[\max(\hat{\kappa}_0 + \hat{\kappa}_1 a, 0), 1],\ \ \tilde{\kappa}(a) = \min[\max(\tilde{\kappa}_0 + \tilde{\kappa}_1 a, 0), 1]$$

The weight on public consumption in the household utility, and public capital adjustment costs are set as $\omega = 0.8$ and $\Omega = 10$ for Argentina and $\omega = 0.8$ and $\Omega = 10$ for Uruguay to replicate average public consumption and transfers-to-GDP ratio of 22.5% for Argentina and 19.4% for Uruguay and standard deviation of public investment relative to that of output of 2.7 for Argentina and of 5.8 for Uruguay, respectively. Bargaining power for the sovereign at both post-default and preemptive restructurings is set at $\phi = 0.73$ as in Yue (2010) for Argentina 2001–05 restructuring. On long-term debt structure in both Argentina and Uruguay, we follow Chatterjee and Eyingungor (2012) to set coupon payment of 3% ($z = 0.03$) and probability of debt maturity of 5% ($\lambda = 0.05$).

Sturzenegger and Zettlemeyer (2006) and Asonuma and Trebesch (2016) report that Argentina and Uruguay experienced 7 and 6 debt restructurings, respectively, in 1820–2020. Moreover, Struzenegger and Zettlemeyer (2008) show that the recovery rates (haircuts) in Argentinean 2001–05 post-default restructuring and Uruguayan 2003 preemptive restructuring were 25.0% (75.0%) and 87.1% (12.9%), respectively. We specify productivity loss due to a default/post-default restructuring as $\tilde{\kappa}_0 = -0.15$ and $\tilde{\kappa}_1 = 0.22$ and that due to a preemptive restructuring as $\hat{\kappa}_0 = -0.15$ and $\hat{\kappa}_1 = 0.20$, and the sovereign's discount factor $\beta = 0.95$ (Argentina) and $\beta = 0.95$ (Uruguay) to replicate the following target statistics; (i) average default frequency of 3.50% for Argentina and of 3.26% for Uruguay; (ii) average and standard deviation of bond spreads of 7.2% and 3.4% for Argentina and of 7.7% and 5.1% for Uruguay; (iii) average output standard deviation ratio (preemptive/post-default) of 0.52. Table 4 summarizes parameter values in our model and Appendix D reports our computation algorithm.

5.2 Numerical Results on Equilibrium Characteristics

We show the sovereign's choice among repayment, a preemptive restructuring and a default/post-default restructuring for Uruguay in Figure 6—that for Argentina in Figure E1 in Appendix E. We measure both debt and public capital as debt/mean TFP and debt/mean TFP. First in part A, we start from replicating key findings in Asonuma and Trebesch (2016) by fixing public capital at the mean level and showing how the sovereign's choice changes respect to debt and lagged/current TFP. Panel A-i, shows the ex ante choice for and against a preemptive restructuring, given debt (vertical axis) and lagged TFP (horizontal axis). The sovereign chooses a preemptive restructuring when debt is high and lagged TFP is low (the blue region). When debt is high with high likelihood of default, it finds a default/post-default restructuring more

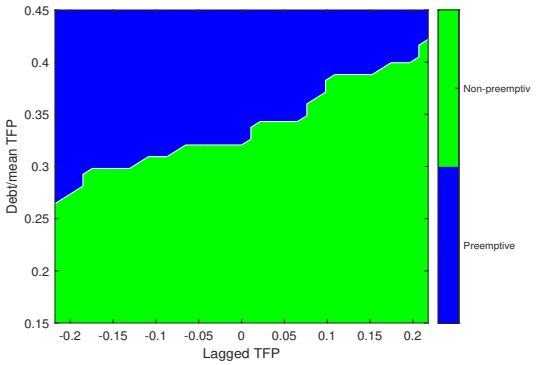
[24] Appendix C.2 applies a functional form of "symmetric" productivity loss which resembles the symmetric "output cost" function in Aguiar and Gopinath (2006) and Yue (2010).

costly—longer periods of financial autarky and larger productivity loss—and avoids a default by taking a preemptive restructuring. On the contrary, it passes a preemptive restructuring option when debt is low and lagged TFP is high (the green region). When debt is low with low likelihood of default, it finds certain costs accompanied with a preemptive restructuring—short periods of financial autarky, smaller productivity loss, and high recovered debt payments—more costly and passes the preemptive restructuring option.

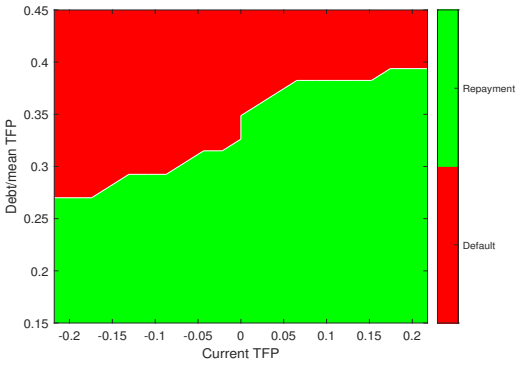
Figure 6: Sovereign's Equilibrium Choice (Uruguay)

Part A: Public Capital at the Mean Level

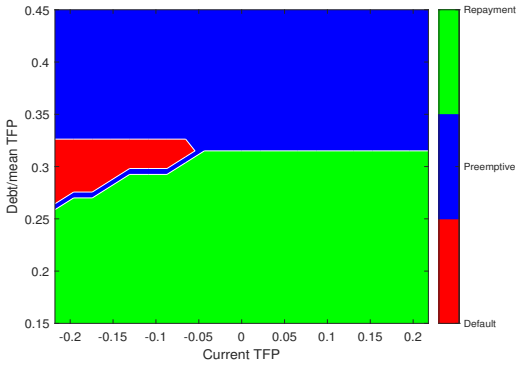
(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring



(iii) Choice for Repayment, Preemptive and Default/Post-default Restructuring



Panel A-ii shows the ex post choice between repayment and a default/post-default restructuring, given debt (vertical axis) and current TFP (horizontal axis). The sovereign opts a default/post-default restructuring when debt is high and current TFP is low (the red region) as in a conventional post-default restructuring model (Yue 2010). It finds repayment more costly because of limited consumption smoothing due to high debt repayment burden and opts a default/post-default restructuring suffering loss in market access and larger productivity loss.

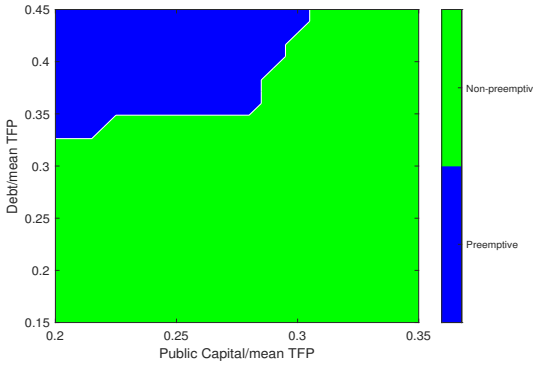
Panel A-iii combines both the ex ante choice and ex post choice, and shows the choice among repayment, a preemptive restructuring, and a default/post-default restructuring, given

debt (vertical axis) and current TFP (horizontal axis) with lagged TFP at the mean level. The sovereign makes the preemptive restructuring choice ex ante, i.e., prior to the current TFP realization, while the repayment and default/post-default restructuring choice ex post, i.e., after the current TFP realization. Before current TFP materializes, it opts a preemptive restructuring when debt is high (i.e., high default probability). Otherwise, it passes the preemptive restructuring choice. After the current TFP materializes, it opts a default/post-default restructuring when the current TFP is low, while repayment otherwise.

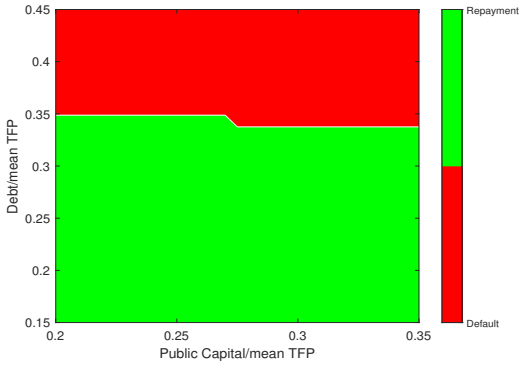
Figure 6: Sovereign's Equilibrium Choice (Uruguay) (cont.)

Part B: Lagged and Current TFP at the Mean Level

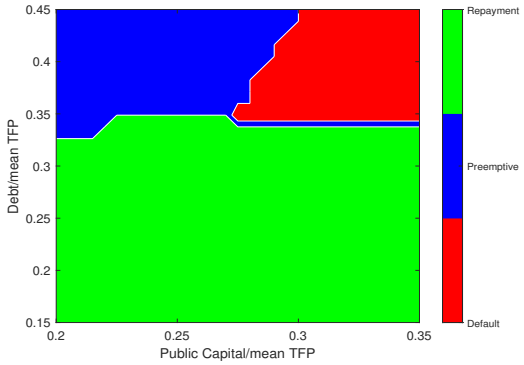
(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring



(iii) Choice for Repayment, Preemptive and Default/Post-default Restructuring



Second in part B, we demonstrate our new findings by fixing both lagged and current productivity (TFP) at the mean level and showing how the sovereign's choice changes respect to debt and public capital. Panel B-i shows the ex ante choice for and against a preemptive restructuring, given debt (vertical axis) and public capital (horizontal axis). We newly find that the sovereign's willingness to take a preemptive restructuring increases—shown in the enlarged blue region—as public capital decreases. This is because when public capital is low, effective costs of a default/post-default restructuring are high due to longer periods of financial autarky and

larger productivity loss. Debt renegotiations, i.e., periods of financial autarky, become lengthy when public capital is low due to slow public capital accumulation. As a result, the sovereign has a high incentive to take a preemptive restructuring to avoid large effective costs due to a default/post-default restructuring.

Panel B-ii shows the ex post choice between repayment and a default/post-default restructuring, given debt (vertical axis) and public capital (horizontal axis). Contrary to a preemptive restructuring, the sovereign's willingness to default and have a post-default restructuring remains constant or is weakly decreasing—shown in the unchanged or slightly enlarged red region—as public capital increases (Asonuma and Joo 2024). On the one hand, high public capital improves the sovereign's capacity of repayment increasing its willingness to repay. On the other hand, high public capital smooths household consumption in financial autarky and achieves quick debt settlement increasing its willingness to default and take a post-default restructuring. The latter effects of high public capital are the same or slightly larger than the former effects of high public capital.

Panel B-iii combines both the ex ante and ex post choice, and shows the choice among repayment, a preemptive restructuring, and a default/post-default restructuring, given debt (vertical axis) and public capital (horizontal axis). Before the current productivity realization, the sovereign is more willing to take a preemptive restructuring—shown in the enlarged blue region—when public capital is low due to a high incentive to avoid high effective costs of a default/post-default restructuring. Otherwise, it passes the preemptive restructuring option. After the current productivity realization, the sovereign is equally or slightly more willing to default and take a post-default restructuring—shown in the enlarged red region—when public capital is high and debt is high.

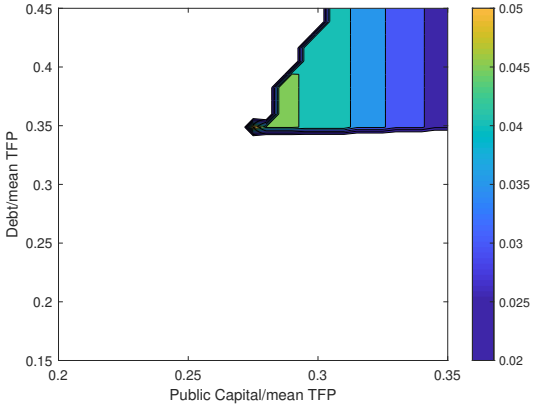
Parts A and B in Figure E2 in Appendix E report the sovereign's choice given lagged TFP at the mean level and current TFP at low and high levels, respectively. When lagged productivity is at mean level and current productivity is at low level in part A, the sovereign is more willing to default and take a post-default restructuring (the enlarged red region). On the contrary, when lagged productivity is at mean level and current productivity is at high level in panel B, the sovereign is more willing to repay debt in full (the enlarged green region).

Figure 7 reports the sovereign's public investment choice, given debt (vertical axis) and public capital (horizontal axis). First, panel i reports public investment under default/post-default restructuring choice given mean current productivity. The colored region corresponds to default/post-default restructuring choice (the red region) in panel B-iii in Figure 6. When public capital is mean or high, it sharply reduces public investment (the blue and dark blue regions). When debt is moderate, after mean productivity materializes, the sovereign opts a default, and has no option but to reduce sharply public investment due to loss in market access and larger productivity loss. This corresponds to "ex post fiscal expenditure consolidation and a default/post-default restructuring".

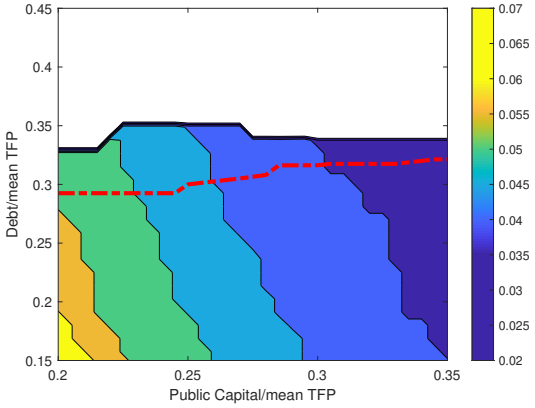
Second, panel ii reports public investment under repayment choice given mean current productivity. The colored region corresponds to repayment choice in the current period (the green

Figure 7: Debtor's Investment Choice (Uruguay)

(i) Under Default Choice (mean current TFP)



(ii) Under Repayment Choice (mean current TFP)



region) in panel B-iii in Figure 6. Furthermore, the colored region is divided into two regions by the red dashed line; (i) repayment choice in the current period and preemptive restructuring choice in the next period (the colored region above the red dashed line), and (ii) repayment choice in the current period and repayment choice in the next period (the colored region below the red dashed line). With high debt, when public capital is high, it sharply reduces public investment, i.e., ex ante fiscal expenditure consolidation (the blue and dark blue regions). Under high public capital (i.e., low marginal product of public capital), benefits of reducing debt repayment burden and default risk by reducing public investment are higher than those of maintaining public investment. In the next period, when debt remains high, before the current TFP materializes, the sovereign opts a preemptive restructuring. This corresponds to "ex ante fiscal expenditure consolidation and a preemptive restructuring". When debt is moderate and high/mean productivity materializes, the sovereign repays debt in full. This corresponds to "fiscal expenditure consolidation and no restructuring (debt distress)".

High public capital allows the sovereign to choose desirable timing of fiscal expenditure consolidation through reduction in public investment, i.e., ex ante or ex post. We call this as "fiscal consolidation channel" of public capital. This is a new channel different from three conventional channels of public capital (Gordon and Guerron-Quintana 2018; Asonuma and Joo 2024). High public capital improves the sovereign's capacity of repayment making it more willing to repay ("smoothing channel"). High public capital smooths household consumption in financial autarky ("autarky channel") and achieves debt settlement ("debt renegotiation channel") making it more willing to default and take a post-default restructuring.

5.3 Simulation Exercise

We present our simulation results and explore how our model successfully accounts for three episodes: (i) Argentine default and post-default restructuring in 2001–05, (ii) Uruguayan pre-

Table 5: Simulation Results of Models

(i) Public Sector Business Cycle Statistics

	Argentina 2001–05 Post-default Restructuring		Uruguay 2003 Preemptive Restructuring		Argentina 1995 Non-restructuring Debt Distress	
	Data	Baseline Model	Data	Baseline Model	Data	Baseline Model
Target statistics						
Pre-restructuring period						
Average public consumption & transfers/GDP ratio (%)	22.5	21.4	19.4	22.2	22.5	21.4
Public investment (std. dev.)/output (std. dev.)	2.70	2.90	5.80	3.80	2.70	2.90
Restructuring period						
Average output standard deviation ratio (preemptive/post-default)[1/]	0.52	0.40	0.52	0.40	0.52	0.40
Non-target statistics						
Pre-restructuring period						
Public sector						
Public consumption & transfers (std. dev.)/output (std. dev.)	1.26	1.90	1.09	1.05	1.62	2.10
Corr.(public consumption & transfers, output)	0.77	0.30	0.35	0.75	0.27	0.40
Average public investment/GDP ratio (%)	1.31	2.50	4.18	3.60	1.37	2.30
Average public expenditure/GDP ratio (%)	21.3	27.4	23.5	25.8	20.9	26.1
Average public investment/public expenditure ratio (%)	6.2	9.1	16.9	14.1	7.0	8.8
Fiscal expenditure consolidation	No	No	Yes (ex ante)	Yes (ex ante)	Yes	Yes
Restructuring period						
Public sector						
Public consumption & transfers (std. dev.)/output (std. dev.)	0.99	2.50	2.00 [2/]	1.68	-	-
Corr.(public consumption & transfers, output)	0.97	0.78	1.00 [2/]	0.49	-	-
Average public consumption & transfers/GDP ratio (%)	20.2	22.5	25.2	20.8	-	-
Average public investment/GDP ratio (%)	1.19	2.20	3.20	3.40	-	-
Average public expenditure/GDP ratio (%)	21.3	24.7	28.4	24.2	-	-
Average public investment/public expenditure ratio (%)	5.7	8.9	11.2	13.9	-	-
Fiscal expenditure consolidation	Yes (ex post)	Yes (ex post)	No	No	-	-

(ii) Non-business Cycle Statistics

	Argentina 2001–05 Post-default Restructuring		Uruguay 2003 Preemptive Restructuring		Argentina 1995 Non-restructuring Debt Distress	
	Data	Baseline Model	Data	Baseline Model	Data	Baseline Model
Target statistics						
Pre-restructuring period						
Default probability (%)	3.50	3.10	3.26	3.81	3.50	3.10
Bond spreads: average (%)	7.2	7.9	7.7	7.3	7.2	7.9
Bond spreads: std. dev. (%)	3.40	3.50	5.1	3.44	3.40	3.50
Non-target statistics						
Pre-restructuring period						
Average debt/GDP ratio (%)	34.7	55.5	59.1	57.9	30.0	50.5
Corr.(debt/GDP, spreads)	0.90	0.20	1.00	0.05	-	0.10
Restructuring period						
Restructuring strategy	post-default	post-default	preemptive	preemptive	-	-
Average debt/GDP ratio (%)	116.7	78.4	130.5	82.2	-	-
Average recovery rate (%)	25.0	18.0	87.1	93.0	-	-
Restructuring duration (quarters)	14.6	10.0	1.00	3.80	-	-
Average public investment recovery (quarterly) from t-1 to pre-restructuring level	12.0	9.1	10.3	6.5	-	-

Sources: BCU, Datastream, IMF WEO, INDEC and MECON.
Notes: [1/] Over three years since the start of debt restructurings.
[2/] Statistics are based on 2003-04 (standard deviation) and 2002-04 (correlation) in Uruguay.

emptive restructuring in 2003, and (iii) Argentine non-restructuring debt distress in 1995. In line with previous quantitative studies on sovereign debt, we apply 1000 rounds of simulation and for each round, we withdraw 40 observations in pre-restructuring periods and observations in restructuring periods. For Argentina, the post-default restructuring episode corresponds 1993Q1–2001Q4 (pre-restructuring period) and 2002Q1–2005Q2 (restructuring period), and non-restructuring debt distress episode corresponds 1993Q1–1997Q4 (pre-restructuring period)—there is no restructuring period. For Uruguay, the preemptive restructuring episode corresponds 1993Q–2002Q4 (pre-restructuring period) and 2003Q1–Q2 (restructuring period).

For private sector indicators, we use seasonally adjusted series of GDP, consumption and net exports at a quarterly frequency from the MECON and INDEC for Argentina and from the BCU for Uruguay. For public sector indicators, we use public expenditure series (expenditure, consumption and transfers, investment) at a yearly frequency from Asonuma and Joo (2024). We also use public debt series at a yearly frequency from the Ministerio de Finanza (MOF) for Argentina and from the IMF WEO for Uruguay. We use bond spreads at a quarterly frequency from J.P Morgan's Emerging Market Bond Index Global (EMBIG) only for pre-restructuring periods.

Moment Statistics Table 5 contrasts non-target statistics in our baseline model with the data for the three episodes. Table F2 in Appendix F.2 also contrasts our baseline model with recalibration results of previous studies of sovereign debt and fiscal policy (Cuadra et al. 2010; Arellano and Bai 2017) and debt renegotiations (Benjamin and Wright 2013; Asonuma and Trebesch 2016). For the recalibration results, we use our parameter values in our baseline model and recalibrate the models of previous studies to fit the target statistics in each of the models.

Furthermore, Table F3 in Appendix F.3 reports calibration results of (a) a model of only a post-default restructuring (Asonuma and Joo 2024); (b) a model of exogenous (fixed) public capital (Arellano and Bai 2017; Cuadra et al. 2010); (c) a model of endogenous aggregate capital (Gordon and Guerron-Quintana 2018; Park 2017). In these calibration results, we incorporate characteristics and parameter values specific to these model in our baseline models.

Panels (i–ii) report public sector business cycle statistics and non-business cycle statistics in the three episodes, respectively—Table F1 in Appendix F.1 reports private sector business cycle statistics. Public sector moment statistics in our baseline models match closely with the data in the three episodes. Our baseline model successfully generates procyclical and volatile public consumption and transfers in EMs (Cuadra et al. 2010).

There are three new findings in our baseline model. First, our baseline model replicates the choice of fiscal expenditure consolidation as observed in the data: ex post fiscal expenditure consolidation for a post-default restructuring, ex ante fiscal expenditure consolidation for a preemptive restructuring, and fiscal expenditure consolidation for non-restructuring debt distress.

Second, our baseline model shows lower average public investment in restructuring period than in pre-restructuring period for both a default/post-default restructuring and a preemp-

tive restructuring. Asonuma and Joo (2024) show the public investment dynamics only for a default/post-default restructuring. What differentiates our model with Asonuma and Joo (2024) is that we replicate the public investment dynamics not only for a default/post-default restructuring but also for a preemptive restructuring. Furthermore, we replicate both a sharp reduction in public investment prior to a preemptive restructuring and quick settlement (i.e., short duration) in the case of a preemptive restructuring. These differ from both a sharp reduction in public investment upon a default/post-default restructuring and prolonged settlement (i.e., long duration) in the case of a default/post-default restructuring.

Third, our baseline model replicates shorter average public investment recovery in a preemptive restructuring than in a default/post-default restructuring as observed in the data (6.5 vs. 9.1 quarters in our model and 10.3 vs. 12.0 quarters in data). In a preemptive restructuring, average public investment recovery is longer than average restructuring duration (6.5 vs. 3.8 quarters). On the contrary, in a default/post-default restructuring, average public investment recovery is shorter than average restructuring duration (9.1 vs. 10.0 quarters). Both of these match with the data.

Our baseline model generates high average debt, high average and standard deviation of bond spreads, and countercyclical bond spreads in pre-restructuring period for both a default/post-default restructuring and a preemptive restructuring as observed in the data. These are common features in the model of long-duration bonds (Hatchondo and Martnnez 2009; Chatterjee and Eyigungor 2012). Our baseline model also replicates higher recovery rates (lower haircuts) in a preemptive restructuring than those in a post-default restructuring. This is a common characteristic in the model of both post-default and preemptive debt restructurings (Asonuma and Trebesch 2016).

Simulated Dynamics Figures 8 contrasts data and simulation results on the choice of fiscal expenditure consolidation and debt restructurings, dynamics of public investment and consumption and transfers, recoveries in public investment and restructuring duration. Panels (i)–(iv) in Figure 8 follow the same presentation format as in Figures 1–4. Solid lines in blue show the Argentine and Uruguay data, and dash lines in red show our baseline model.

First and importantly, panel (i) in Figure 8 shows that our model replicates that post-default restructurings are associated with ex post fiscal expenditure consolidation and that preemptive restructurings and non-restructuring debt distress are associated with ex ante fiscal expenditure consolidation as in the data. Ex post expenditure consolidation accounts for 55 percent of post-default restructurings, while ex ante expenditure consolidation accounts for 74 percent of preemptive restructurings. Fiscal expenditure consolidation accounts for 56 percent of non-restructuring debt distress episodes. Moreover, when our results remain robust when we use an alternative definition of fiscal expenditure consolidation based on expenditure-to-potential GDP ratio (Figure F1 in Appendix F).

Second, panel (ii) in Figure 8 shows that in our model, public investment declines sharply at the start of post-default restructurings and recovers gradually to reach a pre-restructuring level before the end of restructurings. In preemptive restructurings, public investment declines

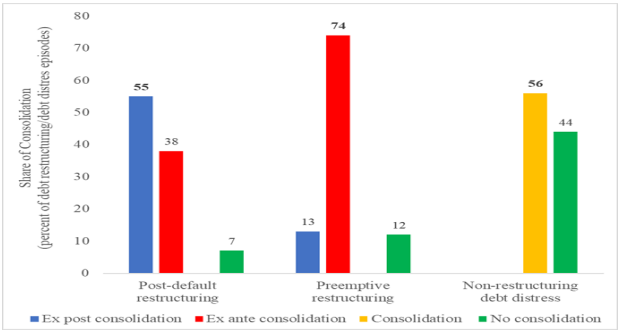
sharply prior to the start of restructurings and recovers only partially at the end of restructurings. On the contrary, in non-restructuring debt distress, public investment declines temporally and marginally, and recovers quickly to a pre-debt distress level. All these public investment dynamics are consistent with the data.

Third, panel (iii) in Figure 8 shows that as in the data, recoveries in public investment are shorter in preemptive restructurings than in post-default restructurings (1.8 years vs. 2.0 years). In preemptive restructurings, average recoveries in public investment are longer than average restructuring duration, while in post-default restructurings, average recoveries in public investment are shorter than average restructuring duration.

Fourthly, panel (iv) in Figure 8 shows that in both post-default and preemptive restructurings, public consumption and transfers decline temporarily at the start of restructurings and recover quickly to reach a pre-restructuring level. In non-restructuring debt distress, public consumption and transfers decline only marginally and recover immediately to reach a pre-debt distress level.

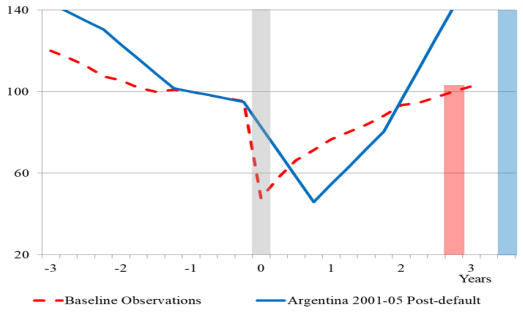
Figure 8: Simulation Results on Argentina and Uruguay

(i) Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings

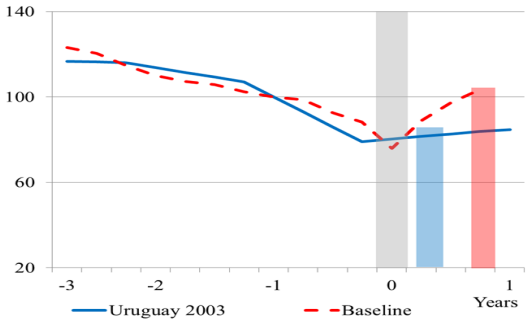


(ii) Public Investment around Debt Restructurings and Non-restructuring Debt Distress (Level)

(a) Post-default Restructuring (Argentina 2001–05)



(b) Preemptive Restructuring (Uruguay 2003)



(c) Non-restructuring Debt Distress (Argentina 1995)

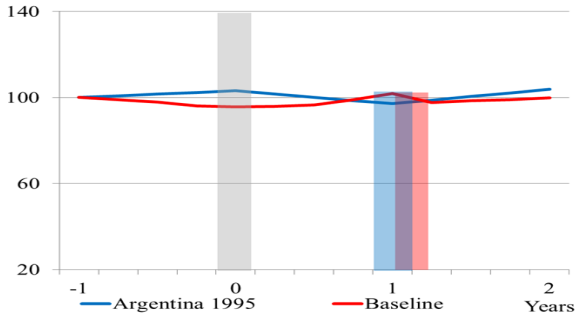
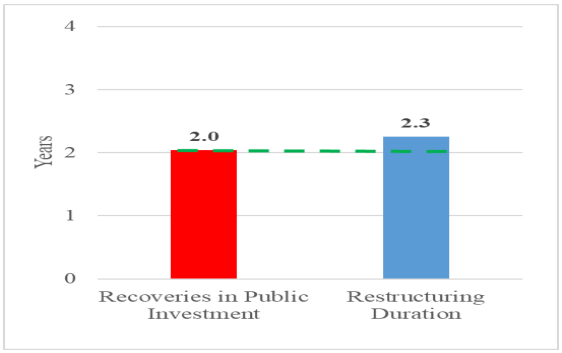


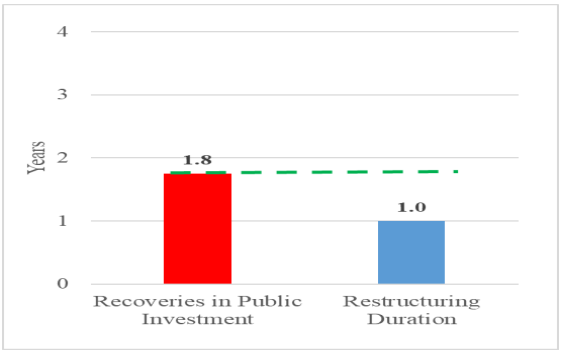
Figure 8: Simulation Results on Argentina and Uruguay (cont.)

(iii) Recoveries in Public Investment and Restructuring Duration

(a) Post-default Restructuring (Argentina 2001–05)

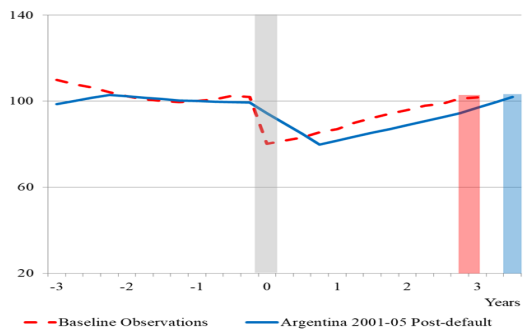


(b) Preemptive Restructuring (Uruguay 2003)

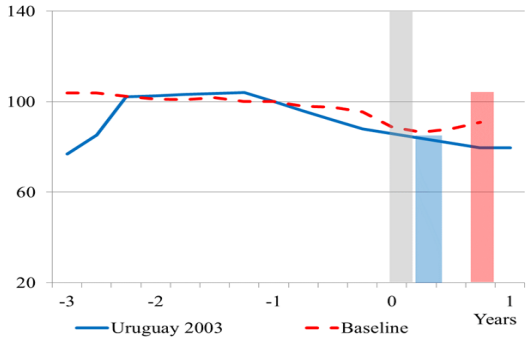


(iv) Public Consumption and Transfers around Restructurings and Non-restructuring Debt Distress (Level)

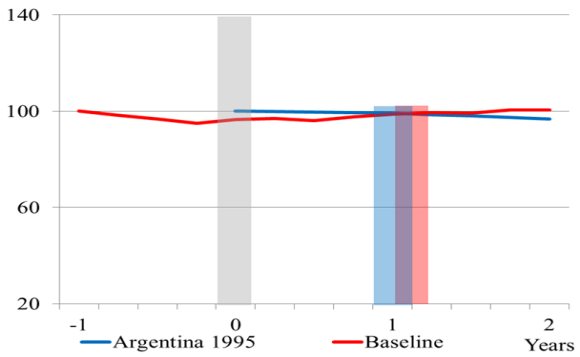
(a) Post-default Restructuring (Argentina 2001–05)



(b) Preemptive Restructuring (Uruguay 2003)



(c) Non-restructuring Debt Distress (Argentina 1995)



Ex Ante Fiscal Consolidation and Preemptive Debt Restructuring We use simulated data series obtained from our baseline model and apply a logit regression on ex ante fiscal expenditure consolidation (binary) and a preemptive debt restructuring (binary) reported in Table 6. First, for ex ante fiscal expenditure consolidation, our main explanatory variables are lagged public capital-to-GDP ratio and lagged change in debt-to-GDP ratio. We show that when both the lagged public capital-to-GDP ratio and lagged change in public debt-to-GDP ratio are at a high level, the sovereign is more likely to implement ex ante fiscal expenditure consolidation (columns 1–1').

Table 6: Simulation Logit Regression Results

	Ex ante fiscal expenditure consolidation (binary)		Preemptive debt restructuring (binary)	
	(1)	(1')	(2)	(2')
	coef/se	dy/dx / Delta-method se	coef/se	dy/dx / Delta-method se
Public capital (lagged, percent of GDP)	2.40**	0.32**	-	-
	(1.21)	(0.16)		
Ex ante fiscal expenditure consolidation (lagged, binary)	-	-	1.56***	0.16***
			(0.28)	(0.02)
Ex ante fiscal expenditure consolidation (2-year lagged, binary)	-	-	0.04	0.004
			(0.26)	(0.03)
Public investment (lagged, percent of GDP)	-	-	-116.31***	-11.91***
			(31.91)	(3.09)
Public capital (2-year lagged, percent of GDP)	-	-	0.02	0.002
			(1.13)	(0.12)
Debt (lagged change, percent of GDP)	2.44***	0.33***	5.63***	0.58***
	(0.61)	(0.08	(0.98)	(0.09)
GDP deviation from the trend (current, percent)	-16.28***	-2.18***	-5.32***	-0.55***
	(2.64)	(0.32)	(1.40)	(0.13)
Constant	-3.70***	-	-	-
	(0.94)			
Episode-specific fixed effects		No		No
Number of restructuring episodes		119		119
Number of observations		357		357
χ^2		66.43		117.18
(p-value)		0.000		0.000
Log-likelihood ratio		-89.39		-98.30

The table shows results from random effects logit regressions. The dependent variables are ex ante fiscal expenditure consolidation choice (binary) and preemptive debt restructuring choice (binary). For a regression on ex ante fiscal expenditure consolidation choice, main explanatory variables are lagged public capital (in percent of GDP) and lagged change in debt (in percent of GDP). For a regression for preemptive debt restructuring choice, main explanatory variables are both ex ante fiscal expenditure consolidation choice (binary), lagged public investment (in percent of GDP), and lagged change in debt (in percent of GDP). Both robust standard errors and Delta-method standard errors are are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Second, for a preemptive debt restructuring, our main explanatory variables are lagged and two-year lagged ex ante fiscal consolidation choice, lagged public investment-to-GDP ratio, and lagged change in debt-to-GDP ratio. We show that when the sovereign implements ex ante fiscal expenditure consolidation in the previous year, public investment-to-GDP ratio is at a lower level and a change in debt-to-GDP ratio is at a higher level in the previous year, the

sovereign is more likely to take a preemptive debt restructuring (columns 2–2').

6 Comparison with Alternative Models

6.1 Preemptive and post-default restructurings vs. Only post-default restructuring

We compare between our baseline model of both preemptive and post-default restructurings and a model of only a post-default restructuring (e.g., Yue 2010; Benjamin and Wright 2013; Asonuma and Joo 2020). Panel i–a in Figure 9 shows the sovereign's choice of fiscal expenditure consolidation and debt restructurings in the model of only a post-default restructuring. Ex post fiscal expenditure consolidation is the most frequent in post-default restructurings (left section). No restructuring (debt distress) choice becomes less frequent and conditional on the choice, no fiscal expenditure consolidation becomes the most frequent (right section). When a preemptive restructuring choice is not available, an advantage associated with ex ante fiscal expenditure consolidation is reduced because there is no secured quick debt resolution such as a preemptive restructuring after the ex ante fiscal expenditure consolidation. As a result, the sovereign is less willing to implement fiscal expenditure consolidation choice under non-restructuring debt distress. The sovereign only implements ex post fiscal expenditure consolidation after it experiences a default/post-default restructuring. Panel (ii) in Figure 9 shows that the model of only a post-default restructuring also replicates the same public investment dynamics with our baseline model in post-default restrucutring. However, it does not generate public investment dynamics in a preemptive restructuring because the preemptive restructuring choice is not available (Figure E3 in Appendix E).

Figure F2 in Appendix F.3 shows that the model of only post-default restructuring accounts for only one fact such as a fifth fact—a temporal decline and a quick recovery in public consumption and transfers. On the contrary, the model of only a post-default restructuring does not account for any of first, second, third, and fourth facts. This is because the sovereign does not opt a preemptive restructuring and the model does not account for any dynamics in a preemptive restructuring.

6.2 Endogenous Public Capital vs. Exogenous Public Capital

We compare between our baseline model of endogenous public capital and a model of exogenous (fixed) public capital (Arellano and Bai 2017; Cuadra et al. 2010). In this model, the sovereign fixes public investment to maintain a constant (given) level of public capital. Panel i–b in Figure 9 shows that the model of exogenous public capital does not replicate observed patterns of the choice of fiscal expenditure consolidation and debt restructurings. Ex post expenditure consolidation remains the most frequent in post-default restructurings (left section). However, ex post expenditure consolidation turns out to be the most frequent in preemptive restructurings (middle section) and no fiscal expenditure consolidation also becomes the most frequent in non-debt restructuring debt distress episodes (right section). When public capital remains at a fixed

level, fiscal expenditure consolidation urges the sovereign to reduce sharply public consumption and transfers. The sovereign with consumption-smoothing motive is less willing to implement ex ante fiscal expenditure consolidation. The sovereign only implements ex post fiscal expenditure consolidation after it experiences a default/post-default restructuring.

Panel ii–a and ii–b in Figure 9 shows that the model of exogenous public capital does not replicate public investment dynamics in both a default/post-default restructuring and a preemptive restructuring as in our baseline model. This is because, in both a default/post-default restructuring and a preemptive restructuring, public investment remains unchanged in the model of exogenous public capital.

Figure F3 in Appendix F.3 shows that the model of exogenous public capital accounts for only one fact such as a fifth fact—a temporal decline and a quick recovery in public consumption and transfers. On the contrary, the model of exogenous public capital does not replicate any of first, second, third, and fourth facts. This is because as forementioned, when the sovereign opts a preemptive debt restructuring, it does not take ex ante fiscal expenditure consolidation but ex post fiscal expenditure consolidation. Furthermore, public investment remains unchanged in both a default/post-default restructuring and a preemptive restructuring.

6.3 Endogenous Public Capital vs. Endogenous Aggregate Capital

Lastly, we compare between our baseline model of endogenous public capital and a model of endogenous aggregate capital with no separation between private and public sectors in which a sovereign has no distortionary taxation but lump-sum taxation (e.g., Gordon and Guerron-Quintana 2018; Park 2017; Galli 2021). In this model, there are no distinct public consumption and transfers or investment—no fiscal expenditure choice—, but only aggregate consumption and and investment—"aggregate" consolidation choice.

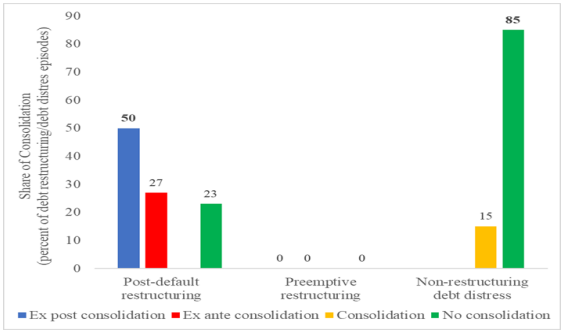
The model of endogenous aggregate capital does not generate public investment dynamics, but only aggregate investment dynamics, i.e., combined private and public investment. Panel ii–c in Figure 9 shows a sharp and small decline and a quick recovery in aggregate investment. However, the sharp decline in aggregate investment is smaller than that in public investment in our baseline model. This is because in the model of endogenous aggregate capital, the sovereign can extract resources from the private sector without distortion and allocate enough resources to aggregate investment as well as to debt settlement quickly. Therefore, the sovereign can achieve quick settlement and costs of a default/post-default restructuring are not high. As a result, the sovereign is more willing to pass a preemptive restructuring and make a choice of repayment and default after TFP realization (Figure E5 in Appendix E).

Figure F4 in Appendix F.3 shows that the model of endogenous aggregate capital accounts for only one fact such as a fifth fact—a temporal and small decline and a quick recovery in aggregate consumption. On the contrary, the model of endogenous aggregate capital does not replicate any of first, second, third, and fourth facts. This is because the sovereign does not opt a preemptive restructuring—a very rare event—and the model does not account for any dynamics for a preemptive restructuring.

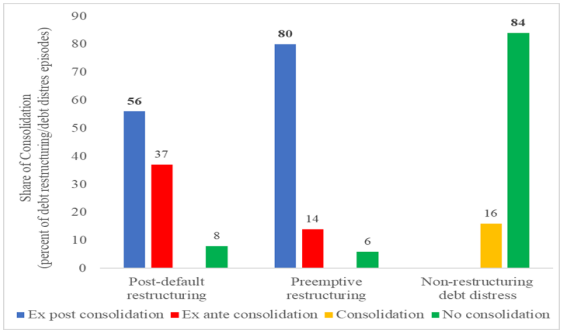
Figure 9: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings, Public Investment, and Public Consumption and Transfers

(i) Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings [1/]

(a) Only post-default restructuring

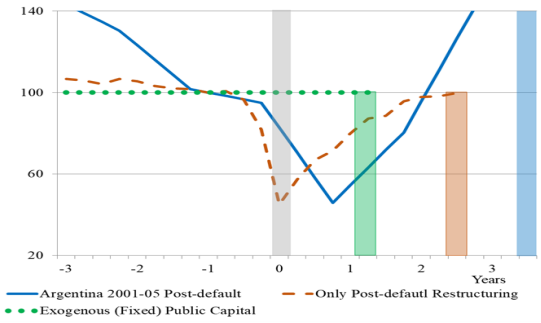


(b) Exogenous Public Capital

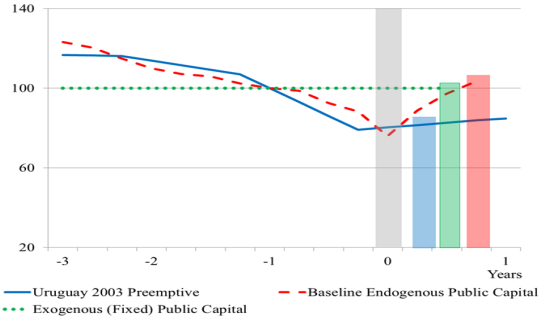


(ii) Public and Aggregate Investment around Debt Restructurings (Level) [2/]

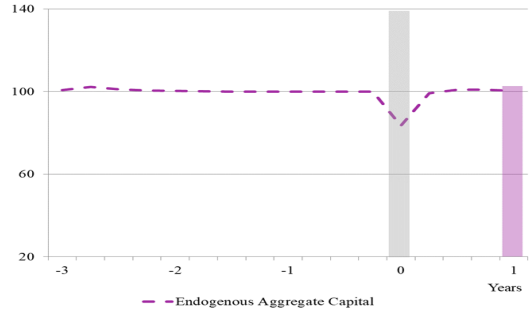
(a) Exogenous Public Capital: Post-default Restructuring



(b) Exogenous Public Capital: Preemptive Restructuring



(c) Aggregate Capital: Post-default Restructuring



1/ In the model of endogenous aggregate capital, there is no "fiscal" expenditure consolidation, but "aggregate" consolidation.
2/ In the model of endogenous aggregate capital, there is no much preemptive restructuring choice (i.e., a very rare event).

6.4 Robustness Checks

Table 7: Uruguay Preemptive Restructuring 2003

	Adjustment Costs			Depreciation Rate			Risk Aversion		
	5	10	15	0.025	0.04	0.075	2	3	4
Target statistics									
Pre-restructuring period									
Average public consumption & transfers/GDP ratio (%)	22.2	22.2	21.8	23.4	22.2	22.0	22.0	22.2	22.5
Public investment (std. dev.)/output (std. dev.)	3.90	3.80	2.30	3.70	3.80	3.70	3.20	3.80	4.00
Restructuring period									
Average output standard deviation ratio (preemptive/post-default)	0.10	0.40	0.10	0.40	0.40	0.30	0.30	0.40	0.30
Non-target statistics									
Pre-restructuring period									
Public sector									
Public consumption & transfers (std. dev.)/output (std. dev.)	1.06	1.05	2.00	1.70	1.05	1.36	1.15	1.05	1.02
Corr.(public consumption & transfers, output)	0.60	0.75	0.56	0.44	0.75	0.56	0.74	0.75	0.70
Average public investment/GDP ratio (%)	3.40	3.60	4.20	3.10	3.60	4.80	3.80	3.60	3.50
Average public expenditure/GDP ratio (%)	25.6	25.8	24.0	23.6	25.8	24.6	25.8	25.8	26.1
Average public investment/public expenditure ratio (%)	13.2	14.1	17.5	13.1	14.1	19.5	14.8	14.1	13.3
Fiscal expenditure consolidation	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)	Yes (ex ante)
Restructuring period									
Public sector									
Public consumption & transfers (std. dev.)/output (std. dev.)	1.60	1.68	1.52	1.50	1.68	1.90	1.90	1.68	1.40
Corr.(public consumption & transfers, output)	0.62	0.49	0.76	0.70	0.49	0.56	0.43	0.49	0.40
Average public consumption & transfers/GDP ratio (%)	20.5	20.8	20.2	21.1	20.8	20.0	20.0	20.8	21.9
Average public investment/GDP ratio (%)	3.20	3.40	4.10	2.70	3.40	3.50	3.50	3.40	3.20
Average public expenditure/GDP ratio (%)	23.7	24.2	24.3	23.8	24.2	23.5	23.5	24.2	25.1
Average public investment/public expenditure ratio (%)	13.5	13.9	16.8	11.3	13.9	14.8	14.7	13.9	12.7
Fiscal expenditure consolidation	No	No	No	No	No	No	No	No	No

Source: Authors' computation

Table 7 shows robustness checks on our key parameter values for Uruguay preemptive debt restructuring in 2003—Table F4 in Appendix F.4 shows robustness checks for Argentina default/post-default restructuring in 2001–05. We only change one specific parameter value leaving other parameter values unchanged, and see how non-target statistics are affected. When adjustment costs on public capital are lower, public investment becomes more volatile. This is because the sovereign accumulates and reduces public capital more frequently given lower adjustment costs.

When depreciation rate is lower, average public investment becomes lower in both pre-restructuring and restructuring periods. The sovereign only needs to spend less on public investment. When the sovereign is more risk averse, it opts to spend more public consumption and transfers and reduce the volatility of public consumption and transfers. As a result, it reduces average public investment and makes public investment more volatile.

7 Conclusion

This paper newly sheds light on the sovereign governments' choice of fiscal expenditure consolidation and debt restructurings during sovereign debt crises. We compile a novel dataset on fiscal expenditure consolidation and sovereign debt restructurings with private external creditors in 1975–2020. We find new five stylized facts on fiscal expenditure consolidation and debt restructurings. To explain these stylized facts, we build a theoretical sovereign long-term debt model that embeds endogenous choice of preemptive and post-default renegotiations and public capital accumulation. The model quantitatively shows the sovereign's choice of ex ante fiscal expenditure consolidation which, in turn, results in a preemptive restructuring or even avoiding any restructuring. Data support our theoretical predictions.

Our empirical and theoretical findings suggest some implications to the policy debate on how a sovereign could potentially prevent a severe debt crisis. When the sovereign has high public capital, by implementing ex ante fiscal consolidation—reducing debt by a reduction of public investment—, it could result in a preemptive restructuring and even more no debt restructuring.

The literature on fiscal austerity has explored empirically multiplier effects of "planned" (pre-announced) fiscal consolidation during recessions (e.g., Alesina et al. 2019; Auerbach and Gorodnichenko 2012). A potential research question is how "planned" fiscal consolidation—the government's choice independent from business cycles and shocks—differs from "endogenous" fiscal consolidation—the government's optimal response to business cycles and shocks. For future work, we can explore whether the government's fiscal consolidation choice is dependent or independent on business cycles and external shocks might result in different outcomes as observed in the data.

References

[1] Aguiar M., and M. Amador, 2014, "Sovereign Debt," In *Handbook of International Economics,* Vol.4, pp.647–687.

[2] Aguiar M., M. Amador, and G. Gopinath, 2009, "Investment Cycles and Sovereign Debt Overhang," *Review of Economic Studies,* Vol.76(1), pp.1–31.

[3] Aguiar, M., S. Chatterjee, H. Cole, and Z. Stangebye, 2016, "Quantitative Models of Sovereign Debt Crises," In *Handbook of Macroeconomics,* Vol.2, edited by J. B. Taylor and H. Uhlig, pp.1697–1755.

[4] Aguiar, M., and G. Gopinath, 2006, "Defaultable Debt, Interest Rates, and the Current Account," *Journal of International Economics*, Vol.69(1), pp.64–83.

[5] Alesina, A., C. Favero, and F. Giavazzi, 2019, *Austerity*, Princeton Univerisity Press.

[6] Alesina, A., and R. Perotti, 1997, "Fiscal Adjustments in OECD Countries: Composition and Macroeconomic Effects," *IMF Staff Papers*, Vol.44(2), pp.210–248.

[7] Alfaro, L., and F. Kanczuk, 2017, "Fiscal Rules and Sovereign Default," NBER Working Paper 23370.

[8] Amador, M., and C. Phelan, 2021, "Reputation and Sovereign Default," *Econometrica,* Vol.89(4), pp.1979–2010.

[9] Ando, S., T. Asonuma, P. Mishra, and A. Sollaci, 2025 "Sovereign Debt Restructuring and Reduction in Debt-to-GDP Ratio," Ashoka University Economics Discussion Paper 145.

[10] Arellano, C., 2008, "Default Risk and Income Fluctuations in Emerging Economies," *American Economic Review,* Vol.98(3), pp.690–712.

[11] Arellano, C., and Y. Bai, 2017, "Fiscal Austerity during Debt Crises," *Economic Theory,* Vol.64, pp.657–673.

[12] Arellano, C., X. Mateos-Planas, and J. V. Rios-Rull, 2023, "Partial Default," *Journal of Political Economy,* Vol.131(6), pp.1385–1617

[13] Asonuma, T., M. Chamon, A. Erce, and A. Sasahara, 2024, "Costs of Sovereign Debt Crises: Restructuring Strategies and Financial Intermediation," *Journal of International Economics,* Vol.152, 104002.

[14] Asonuma, T., and H. Joo, 2020, "Sovereign Debt Restructurings: Delays in Renegotiations and Risk Averse Creditors," *Journal of the European Economic Association.*, Vol.18(5), pp.2394–2440.

[15] Asonuma, T., and H. Joo, 2024, "Sovereign Defaults and Public Investment (Capital)," University of Surrey Discussion Paper in Economics DP 11/23.

[16] Asonuma, T., H. Joo, and J. Zhang, 2022, "Fiscal Policy Analysis of Sovereign Debt," manuscript, Federal Reserve Bank of Chicago, IMF and University of Surrey.

[17] Asonuma, T., and C. Trebesch, 2016, "Sovereign Debt Restructurings: Preemptive or Post-default," *Journal of the European Economic Association,* Vol.14(1), pp.175–214.

[18] Auerbach, A., and Y. Gorodnichenko, 2012, "Fiscal Multipliers in Recession and Expansion," in A. Alesina and G. Giavazzi eds., *Fiscal Policy after the Financial Crisis*, University of Chicago Press.

[19] Azzimonti, M., 2015, "The Dynamics of Public Investment under Persistent Electoral Advantage," *Review of Economic Dynamics,* Vol.18(3), pp.653–678.

[20] Bai, Y., and J. Zhang, 2012, "Duration of Sovereign Debt Renegotiation," *Journal of International Economics,* Vol.86(2), pp.252–268.

[21] Benjamin, D., and M. L. J. Wright, 2013, "Recovery Before Redemption? A Theory of Delays in Sovereign Debt Renegotiations," manuscript, Federal Reserve Bank of Chicago and State University of New York Buffalo.

[22] Bi, R., 2008, ""Beneficial" Delays in Debt Restructuring Negotiations," IMF Working Paper 08/38.

[23] Bianchi, J., P. Ottonello, and I. Presno, 2023, "Fiscal Stimulus under Sovereign Risk," *Journal of Political Economy,* Vol.131(9), pp.2328–2369.

[24] Bulow, J., and K. S. Rogoff, 1989, "Sovereign Debt: Is to Forgive or to Forget?" *American Economic Review,* Vol.79(1), pp.43–50.

[25] Chatterjee, S., and B. Eyigungor, 2012, "Maturity, Indebtedness, and Default Risk," *American Economic Review,* Vol.102(6), pp.2674–2699.

[26] Conesa, J. C., and T. J. Kehoe, 2024, "Preemptive Austerity without Rollover Risk," *Journal of International Economics,* Vol.150, 130914.

[27] Cruces, J., and C. Trebesch, 2013, "Sovereign Defaults: The Price of Haircuts," *American Economic Journal: Macroeconomics,* Vol.5(3), pp.85–117.

[28] Cuadra, G., J. M. Sanchez, and H. Sapriza, 2010, "Fiscal Policy and Default Risk in Emerging Markets," *Review of Economic Dynamics,* Vol.13(2), pp.452–469.

[29] D'Erasmo, P., 2011, "Government Reputation and Debt Repayment in Emerging Economies," manuscript, University of Maryland.

[30] D'Erasmo, P., and E. G., Mendoza, 2016, "Distributional Incentive in an Equilibrium Model of Domestic Sovereign Default," *Journal of the European Economic Association,* Vol.14(1), pp.7–44.

[31] D'Erasmo, P., and E. G., Mendoza, 2021, "History Remembered: Optimal Sovereign Default on Domestic and External Debt," *Journal of Monetary Economics,* Vol.117, pp.969–989.

[32] Dvorkin, M., J. M. Sanchez, H. Sapriza, and E. Yurdagul, 2021, "Sovereign Debt Restructurings," *American Economic Journal: Macroeconomics,* Vol.13(2), pp.26–77.

[33] Eaton, J., and M. Gersovitz, 1981, "Debt with Potential Repudiation: Theoretical and Empirical Analysis," *Review of Economic Studies,* Vol.48(2), pp.289–309.

[34] Espino, E., J. Kozlowski, F.M. Martin, and J.M. Sanchez, forthcoming, "Domestic Policies and Sovereign Default," forthcoming in *American Economic Journal: Macroeconomics*.

[35] Galli, C., 2021, "Self-fulfilling Debt Crises, Fiscal Policy and Investment," *Journal of International Economics,* Vol.131, pp.103475.

[36] Gordon, G., and P. A. Guerron-Quintana, 2018, "Dynamics of Investment, Debt, and Default," *Review of Economic Dynamics*, Vol.28, pp.71–95.

[37] Greenwood, J., Z. Hercowitz, and G. W. Huffman, 1988, "Investment, Capacity Utilization, and the Real Business Cycle," *American Economic Review,* Vol.78(3), pp.402–417.

[38] Gunter, S., D. Riera-Crichton, C. A. Vegh, and G. Vuletin, 2021, "Non-liner Distortion-based Effects of Tax Changes on Output: The Role of the Initial Level of Taxation," *Journal of International Economics,* Vol.131, pp.103450.

[39] Hatchondo, J. C., and L. Martinez, 2009, "Long-duration Bonds and Sovereign Defaults," *Journal of International Economics,* Vol.79(1), pp.117–125.

[40] Hatchondo, J. C., L. Martinez, and C. S. Padilla, 2014, "Voluntary Sovereign Debt Exchanges," *Journal of Monetary Economics,* Vol.61(C), pp.32–50.

[41] Hatchondo, J. C., L. Martinez, and F. Roch, 2022, "Fiscal Rules and the Sovereign Default Premium," *American Economic Journal: Macroeconomics*, Vol.14(4), pp.244–73.

[42] Ilzetzki, E, 2011, "Rent-seeking Distortions and Fiscal Procyclicality," *Journal of Development Economics,* Vol.96(1), pp.30–46.

[43] Izquierdo, A., R. E. Lama, J. P. Medina, J. P. Puig, D. Riera-Crichton, C. A. Vegh, G. Vuletin, 2019, "Is the Public Investment Multiplier Higher in Developing Countries? An Empirical Investigation," NBER Working Paper No.26478.

[44] Kaminsky, G. L., C. M. Reinhart, and C. A. Vegh, 2005, "When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies," In: Gertler, M., Rogoff, K. (Eds.), *NBER Macroeconomics Annual 2004*, Vol.19, MIT Press.

[45] Karantounias, A. G., 2018, "Optimal Fiscal Policy with Recursive Preferences," *Review of Economic Studies,* Vol.85(4), pp.2283–2317.

[46] Kovrijnykh, N., and B. Szentes, 2007, "Equilibrium Default Cycles," *Journal of Political Economy,* Vol.115(3), pp.403–446.

[47] Leeper, E. M., T. B. Walker, S. S. Yang, 2010, "Government Investment and Fiscal Stimulus," *Journal of Monetary Economics*, Vol.57(8), pp.1000–1012.

[48] Levy-Yeyati, E., and U. Panizza, 2011, "The Elusive Costs of Sovereign Defaults," *Journal of Development Economics*, Vol.94(1), pp.95–105.

[49] Mendoza E. G., 1991, "Capital Controls and the Gains from Trade in a Business Cycle Model of a Small Open Economy," *IMF Staff Papers*, Vol.38(3), pp.480–505.

[50] Mendoza, E. G., L. Tessa, and J. Zhang, 2014, "Saving Europe?: The Unpleasant Arithmetic of Fiscal Austerity in Integrated Economies," SAFE Working Paper Series 80.

[51] Mendoza, E. G, and V. Z. Yue, 2012, "A General Equilibrium Model of Sovereign Default and Business Cycles," *Quarterly Journal of Economics,* Vol.127(2), pp.889–946.

[52] Merlo, A., and C. Wilson, 1995, "A Stochastic Model of Sequential Bargaining with Complete Information," *Econometrica,* Vol.63(2), pp.371–399.

[53] Morelli, J. M., and M. Moretti, 2023, "Information Frictions, Reputation, and Sovereign Spreads," *Journal of Political Economy,* Vol.131(11), pp.3066–3102.

[54] Pitchford, R., and M. L. J. Wright, 2012, "Holdouts in Sovereign Debt Restructurings: A Theory of Negotiations in a Weak Contractual Environment," *Review of Economic Studies,* Vol.79(2), pp.1–26.

[55] Pouzo, D., and I. Presno, 2022, "Optimal Taxation with Endogenous Default under Incomplete Markets,"*American Economic Journal: Macroeconomics,* Vol.14(3), pp.1–41.

[56] Ramey, V. A., 2021, "The Macroeconomic Consequences of Infrastructure Investment," In: Glaeser E. L., and J. M. Poterba (Eds.), *Economic Analysis and Infrastructure Investment*, University of Chicago Press.

[57] Reinhart, C. M., V. R. Reinhart, and K. S. Rogoff, 2012, "Public Debt Overhangs: Advanced-Economy Episodes Since 1800," *Journal of Economic Perspective,* Vol.26(3), pp.69–86.

[58] Reinhart, C. M., and K. S. Rogoff, 2009, *This Time is Different: Eight Centuries of Financial Folly,* Princeton University Press.

[59] Roch, F., and H. Uhlig, 2018, "The Dynamics of Sovereign Debt Crises and Bailouts," *Journal of International Economics,* Vol.114, pp.1–13.

[60] Sanchez, J.M., H. Sapriza, and E. Yurdagul, 2018,"Sovereign Default and Maturity Choice," *Journal of Monetary Economics,* Vol.95, pp.72–85.

[61] Sturzenegger, F., and J. Zettelmeyer, 2006, *Debt Defaults and Lessons from a Decade of Crises,* MIT Press.

[62] Sturzenegger, F., and J. Zettelmeyer, 2008, "Haircuts: Estimating Investors Losses in Sovereign Debt Restructuring, 1998–2005," *Journal of International Money and Finance,* Vol.27(5), pp.780–805.

[63] Tauchen, G, 1986, "Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions," *Economic Letters,* Vol.20(2), pp.177–181.

[64] Tomz, M., and M. L. J. Wright, 2007, "Do Countries Default in "Bad" Times?" *Journal of the European Economic Association*, Vol.5(2–3), pp.352–360.

[65] U.S. Bureau of Economic Analysis (BEA), 1999, "Fixed Reproducible Tangible Wealth in the United States, 1925–94," August 1999.

[66] Yue, V. Z., 2010, "Sovereign Default and Debt Renegotiation," *Journal of International Economics,* Vol.80(2), pp.176–187.

Appendix A Datasets

A.1 Non-restructuring Debt Distress

Table A1: Non-restructuring Debt Distress Episodes

Country	**Non-restructuring Debt Distress Periods**		**Estimated Probability**		**EMBIG Bond Spreads**	**No Overlap with Restructurings**	**Being Cured** (an interval of 2 years)
	start	end	Post-default (percent)	Preemptive (percent)	(basis points)	(Yes/No)	(Yes/No)
Algeria	1982	1982	15.1			Yes	Yes
Algeria	1984	1984	15.0			Yes	Yes
Argentina	1975	1975	25.5			Yes	Yes
Argentina	1995	1995			1,232	Yes	Yes
Argentina	2009	2009			1,174	Yes	Yes
Brazil	1995	1995			1,108	Yes	Yes
Brazil	2002	2002			1,418	Yes	Yes
Congo, Rep.	1976	1976	19.6			Yes	Yes
Costa Rica	1991	1991	17.0			Yes	Yes
Ecuador	2001	2002	18.0			Yes	Yes
Jordan	1982	1982	14.8			Yes	Yes
Kenya	1982	1982	19.9			Yes	Yes
Madagascar	1975	1975	14.8			Yes	Yes
Malawi	1984	1984	30.0			Yes	Yes
Mauritania	1982	1982	29.5			Yes	Yes
Mauritania	1984	1985	17.9			Yes	Yes
Mexico	1985	1985			1,142	Yes	Yes
Mongolia	2010	2010		39.9		Yes	Yes
Nigeria	1992	1995	34.5		1,910	Yes	Yes
Nigeria	2001	2001	15.9			Yes	Yes
Pakistan	2008	2009			1,118	Yes	Yes
Seychelles	1982	1982	15.4			Yes	Yes
Togo	1983	1984	34.6			Yes	Yes
Ukraine	2010	2010		37.6		Yes	Yes
Venezuela, RB	2009	2011			1,191	Yes	Yes

A.2 Fiscal Expenditure Consolidation Episodes in 1975–2020

Table A2: Fiscal Expenditure Consolidation Episodes in 1975–2020

(A) 1st group—11 countries (Albania, Algeria, Argentina, Barbados, Belize, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Chad and Chile)

Restructuring Index	**Country**	**Sovereign Debt Crisis (Debt Restructuring)**	**Fiscal Expenditure Consolidation**					
Asonuma and Trebesch (2016)		Start year	Yes/No	Type	Start	Start year	End	End year
1	Albania	1981	Yes	Ex post	T+1	1992	T+3	1994
2	Algeria	1990	Yes	Ex ante	T-1	1989	T	1990
3	Algeria	1993	Yes	Ex post	T+1	1994	T+2	1995
4	Argentina	1982	No					
5	Argentina	1985	No					
6	Argentina	1988	No					
7	Argentina	2001	No					
8	Argentina	2019	No					
9	Barbados	2018	No					
10	Belize	2006	Yes	Ex ante	T-2	2004	T-1	2005
11	Belize	2012	No					
12	Belize	2016	No					
13	Belize	2020	No					
14	Bolivia	1980	Yes	Ex post	T+5	1985	T+6	1986
15	Bolivia	1988	Yes	Ex ante	T-2	1986	T	1988
16	Bosnia and Herzegovina	1992	Yes	Ex post	T+5	1997	T+5	1997
17	Brazil	1982	No					
18	Brazil	1983	No					
19	Brazil	1984	No					
20	Brazil	1986	No					
21	Brazil	1989	No					
22	Brazil	1989	No					
23	Bulgaria	1990	Yes	Ex post	T+4	1994	T+4	1994
24	Cameroon	1985	Yes	Ex post	T+9	1994	T+9	1994
25	Chad	2014	No					
26	Chad	2017	No					
27	Chile	1983	Yes	Ex post	T	1983	T	1983
28	Chile	1983	Yes	Ex post	T	1983	T	1983
29	Chile	1984	Yes	Ex ante	T-1	1983	T-1	1983
30	Chile	1986	Yes	Ex ante	T-1	1984	T-1	1985

A.3 Joint Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings

There are eight joint choice of fiscal expenditure consolidation and sovereign debt restructurings:

- Default/Post-default restructuring
  - Ex post fiscal expenditure consolidation
  - Ex ante fiscal expenditure consolidation
  - No fiscal expenditure consolidation
- Preemptive debt restructuring
  - Ex post fiscal expenditure consolidation
  - Ex ante fiscal expenditure consolidation
  - No fiscal expenditure consolidation
- Non-restructuring debt distress
  - Fiscal expenditure consolidation
  - No fiscal expenditure consolidation

There are two joint choice of fiscal expenditure consolidation and non-debt crisis recession (i.e., no debt restructuring)

- Non-debt crisis recession
  - Fiscal expenditure consolidation
  - No fiscal expenditure consolidation

Appendix B Further Empirical Analysis

Figure B1: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings in 1975–2020—Alternative Classification

(i) Expenditure-to-potential GDP ratio

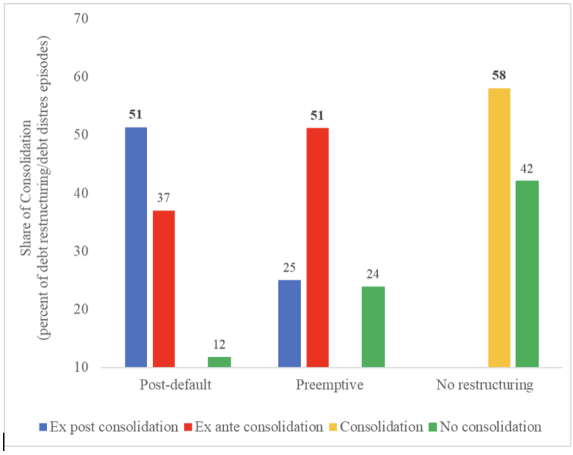


Figure B2: Choice of Fiscal Expenditure Consolidation around Non-debt Crisis Recessions in 1975–2020

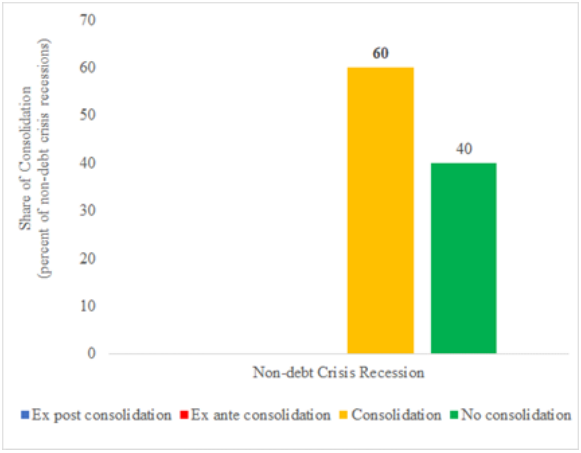
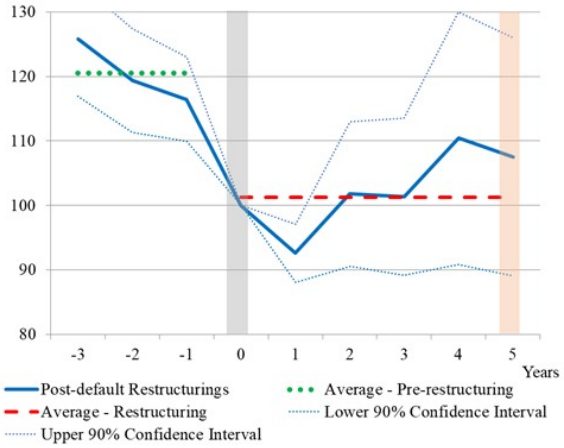
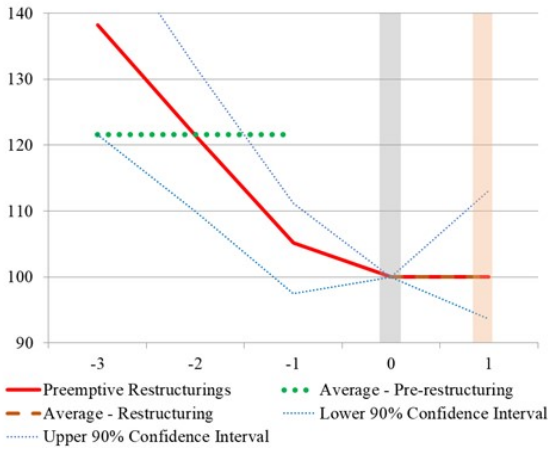


Figure B3: Public Investment (percent of GDP)

(i) Post-default Restructurings



(ii) Preemptive Restructurings



(iii) Non-restructuring Debt Distress

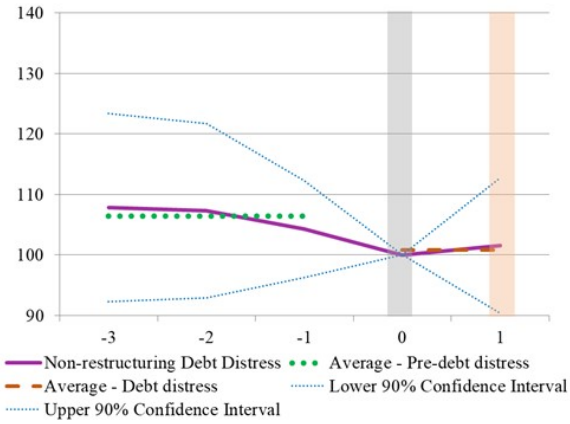


Figure B4: Public Investment (Level)

(i) Non-debt Crisis Recessions

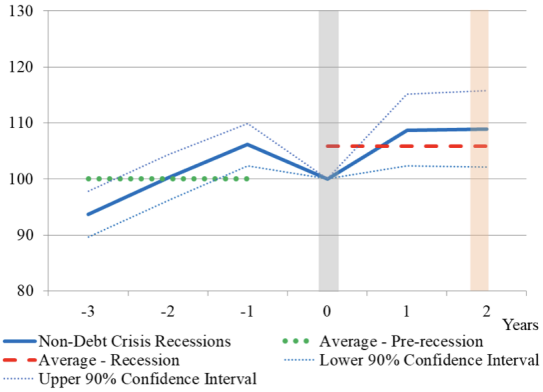
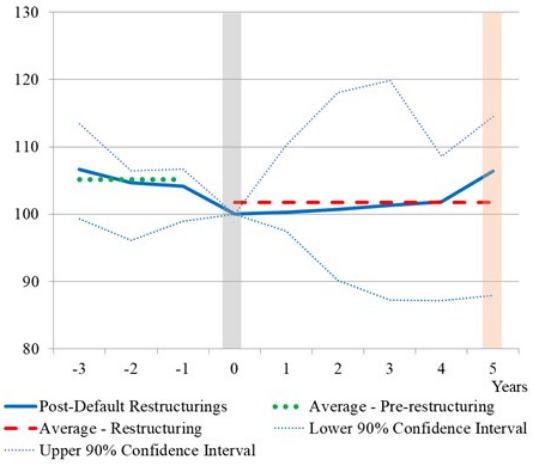
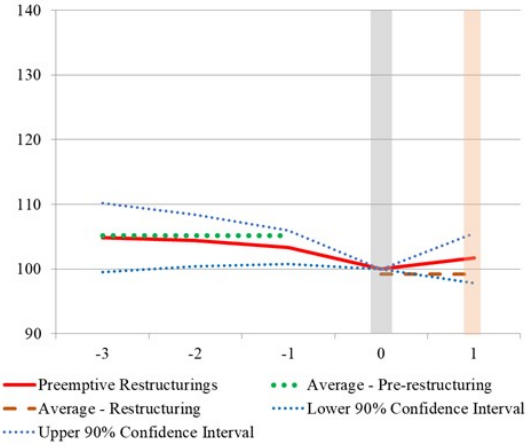


Figure B5: Public Consumption and Transfers (percent of GDP)

(i) Post-default Restructurings



(ii) Preemptive Restructurings



(iii) Non-restructuring Debt Distress

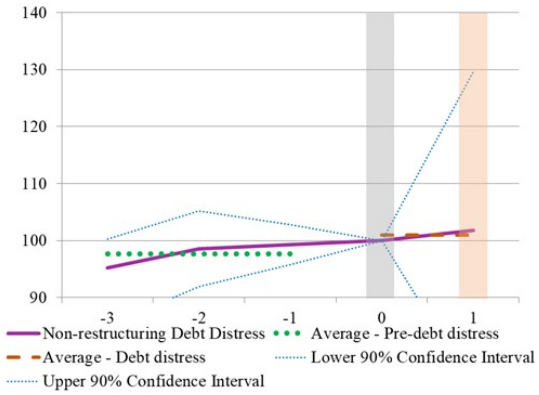
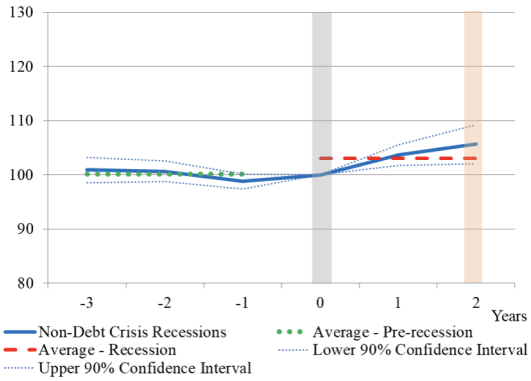


Figure B6: Public Consumption and Transfers (Level)

(i) Non-debt Crisis Recessions



Appendix C Further Theoretical Model

C.1 Debt Renegotiations when Lender Proposes

The case when the lender proposes is identical to the case the borrower proposes in Section 4.5.

First, we start with post-default debt renegotiation. We denote the offered recovery rates as α_t^L, the borrower's values of accepting and rejecting as V^{ACT} and V^{REJ}, and the lender's values of proposing and passing as V^{*PRO} and V^{*PASS}, respectively. When the borrower L proposes and the offer is accepted,

$$V^{*PRO}(b_t, k_t^g, 2, a_t) = -\alpha_t^L b_t \tag{47}$$

$$V^{ACT}(b_t, k_t^g, 2, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta \int_A V(b_{t+1}, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{48}$$

$$s.t. \quad (9),\ (10b),\ (11b),\ \text{and}$$

$$g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 2, a_t) b_{t+1} = \tau c_t + (1-\delta^k) k_t^g - \frac{\Omega}{2}(\frac{k_{t+1}^g - k_t^g}{k_t^g})^2 k_t^g + \alpha_t^L b_t \tag{8b'}$$

When the lender passes, both parties proceed to the next period and continue post-default renegotiations with accumulated arrears:

$$V^{*PASS}(b_t, k_t^g, 2, a_t) = \frac{1}{1+r^*} \int_A \Gamma^*((1+r^*)b_t, k_{t+1}^g, 2, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{49}$$

$$V^{REJ}(b_t, k_t^g, 2, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \beta \int_A V((1+r^*)b_t, k_{t+1}^g, 2, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{50}$$

$$s.t. \quad (8),\ (9),\ (10b),\ \text{and}\ (11b)$$

In equilibrium, the agreed recovery rates α_t^{L*} satisfy the following:[25]

$$\begin{aligned} \alpha_t^{L*} &= argmax V^{*PRO}(b_t, k_t^g, 2, a_t) \\ s.t. \quad V^{*PRO}(b_t, k_t^g, 2, a_t) &\geq V^{*PASS}(b_t, k_t^g, 2, a_t) \\ V^{ACT}(b_t, k_t^g, 2, a_t) &\geq V^{REJ}(b_t, k_t^g, 2, a_t) \end{aligned} \tag{28a}$$

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

[25] Off-equilibrium paths are eliminated in equilibrium.

$$\Gamma^{*L}(b_t, k_t^g, 2, a_t) = V^{*PRO}(b_t, k_t^g, 2, a_t)$$
$$\Gamma^{L}(b_t, k_t^g, 2, a_t) = V^{ACT}(b_t, k_t^g, 2, a_t) \tag{29b}$$

Otherwise,

$$\Gamma^{*L}(b_t, k_t^g, 2, a_t) = V^{*PASS}(b_t, k_t^g, 2, a_t)$$
$$\Gamma^{L}(b_t, k_t^g, 2, a_t) = V^{REJ}(b_t, k_t^g, 2, a_t) \tag{29c}$$

The renegotiation settlement can be characterized by a settlement set $R^L(b_t, k_t^g, 2) \subset A$. It is a set of productivity shocks a_t at which both parties reach an agreement:

$$R^L(b_t, k_t^g, 2) = \left\{ \begin{array}{c} a_t \in A : V^{*PRO}(b_t, k_t^g, 2, a_t) \geq V^{*PASS}(b_t, k_t^g, 2, a_t) \\ V^{ACT}(b_t, k_t^g, 2, a_t) \geq V^{REJ}(b_t, k_t^g, 2, a_t) \end{array} \right\}. \tag{30a}$$

Second, we consider preemptive debt renegotiations. We denote the offered recovery rates as δ_t^L, the lender's values of proposing, passing, and quitting as V^{*PRO}, V^{*PASS}, and V^{*QUIT}, the borrower's values of accepting, rejecting, and quitting as V^{ACT}, V^{REJ}, V^{QUIT}. When the lender L proposes and the offer is accepted,

$$V^{*PRO}(b_t, k_t^g, 1, a_{t-1}) = -\delta_t^L b_t \tag{51}$$

$$V^{ACT}(b_t, k_t^g, 1, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t, b_{t+1}} \int_A \left[\begin{array}{c} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \\ \beta V^{EXANTE}(b_{t+1}, k_{t+1}^g, 0, a_t) \end{array} \right] d\mu(a_t|a_{t-1}) \tag{52}$$

$$s.t. \quad (9),\ (10),\ (11),\ \text{and}$$

$$g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 1, a_{t-1}) b_{t+1} = \tau c_t + (1-\delta^k) k_t^g - \frac{\Omega}{2}\left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g + \delta_t^L b_t \tag{8c'}$$

When the lender L passes, both parties proceed to the next period and continue preemptive renegotiations with the same level of debt (i.e., no accumulation of arrears).

$$V^{*PASS}(b_t, k_t^g, 1, a_{t-1}) = \frac{1}{1+r^*} \int_A \Psi^*(b_t, k_{t+1}^g, 1, a_t) d\mu(a_t|a_{t-1}) \tag{53}$$

$$V^{REJ}(b_t, k_t^g, 1, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t} \int_A \left[\begin{array}{c} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \\ \beta \Psi(b_t, k_{t+1}^g, 1, a_t) \end{array} \right] d\mu(a_t|a_{t-1}) \tag{54}$$

$$s.t. \quad (8),\ (9),\ (10),\ \text{and},\ (11)$$

When the borrower L quits the preemptive debt renegotiations, the sovereign proceeds to

its choice between repayment and default without any debt treatment and the foreign creditors receive expected return on sovereign bonds:

$$V^{*QUIT}(b_t, k_t^g, 1, a_{t-1}) = \Big[(1 - p^D(b_t, k_t^g, 0, a_{t-1})) + p^D(b_t, k_t^g, 0, a_{t-1})\alpha(b_t, k_t^g, 0, a_{t-1})\Big] b_t \quad (36)$$

$$V^{QUIT}(b_t, k_t^g, 1, a_{t-1}) = \max_{g_t, k_{t+1}^g, T_t} \int_A \left[\begin{array}{c} (1-\omega)u(c_t, l_t) + \omega v(g_t) + \\ \beta \int_A V(b_t, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \end{array} \right] d\mu(a_t|a_{t-1}) \quad (35)$$

$$s.t. \quad (8),\ (9),\ (10),\ \text{and } (11)$$

In equilibrium, agreed recovery rates δ_t^{L*} satisfy the following:[26]

$$\begin{aligned} \delta_t^{L*} &= argmax V^{PRO}(b_t, k_t^g, 1, a_t) \\ s.t. \quad V^{*PRO}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{*PASS}(b_t, k_t^g, 1, a_{t-1}) \\ V^{*PRO}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{*QUIT}(b_t, k_t^g, 1, a_{t-1}) \\ V^{ACT}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{REJ}(b_t, k_t^g, 1, a_{t-1}) \\ V^{ACT}(b_t, k_t^g, 1, a_{t-1}) &\geq V^{QUIT}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \quad (37a)$$

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

$$\begin{aligned} \Psi^{*L}(b_t, k_t^g, 1, a_{t-1}) &= V^{*PRO}(b_t, k_t^g, 1, a_{t-1}) \\ \Psi^{L}(b_t, k_t^g, 1, a_{t-1}) &= V^{ACT}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \quad (38a)$$

Otherwise,

$$\begin{aligned} \Psi^{*L}(b_t, k_t^g, 1, a_{t-1}) &= V^{*PASS}(b_t, k_t^g, 1, a_{t-1}) \\ \Psi^{L}(b_t, k_t^g, 1, a_{t-1}) &= V^{REJ}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \quad (39b)$$

or

$$\begin{aligned} \Psi^{*L}(b_t, k_t^g, 1, a_{t-1}) &= V^{*QUIT}(b_t, k_t^g, 1, a_{t-1}) \\ \Psi^{L}(b_t, k_t^g, 1, a_{t-1}) &= V^{REJ\_QUIT}(b_t, k_t^g, 1, a_{t-1}) \end{aligned} \quad (39c)$$

The renegotiation settlement can be characterized by a settlement set $R^L(b_t, k_t^g, 1) \subset A$. It is the set of productivity shocks a_{t-1} which both parties agree on settlements:

[26] Off-equilibrium paths are eliminated in equilibrium.

$$R^L(b_t, k_t^g, 1) = \left\{ \begin{array}{c} a_{t-1} \in A : V^{*PRO}(b_t, k_t^g, 1, a_{t-1}) \geq V^{*PASS}(b_t, k_t^g, 1, a_{t-1}) \\ V^{ACT}(b_t, k_t^g, 1, a_{t-1}) \geq V^{REJ}(b_t, k_t^g, 1, a_{t-1}) \end{array} \right\} \tag{40a}$$

C.2 Implications for Key Theoretical Assumptions

We provide implications for the following two main theoretical assumptions: (i) productivity loss and (ii) taxation method. We explore an alternative function form for productivity loss and an alternative method for consumption taxation. In both cases, our baseline qualitative results remain robust.

First on productivity loss, previous studies in the literature of sovereign debt assumes symmetric "output costs" which the sovereign suffers a constant (fixed) fraction of output costs at any level of its output (income) as in Aguiar and Gopinath (2006) and Yue (2010). To resemble the symmetric output cost function, we assume "symmetric" productivity loss which the sovereign suffers a constant fraction of productivity loss at any level of its productivity:

$$\tilde{a}_t = (1 - \lambda_D)a_t, \ \hat{a}_t = (1 - \lambda_P)a_t \tag{46a}$$

Following Asonuma and Trebesch (2016), we set $\lambda_D = 0.02$ and $\lambda_P = 0.015$ to be consistent with different output dynamics between preemptive and post-default restructurings in empirical literature (e.g., Asonuma et al. 2024).

Figure C1 reports the sovereign's choice between repayment and default, and between settlement and delay under symmetric productivity loss. At the mean level of public debt in panel A, prior to the current TFP realization, the sovereign opts a preemptive restructuring when debt is high and lagged TFP is low (the blue region in panel A-i). After the current TFP realization, it opts a default/post-default restructuring when debt is high and current TFP is low (the red region in panel A-ii). Furthermore, at the mean level of lagged and current TFP in penal B, the sovereign is more willing to take a preemptive restructuring when public capital is low. Its willingness to default and take a post-default restructuring is weakly decreasing as public capital increases.

Second on taxation method, we assume "two-stage consumption taxation" that the sovereign increases consumption tax rate to raise tax revenues during both preemptive and post-default restructurings. During both debt restructurings, the sovereign yields additional revenue measures.

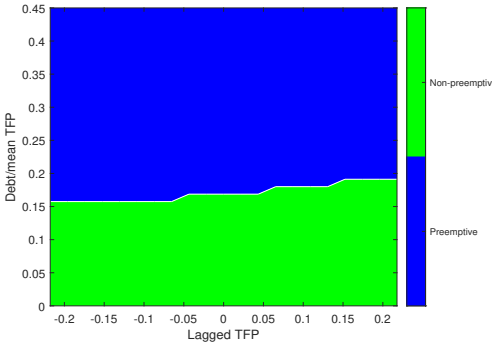
Figure C2 reports the sovereign's choice between repayment and default, and between settlement and delay under two-stage consumption taxation. At the mean level of lagged and current TFP in panel B, prior to the current TFP realization, the sovereign is more willing to take a preemptive restructuring due to lower effective costs of a preemptive debt restructuring (larger "preemptive restructuring" region in blue in panel B-i). After the current TFP realization, it is also more willing to default and take a post-default restructuring due to lower effective costs of a default/post-default restructuring (larger "default" region in red in panel B-ii). An increase in

tax revenues improves repayment capacity during both preemptive and post-default restructurings and results in quick settlement in both preemptive and post-default restructurings—lower effective costs of both a preemptive restructuring and a default/post-default restructuring.

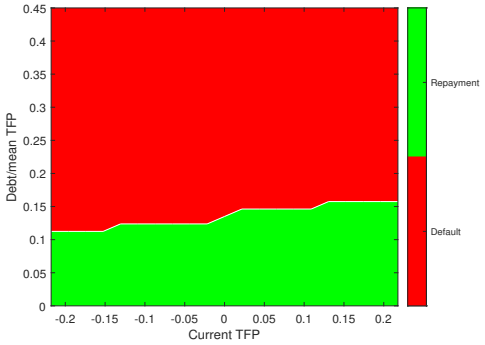
Figure C1: Symmetric Productivity Loss (Uruguay)

Part A: Public Capital at the Mean Level

(i) Choice for Preemptive Restructuring

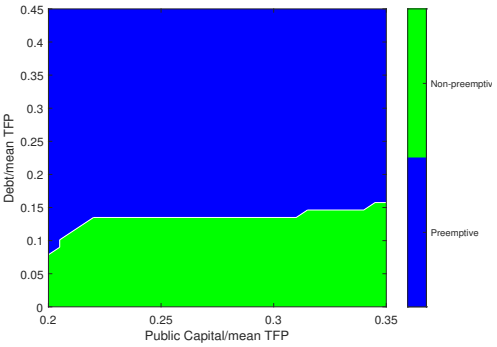


(ii) Choice for Default/Post-default Restructuring



Part B: Lagged and Current TFP at the Mean Level

(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring

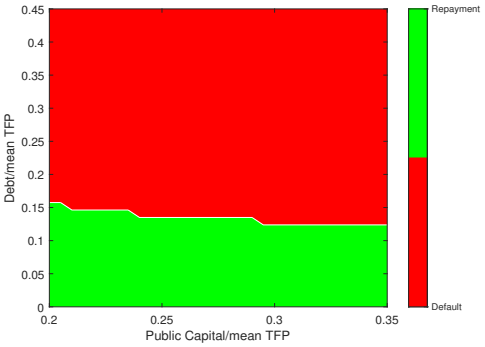
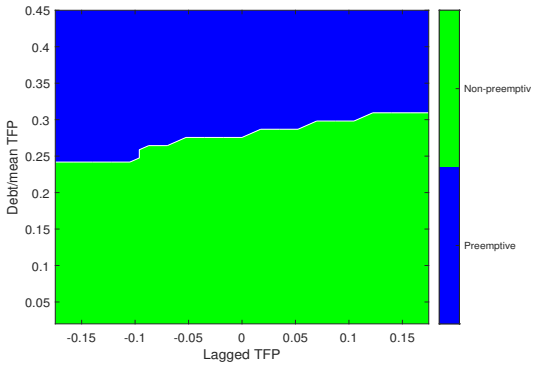


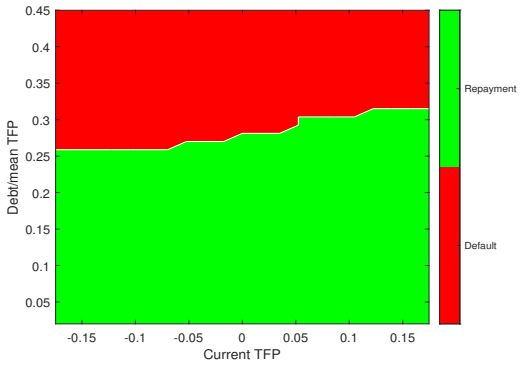
Figure C2: Two-stage Consumption Taxation (Uruguay)

Part A: Public Capital at the Mean Level

(i) Choice for Preemptive Restructuring

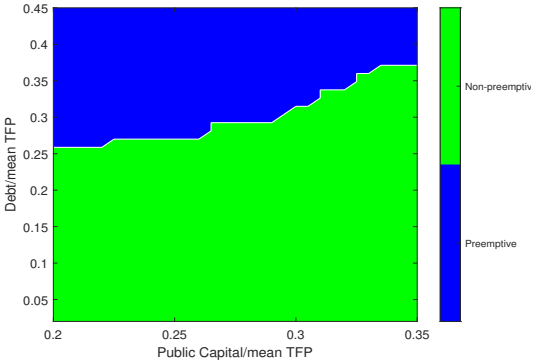


(ii) Choice for Default/Post-default Restructuring

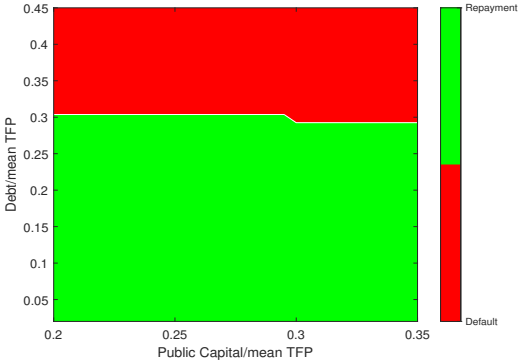


Part B: Lagged and Current TFP at the Mean Level

(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring



Appendix D Computation Algorithm

We use a global solution method following Chatterjee and Eyigungor (2012) and Morelli and Moretti (2023). The procedure to compute the equilibrium distribution of the model is the following:

1. First, we set finite grids on the space of debt, pubic capital and productivity as by $B = [b_{min}, b_{max}]$, $K^g = [k^g_{min}, k^g_{max}]$, and $A = [a_{min}, a_{max}]$. Limits of productivity are large enough to include large deviations from mean value of shocks. We approximate the stochastic productivity process of the sovereign shown by equation (45) using a discrete Markov chain as in Tauchen (1986). Moreover, we compute the transition matrix based on the probability distribution $\mu(a_{t+1}|a_t)$.

2. Second, we set finite grids on the space of recovery rates (δ_t and α_t) at preemptive and post-default renegotiations. 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 sovereign bond price, payoffs for debt renegotiations for the sovereign and the creditors, and the sovereign's value functions for preemptive and post-default renegotiations. We use the risk-free bond price ($q^0 = (1+r^*)^{-1}$) for the baseline equilibrium bond price. We set payoffs for debt renegotiations for the sovereign and the creditors as $\Gamma^{B,0} = \Gamma^{L,0} = 0$, $\Gamma^{*B,0} = \Gamma^{*L,0} = 0$, $\Psi^{B,0} = \Psi^{L,0} = 0$, and $\Psi^{*B,0} = \Psi^{*L,0} = 0$, and the initial value functions for the sovereign and creditors as $V^0 = V^{R,0} = V^{D,0} = 0$, $V^{PRO,0} = V^{PASS,0} = V^{QUIT,0} = 0$, $V^{ACT,0} = V^{REJ,0} = V^{QUIT,0} = 0$, $V^{*,PRO,0} = V^{*,PASS,0} = V^{*,QUIT,0} = 0$ and $V^{*,ACT,0} = V^{*,REJ,0} = V^{*,QUIT,0} = 0$.

4. Fourth, given the baseline equilibrium bond price, payoffs for debt renegotiations, and the sovereign's value functions, we solve for the household's and the firm's maximization problems to obtain private consumption, labor supply, and labor demand.

5. Fifth, given the baseline equilibrium sovereign bond price, payoffs for debt renegotiations, and the private sector's equilibrium policy functions, we solve for the sovereign's optimization problem for a good credit record ($h_t = 0$). Similar to Chatterjee and Eyigungor (2012) and Morelli and Moretti (2023), we solve for the default decision. This procedure finds the value functions for the sovereign ($V^1, V^{R,1}, V^{D,1}$), debt functions ($b^1, b^{R,1}, b^{D,1}$), and public capital functions ($k^{g,1}, k^{g,R,1}, k^{g,D,1}$). Furthermore, we obtain the default choice. Based on the default choice, we also evaluate the default probability using the transition matrix.

6. Sixth, given the baseline equilibrium sovereign bond price, payoffs for debt renegotiations, the private sector's equilibrium policy functions, the value functions for the sovereign, and the default (and post-default restructuring) choice, we solve for the sovereign's choice of

a preemptive restructuring or pass it when its credit record is good ($h_t = 0$) and before productivity shock materializes. We solve for the preemptive restructuring choice.

7. Seventh, using the default (post-default restructuring) choice and the preemptive restructuring choice in step 5 and 6, and the zero profit condition for the foreign creditors, we compute the new price of sovereign bonds (q^1).

8. Eighth, given the value functions for the sovereign, we solve for multi-round post-default and preemptive debt renegotiations and compute the new payoffs for both the sovereign and the creditors for two types of debt renegotiations ($\Gamma^{B,1}, \Gamma^{L,1}$, $\Gamma^{*B,1}, \Gamma^{*L,1}$, $\Psi^{B,1}, \Psi^{L,1}$, $\Psi^{*B,1}$ and $\Psi^{*L,1}$). There are two cases which either the sovereign or the creditors is the proposer. Furthermore, we obtain the settlement and delay choice. Based on the settlement and delay choice, we also evaluate the settlement probability. We obtain the equilibrium recovery rates for two types of debt renegotiations (δ^* and α^*).

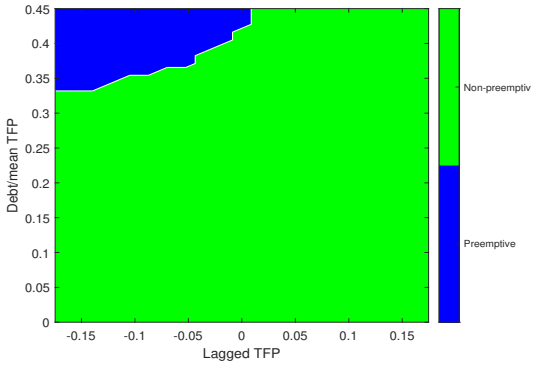
9. We iterate steps steps 4, 5, 6, 7, and 8 to have fixed value functions, default (post-default restructuring) choice and preemptive restructuring choice for the sovereign, price of sovereign bonds, payoffs for two types of debt renegotiations, settlement and delay choice, and the private sector's policy functions.

Appendix E Further Analysis on Equilibrium Characteristics

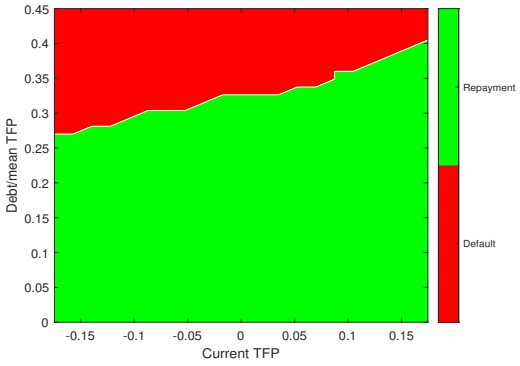
Figure E1: Sovereign's Equilibrium Choice (Argentina) in the Baseline Model

Part A: Public Capital at the Mean Level

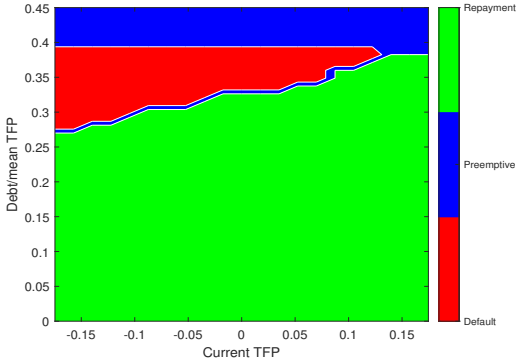
(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring

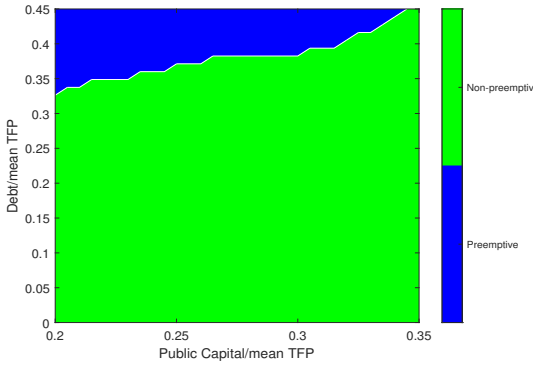


(iii) Choice for Repayment, Preemptive and Default/Post-default Restructuring

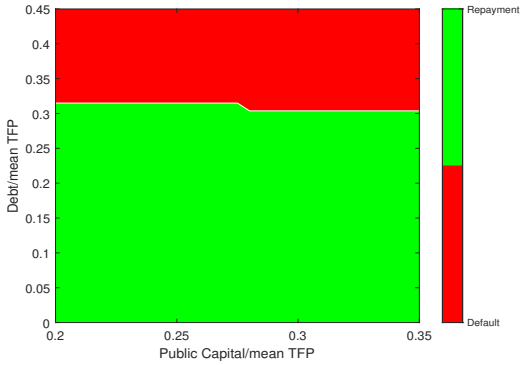


Part B: Lagged and Current Productivity at the Mean Level

(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring



(iii) Choice for Repayment, Preemptive and Default/Post-default Restructuring

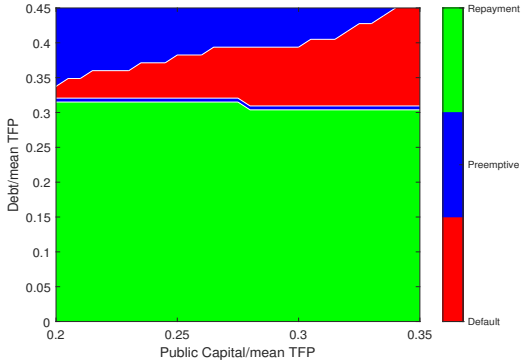
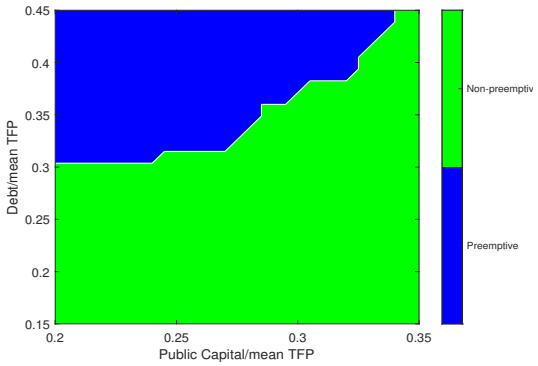


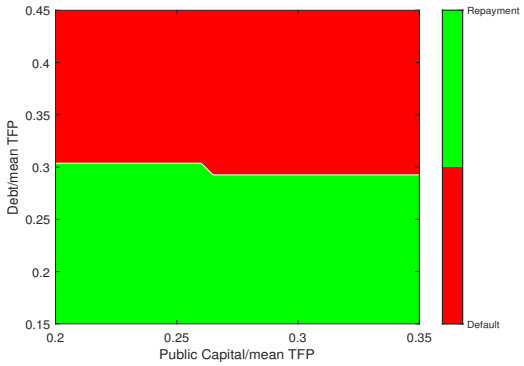
Figure E2: Sovereign's Equilibrium Choice (Uruguay) in the Baseline Model

Part A: Lagged Productivity at Mean Level and Current Productivity at Low Level

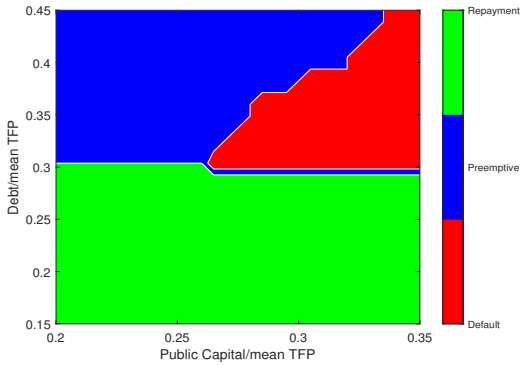
(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring

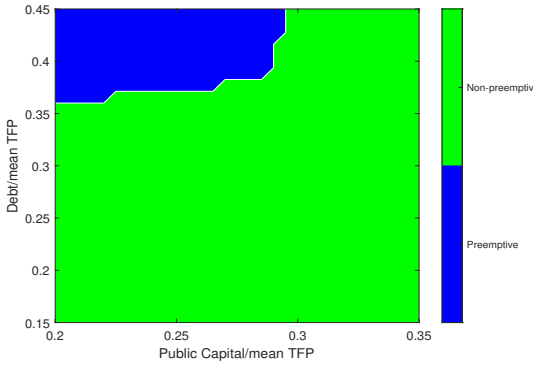


(iii) Choice for Repayment, Preemptive and Default/Post-default Restructuring

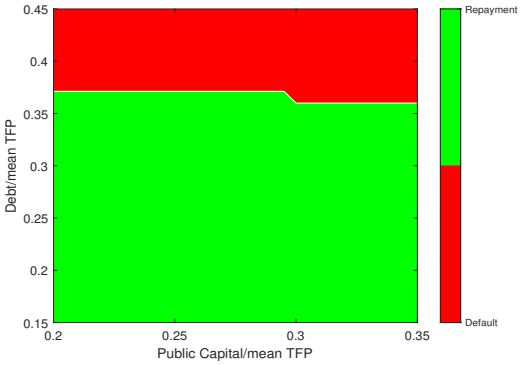


Part B: Lagged Productivity at Mean Level and Current Productivity at High Level

(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring



(iii) Choice for Repayment, Preemptive and Default/Post-default Restructuring

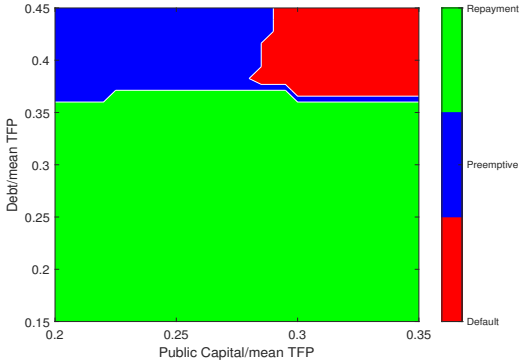
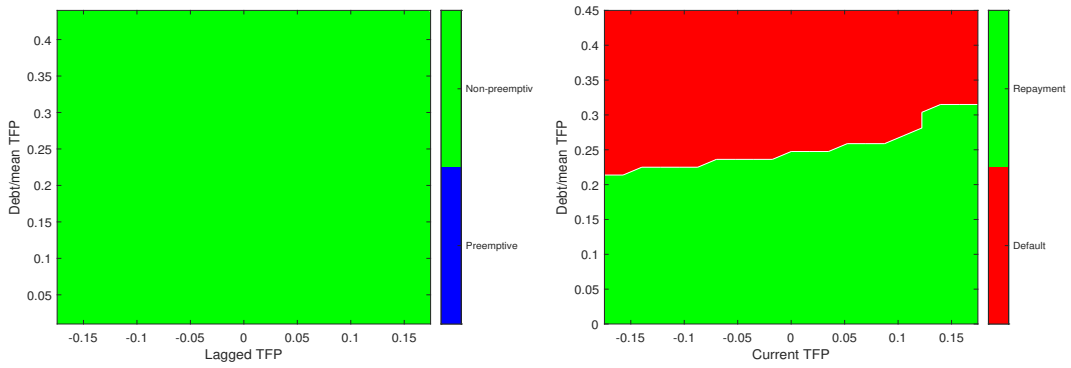


Figure E3: Sovereign's Equilibrium Choice (Uruguay) in a Model of Only a Post-default Restructuring

Part A: Public Capital at the Mean Level

(i) Choice for Preemptive Restructuring (ii) Choice for Default/Post-default Restructuring



Part B: Lagged and Current Productivity at the Mean Level

(i) Choice for Preemptive Restructuring (ii) Choice for Default/Post-default Restructuring

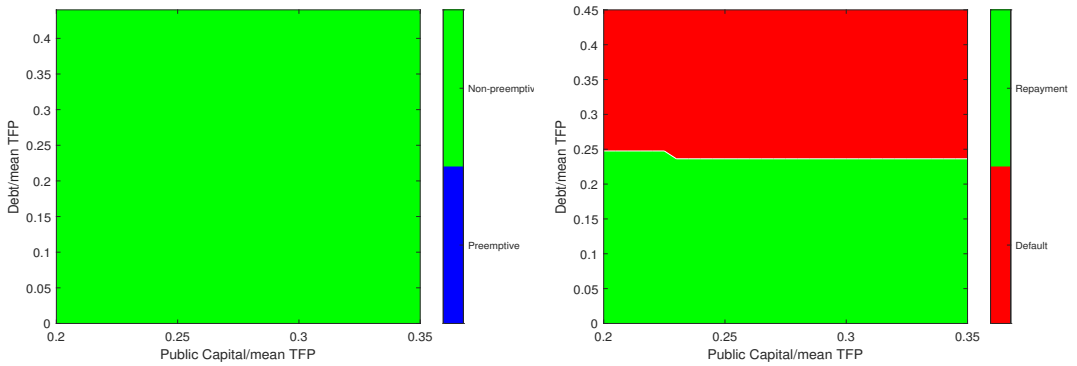
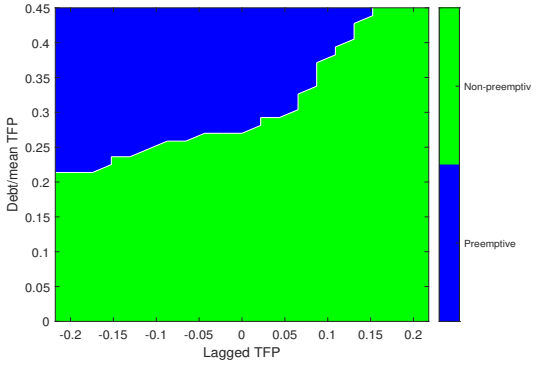


Figure E4: Sovereign's Equilibrium Choice (Uruguay) in a Model of Exogenous Public Capital

Part A: Public Capital at the Mean Level

(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring

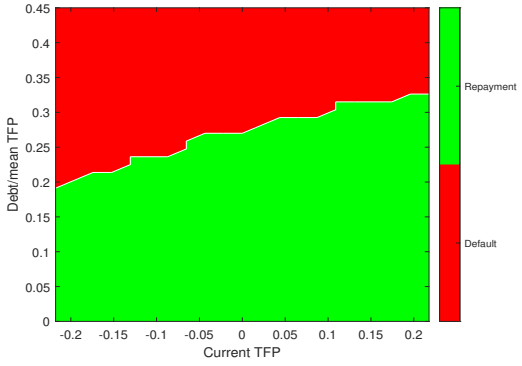
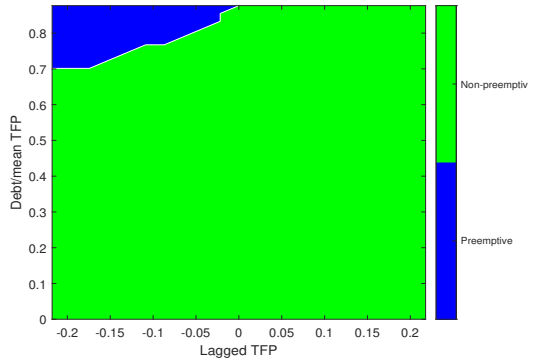


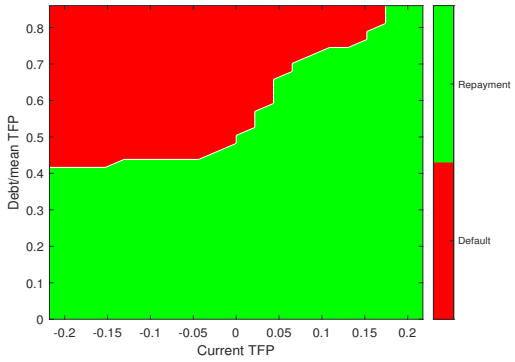
Figure E5: Sovereign's Equilibrium Choice (Uruguay) in a Model of Endogenous Aggregate Capital

Part A: Aggregate Capital at the Mean Level

(i) Choice for Preemptive Restructuring

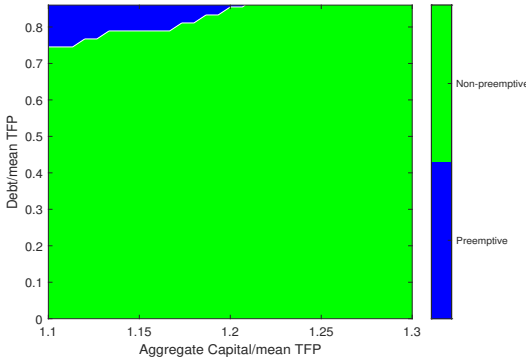


(ii) Choice for Default/Post-default Restructuring

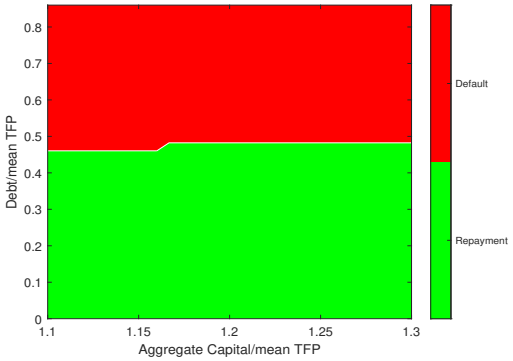


Part B: Lagged and Current Productivity at the Mean Level

(i) Choice for Preemptive Restructuring



(ii) Choice for Default/Post-default Restructuring



Appendix F Appendix F Further Quantitative Analysis

F.1 Further Simulation Results in Our Baseline Model

Figure F1: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings —Alternative Definitions

(i) Expenditure-to-potential GDP ratio

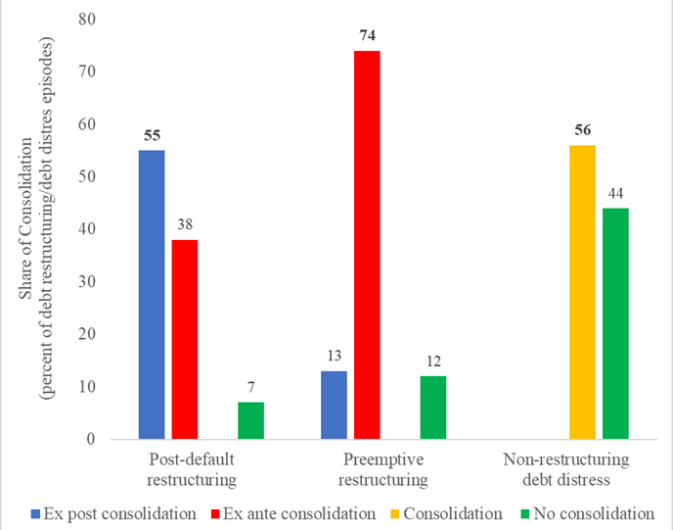


Table F1: Moment Statistics from Simulation Results

(i) Private Sector Business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring		Uruguay 2003 Preemptive Restructuring		Argentina 1995 Non-restructuring Debt Distress	
	Data	Baseline Model	Data	Baseline Model	Data	Baseline
Non-target statistics						
Pre-restructuring period						
Private sector						
Private consumption (std. dev.)/output (std. dev.)	1.11	1.01	1.09	1.01	1.11	1.01
Trade balance/output: std. dev. (%)	1.28	1.58	0.39	1.50	1.18	1.56
Corr.(trade balance, output)	-0.87	-0.10	-0.87	-0.12	-0.91	-0.15
Restructuring period						
Private sector						
Private consumption (std. dev.)/output (std. dev.)	1.17	1.01	0.87 1/	1.01	-	-
Trade balance/output: std. dev. (%)	0.45	0.00	0.02 1/	0.00	-	-
Corr.(trade balance, output)	-0.97	0.00	-0.64 1/	0.00	-	-

(ii) Non-business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring		Uruguay 2003 Preemptive Restructuring		Argentina 1995 Non-restructuring Debt Distress	
	Data	Baseline Model	Data	Baseline Model	Data	Baseline
Non-target statistics						
Pre-restructuring period						
Corr.(debt/GDP, output)	-0.97	-0.76	-0.79 1/	-0.38	-0.97	-0.84
Restructuring period						
Corr.(debt/GDP, output)	-0.95	-0.85	0.10 1/	-0.05	-	-

Sources: BCU, IMF WEO, INDEC and MECON.
Notes: 1/ Statistics are based on 2003-04 (standard deviation) and 2002-04 (correlation) in Uruguay.

F.2 Comparison with Recalibrations of Previous Studies

Table F2: Moment Statistics from Recalibration Results of Previous Studies
Part A: Argentina Default and Post-default Restructuring 2001–05

(i) Public Sector Business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring					
	Data	Baseline Model	Cuadra et al. (2010) Recalibration [1/]	Arellano and Bai (2017) Recalibration [2/]	Benjamin and Wright (2013) Recalibration [3/]	Benjamin and Wright (2013) Statistics [4/]
Target statistics						
Pre-restructuring period						
Average public consumption & transfers/GDP ratio (%)	22.5	21.4	24.5	-	-	-
Public investment (std. dev.)/output (std. dev.)	2.70	2.90	-	-	-	-
Public consumption & transfers (std. dev.) / output (std. dev)	-	-	1.38	-	-	-
Restructuring period						
Average output standard deviation ratio (preemptive/post-default) three years since the start [1/]	0.52	0.40	-	-	-	-
Non-target statistics						
Pre-default periods						
Public sector						
Public consumption & transfers (std. dev.)/output (std. dev.)	1.26	1.90	-	1.09	1.05	1.39
Corr.(public consumption & transfers, output)	0.77	0.30	0.91	0.92		
Average public consumption & transfers/GDP ratio (%)	-	-	-	24.6	-	-
Average public investment/GDP ratio (%)	1.31	2.50	-	-	-	-
Average public expenditure/GDP ratio (%)	21.3	23.9	24.5	24.6	-	-
Average public investment/public expenditure ratio (%)	6.2	10.4	-	-	-	-
Fiscal expenditure consolidation	No	No	No	No		
Renegotiation periods						
Public sector						
Public consumption & transfers (std. dev.)/output (std. dev.)	0.99	2.50	-	-	-	-
Corr.(public consumption & transfers, output)	0.97	0.78	-	-	-	-
Average public consumption & transfers/GDP ratio (%)	20.2	21.3	-	-	-	-
Average public investment/GDP ratio (%)	1.19	2.20	-	-	-	-
Average public expenditure/GDP ratio (%)	21.3	23.5	-	-	-	-
Average public investment/public expenditure ratio (%)	5.7	9.3	-	-	-	-
Fiscal expenditure consolidation	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	-	-

(ii) Non-business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring					
	Data	Baseline Model	Cuadra et al. (2010) Recalibration [1/]	Arellano and Bai (2017) Recalibration [2/]	Benjamin and Wright (2013) Recalibration [3/]	Benjamin and Wright (2013) Statistics [4/]
Target statistics						
Pre-default periods						
Default probability (%)	3.50	3.10	-	-	3.11	4.80
Average recovery rate (%)	25.0	-	-	28.0	29.6	45.0
Average debt service/GDP ratio (%)	8.0	-	7.2	7.5	-	-
Bond spreads: average (%)	7.2	7.9	-	7.0	-	-
Bond spreads: std. dev. (%)	3.40	3.50	-	-	-	-
Non-target statistics						
Pre-default periods						
Default probability (%)	3.50	-	3.36	4.30	-	
Average debt/GDP ratio (%)	34.7	55.4	-	-	41.7	80.0
Bond spreads: average (%)	7.2	-	1.50	-	1.10	-
Bond spreads: std. dev. (%)	3.40	-	1.10	8.2	1.98	-
Corr.(debt/GDP, spreads)	0.90	0.20	0.06	0.05	0.23	-
Renegotiation periods						
Restructuring strategy	post-default	post-default	post-default	post-default	post-default	post-default
Average debt/GDP ratio (%)	116.7	78.4	-	-	65.4	85.6
Average restructuring duration (quarters)	14.6	10.0	-	2.00	6.0	16.0
Average recovery rate (%)	25.0	18.0	-	-	-	-

Sources: Datastream, IMF WEO, INDEC and MECON.

[1/] Cuadra et al. (2010) recalibration corresponds to calibration results of one-period (short-term) debt with three target statistics (i) debt service-to-GDP ratio, (ii) ratio between public consumption and transfers and private consumption (output), and (iii) ratio between standard deviation of public consumption and standard deviation of output.

[2/] Arellano and Bai (2017) recalibration corresponds to calibration results with three target statistics (i) average bond spreads, (ii) debt service-to-GDP ratio, and (iii) average recovery rate.

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

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

Table F2: Moment Statistics from Recalibration Results of Previous Studies (Cont.)

Part A: Argentina Default and Post-default Restructuring 2001–05

(iii) Private Sector Business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring					
	Data	Baseline Model	Cuadra et al. (2010) Recalibration [1/]	Arellano and Bai (2017) Recalibration [2/]	Benjamin and Wright (2013) Recalibration [3/]	Benjamin and Wright (2013) Statistics [4/]
Non-target statistics						
Pre-default periods						
Private sector						
Private consumption (std. dev.)/output (std. dev.)	1.11	1.01	1.03	1.02	1.15	1.10
Trade balance/output: std. dev. (%)	1.28	1.58	0.30	0.40	0.50	-
Corr.(trade balance, output)	-0.87	-0.10	-0.57	-0.57	-0.50	-0.23
Renegotiation periods						
Private sector						
Private consumption (std. dev.)/output (std. dev.)	1.17	1.01	-	-	1.00	-
Trade balance/output: std. dev. (%)	0.45	0.00	-	-	0.00	-
Corr.(trade balance, output)	-0.97	0.00	-	-	0.00	-

Sources: Datastream, IMF WEO, INDEC and MECON.

[1/] Cuadra et al. (2010) recalibration corresponds to calibration results with three target statistics (i) debt service-to-GDP ratio, (ii) ratio between public consumption and transfers and private consumption, and (iii) ratio between standard deviation of public consumption and standard deviation of output.
[2/] Arellano and Bai (2017) recalibration corresponds to calibration results with three target statistics (i) average bond spreads, (ii) debt service-to-GDP ratio, and (iii) average recovery rate.
[3/] Benjamin and Wright (2013) recalibration corresponds to calibration results with three target statistics (i) default frequency, (ii) average recovery rate, and (iii) average debtor output deviation during renegotiations.
[4/] Benjamin and Wright (2013) statistics correspond to their moment statistics in calibration results using average emerging market income process and stochastic bargaining power.

Table F2: Moment Statistics from Recalibration Results of Previous Studies (Cont.)

Part B: Uruguay Preemptive Restructuring 2003

(i) Public Sector Business Cycle Statistics

	Uruguay 2003 Preemptive Restructuring		
	Data	Baseline Model	Asonuma and Trebesch (2016) Recalibration [2/] [3/]
Target statistics			
Pre-restructuring period			
Average public consumption & transfers/GDP ratio (%)	19.4	22.2	-
Public investment (std. dev.)/output (std. dev.)	5.8	3.80	-
Restructuring period			
Average output standard deviation ratio (preemptive/post-default) three years since the start [1/]	0.52	0.40	-
Non-target statistics			
Pre-default periods			
Public sector			
Public consumption & transfers (std. dev.)/output (std. dev.)	1.09	1.05	-
Corr.(public consumption & transfers, output)	0.35	0.75	-
Average public consumption & transfers/GDP ratio (%)	19.4	22.2	-
Average public investment/GDP ratio (%)	4.18	3.60	-
Average public expenditure/GDP ratio (%)	23.5	24.1	-
Average public investment/public expenditure ratio (%)	16.9	14.1	-
Fiscal expenditure consolidation	Yes (ex ante)	Yes (ex ante)	-
Renegotiation periods			
Public sector			
Public consumption & transfers (std. dev.)/output (std. dev.)	2.00 [1/]	1.68	-
Corr.(public consumption & transfers, output)	1.00 [1/]	0.49	-
Average public consumption & transfers/GDP ratio (%)	25.2	20.8	-
Average public investment/GDP ratio (%)	3.20	3.40	-
Average public expenditure/GDP ratio (%)	28.4	24.4	-
Average public investment/public expenditure ratio (%)	11.2	12.7	-
Fiscal expenditure consolidation	No	No	-

(ii) Non-business Cycle Statistics

	Uruguay 2003 Preemptive Restructuring		
	Data	Baseline Model	Asonuma and Trebesch (2016) Recalibration [2/]
Target statistics			
Pre-default periods			
Restructuring probability (%)	3.26	3.81	3.65
Average recovery rate (%)	87.1	-	78.5
Bond spreads: average (%)	7.7	7.3	-
Bond spreads: std. dev. (%)	5.1	3.44	-
Restructuring strategy	preemptive	-	preemptive
Non-target statistics			
Pre-default periods			
Average debt/GDP ratio (%)	59.1	57.9	15.0
Bond spreads: average (%)	-	7.7	1.23
Bond spreads: std. dev. (%)	5.1	-	1.30
Corr.(debt/GDP, spreads)	1.00	0.05	0.11
Renegotiation periods			
Restructuring strategy	preemptive	preemptive	-
Average debt/GDP ratio (%)	130.5	82.2	18.4
Average duration of renegotiations (quarters)	1.0	3.8	2.8
Average recovery rate (%)	87.1	93.0	-

Sources: BCU, Datastream and IMF WEO.

[1/] Statistics are based on 2003-04 (standard deviation) and 2002-04 (correlation) in Uruguay.

[2/] Asonuma and Trebesch (2016) recalibration corresponds to calibration results of one-period (short-term) debt with three target statistics (i) restructuring probability, (ii) average recovery rate, and (iii) restructuring strategy.

[3/] Asonuma and Trebesch (2016) assumes no separation between public and private sectors. Therefore, we obtain no moment for public sector business cycle statistics.

Table F2: Moment Statistics from Recalibration Results of Previous Studies (Cont.)

Part B: Uruguay Preemptive Restructuring 2003

(iii) Private Sector Business Cycle Statistics

	Uruguay 2003		
	Data	Baseline Model	Asonuma and Trebesch (2016) Recalibration [2/] [3/]
Non-target statistics			
Pre-default periods			
Private sector			
Private consumption (std. dev.)/output (std. dev.)	1.09	1.01	1.04
Trade balance/output: std. dev. (%)	0.39	1.50	0.10
Corr.(trade balance, output)	-0.87	-0.12	-0.05
Renegotiation periods			
Private sector			
Private consumption (std. dev.)/output (std. dev.)	0.87 [1/]	1.01	-
Trade balance/output: std. dev. (%)	0.02 [1/]	0.00	-
Corr.(trade balance, output)	-0.64 [1/]	0.00	-

Sources: BCU.
[1/] Statistics are based on 2003-04 (standard deviation) and 2002-04 (correlation) in Uruguay.
[2/] Asonuma and Trebesch (2016) recalibration corresponds to calibration results with three target statistics (i) restructuring probability, (ii) average recovery rate, and (iii) restructuring strategy.
[3/] Since average restructuring duration is only 1 quarter, we do not obtain moment statistics for standard deviation and correlation during renegotiation periods.

F.3 Comparison with Models of Only a Post-default Restructuring, Exogenous Public Capital and Endogenous Aggregate Capital

Table F3: Moment Statistics from Simulation Results in Models of Public Capital and Aggregate Capital

Part A: Argentina Default and Post-default Restructuring 2001–05

(i) Public Sector Business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring				
	Data	Baseline Model	Only a post default restructuring [1/]	Exogenous Public capital [2/]	Endogenous Aggregate capital [3/]
Target statistics					
Pre-restructuring period					
Average public consumption & transfers/GDP ratio (%)	22.5	21.4	21.3	21.5	-
Public investment (std. dev.)/output (std. dev.)	2.70	2.90	2.55	-	-
Restructuring period					
Average output standard deviation ratio (preemptive/post-default) three years since the start [1/]	0.52	0.40	-	-	-
Non-target statistics					
Pre-default periods					
Public sector					
Public consumption & transfers (std. dev.)/output (std. dev.)	1.26	1.90	0.80	2.50	
Corr.(public consumption & transfers, output)	0.77	0.30	0.85	0.10	
Average public consumption & transfers/GDP ratio (%)	22.5	-	-	-	-
Average public investment/GDP ratio (%)	1.31	2.50	2.20	1.83	-
Average public expenditure/GDP ratio (%)	21.3	23.9	23.5	23.2	-
Average public investment/public expenditure ratio (%)	6.2	10.4	9.3	7.9	-
Fiscal expenditure consolidation	No	No	No	No	
Renegotiation periods					
Public sector					
Public consumption & transfers (std. dev.)/output (std. dev.)	0.99	2.50	1.12	-	-
Corr.(public consumption & transfers, output)	0.97	0.78	0.09	0.90	-
Average public consumption & transfers/GDP ratio (%)	20.2	21.3	22.7	21.6	-
Average public investment/GDP ratio (%)	1.19	2.20	1.90	2.05	-
Average public expenditure/GDP ratio (%)	21.3	23.5	24.6	23.6	-
Average public investment/public expenditure ratio (%)	5.7	9.3	7.7	8.6	-
Fiscal expenditure consolidation	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	-

(ii) Non-business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring				
	Data	Baseline Model	Only a post default restructuring [1/]	Exogenous Public capital [2/]	Endogenous Aggregate capital [3/]
Target statistics					
Pre-restructuring period					
Default probability (%)	3.50	3.10	2.30	2.30	5.0
Bond spreads: average (%)	7.2	7.9	14.0	7.43	8.9
Bond spreads: std. dev. (%)	3.40	3.50	16.5	2.55	5.72
Non-target statistics					
Pre-restructuring period					
Average debt/GDP ratio (%)	34.7	55.5	66.8	61.0	89.0
Corr.(debt/GDP, spreads)	0.90	0.20	0.15	0.31	0.25
Restructuring period					
Restructuring strategy	post-default	post-default	post-default	preemptive	post-default
Average debt/GDP ratio (%)	116.7	78.4	90.2	96.2	92.0
Average recovery rate (%)	25.0	18.0	16.0	17.5	77.6
Restructuring duration (quarters)	14.6	10.0	9.5	2.80	4.00
Average public investment recovery (quarterly) from t-1 to pre-restructuring level	12.0	9.1	9.1	0.00	-

Sources: Datastream, IMF WEO, INDEC and MECON.
1/ Model with only a post-default restructuring corresponds to our baseline model (with the same parameter values) in which there is no preemptive restructuring choice.
2/ Model with exogenous public capital corresponds to our baseline model of public capital (with the same parameter values) in which public capital is exogenously fixed at the mean level.
3/ Model with endogenous aggregate capital corresponds to our baseline model (with the same parameter values) in which the aggregate capital income share is assigned and there is no distortionary taxation (and lump-sum taxation).

Table F3: Moment Statistics from Simulation Results in Models of Public Capital and Aggregate Capital (Cont.)

Part A: Argentina Default and Post-default Restructuring 2001–05

(iii) Private Sector Business Cycle Statistics

	Argentine 2001-05 Post-default Restructuring				
	Data	Baseline Model	Only a post default restructuring [1/]	Exogenous Public capital [2/]	Endogenous Aggregate capital [3/]
Non-target statistics					
Pre-restructuring period					
Private sector					
Private consumption (std. dev.)/output (std. dev.)	1.11	1.01	1.00	1.00	1.89
Trade balance/output: std. dev. (%)	1.28	1.58	0.30	0.35	1.37
Corr.(trade balance, output)	-0.87	-0.10	-0.15	-0.12	-0.07
Restructuring period					
Private sector					
Private consumption (std. dev.)/output (std. dev.)	1.17	1.01	1.01	1.00	1.30
Trade balance/output: std. dev. (%)	0.45	0.00	0.00	0.00	0.00
Corr.(trade balance, output)	-0.97	0.00	0.00	0.00	0.00

Sources: INDEC and MECON.
Notes: 1/ Model with only a post-default restructuring corresponds to our baseline model (with the same parameter values) in which there is no preemptive restructuring choice.
2/ Model with exogenous public capital corresponds to our baseline model of public capital (with the same parameter values) in which public capital is exogenously fixed at the mean level.
3/ Model with endogenous aggregate capital corresponds to our baseline model (with the same parameter values) in which the aggregate capital income share is assigned and there is no distortionary taxation (and lump-sum taxation).

Table F3: Moment Statistics from Simulation Results in Models of Public Capital and Aggregate Capital (Cont.)

Part B: Uruguay Preemptive Restructuring 2003 [1/]

(i) Public Sector Business Cycle Statistics

	Uruguay 2003 Preemptive Restructuring		
	Data	Baseline Model	Exogenous Public Capital [2/]
Target statistics			
Pre-restructuring period			
Average public consumption & transfer/GDP ratio (%)	19.4	22.2	21.6
Public investment (std. dev.)/output (std. dev.)	5.8	3.80	-
Restructuring period			
Average output standard deviation ratio (preemptive/post-default) three years since the start [1/]	0.52	0.40	-
Non-target statistics			
Pre-default periods			
Public sector			
Public consumption & transfers (std. dev.)/output (std. dev.)	1.09	1.05	2.25
Corr.(public consumption & transfers, output)	0.35	0.75	0.55
Average public consumption & transfers/GDP ratio (%)	19.4	-	-
Average public investment/GDP ratio (%)	4.18	3.60	2.80
Average public expenditure/GDP ratio (%)	23.5	25.8	24.4
Average public investment/public expenditure ratio (%)	16.9	14.1	11.4
Fiscal expenditure consolidation	Yes (ex ante)	Yes (ex ante)	No
Renegotiation periods			
Public sector			
Public consumption & transfers (std. dev.)/output (std. dev.)	2.0 [3/]	1.68	2.50
Corr.(public consumption & transfers, output)	1.0 [3/]	0.49	0.50
Average public consumption & transfers/GDP ratio (%)	25.2	20.8	20.6
Average public investment/GDP ratio (%)	3.20	3.40	3.20
Average public expenditure/GDP ratio (%)	28.4	24.2	23.8
Average public investment/public expenditure ratio (%)	11.2	13.9	13.4
Fiscal expenditure consolidation	No	No	Yes (ex post)

(ii) Non-business Cycle Statistics

	Uruguay 2003 Preemptive Restructuring		
	Data	Baseline Model	Exogenous Public Capital [2/]
Target statistics			
Pre-restructuring period			
Default probability (%)	3.26	3.81	2.10
Bond spreads: average (%)	7.7	7.3	5.50
Bond spreads: std. dev. (%)	5.1	3.44	2.89
Non-target statistics			
Pre-restructuring period			
Average debt/GDP ratio (%)	59.1	57.9	44.5
Corr.(debt/GDP, spreads)	1.00	0.05	0.25
Restructuring period			
Restructuring strategy	preemptive	preemptive	preemptive
Average debt/GDP ratio (%)	130.5	82.2	50.2
Average recovery rate (%)	87.1	93.0	60.0
Restructuring duration (quarters)	1.00	3.80	2.20
Average public investment recovery (quarterly) from t-1 to pre-restructuring level	10.3	6.5	0.00

Sources: BCU, Datastream and IMF WEO.
1/ Neither a model of only a post-default restructuring nor a model of endogenous aggregate capital replicates a preemptive restructuring.
2/ Model with exogenous public capital corresponds to our baseline model of public capital (with the same parameter values) in which public capital is exogenously fixed at the mean level.
3/ Statistics are based on 2003-04 (standard deviation) and 2002-04 (correlation) in Uruguay.

Table F3: Moment Statistics from Simulation Results in Models of Public Capital and Aggregate Capital (Cont.)

Part B: Uruguay Preemptive Restructuring 2003 [1/]

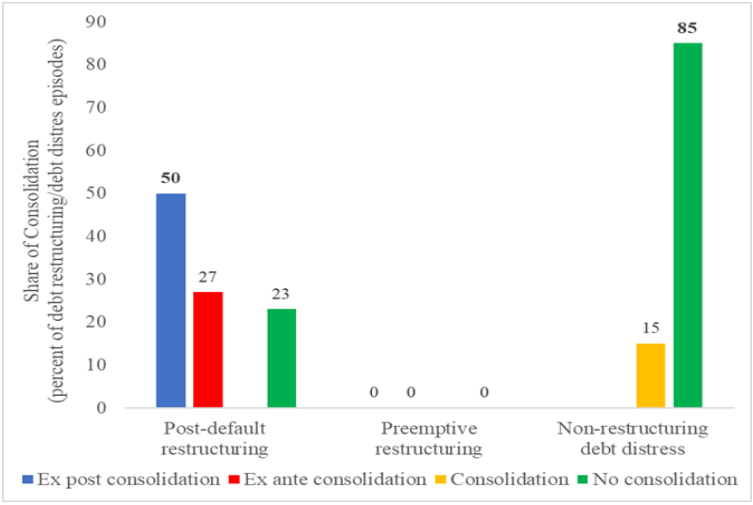
(iii) Private Sector Business Cycle Statistics

	Uruguay 2003 Preemptive Restructuring		
	Data	Baseline Model	Exogenous Public Capital [2/]
Pre-restructuring period			
Non-target statistics			
Private sector			
Private consumption (std. dev.)/output (std. dev.)	1.09	1.01	1.00
Trade balance/output: std. dev. (%)	0.39	1.50	0.40
Corr.(trade balance, output)	-0.87	-0.12	-0.10
Restructuring period			
Private sector			
Private consumption (std. dev.)/output (std. dev.)	0.87 [3/]	1.01	1.00
Trade balance/output: std. dev. (%)	0.02 [3/]	0.00	0.00
Corr.(trade balance, output)	-0.64 [3/]	0.00	0.00

Sources: BCU.
1/ Neither a model of only a post-default restructuring nor a model of endogenous aggregate capital replicates a preemptive restructuring.
2/ Model with exogenous public capital corresponds to our baseline model of public capital (with the same parameter values) in which public capital is exogenously fixed at the mean level.
3/ Statistics are based on 2003-04 (standard deviation) and 2002-04 (correlation) in Uruguay.

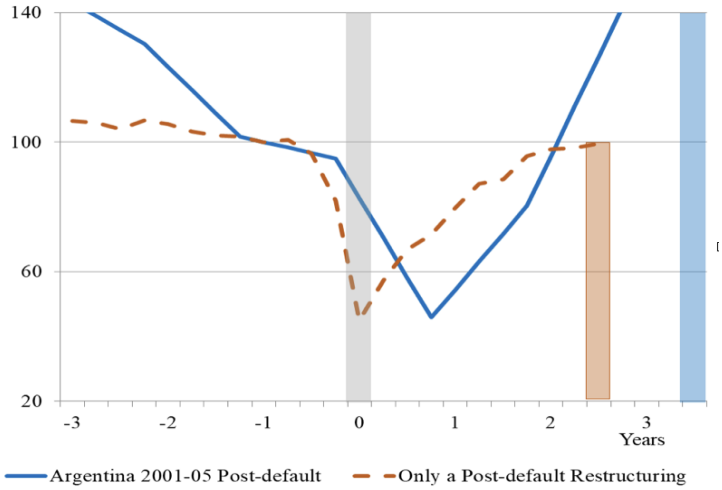
Figure F2: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings, Public Investment, and Public Consumption and Transfers in Model of Only a Post-default restructuring

(i) Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings



(ii) Public Investment around Debt Restructurings (Level) [1/]

(a) Post-default Restructuring (Argentina 2001–05)

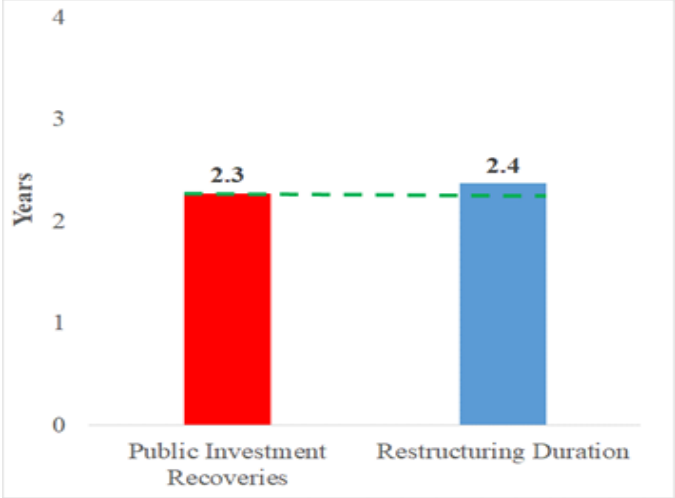


1/ In the model of only a post-default restructuring, there is no preemptive restructuring choice.

Figure F2: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings, Public Investment, and Public Consumption and Transfers in Model of Only a Post-default restructuring (Cont)

(iii) Recoveries in Public Investment and Restructuring Duration

(a) Post-default Restructuring (Argentina 2001–05)



(iv) Public Consumption and Transfers around Debt Restructurings (Level)

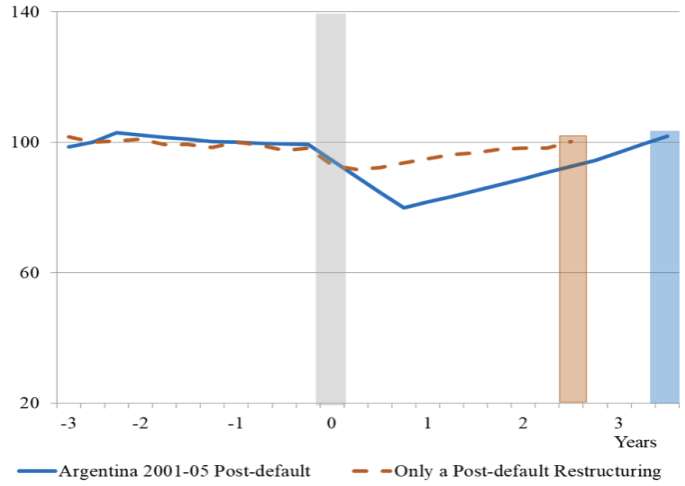
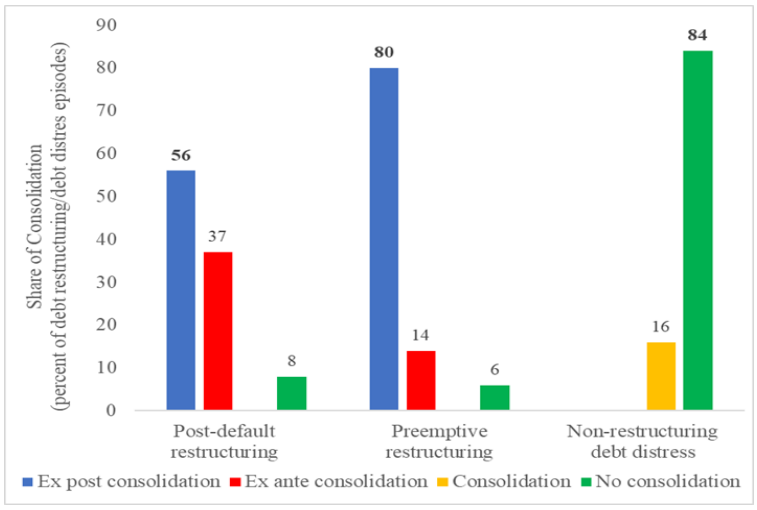


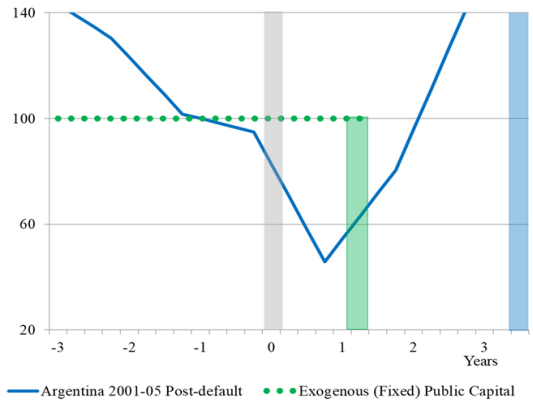
Figure F3: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings, Public Investment, and Public Consumption and Transfers in Model of Exogenous Public Capital

(i) Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings



(ii) Public Investment around Debt Restructurings (Level)

(a) Post-default Restructuring (Argentina 2001–05)



(b) Preemptive Restructuring (Uruguay 2003)

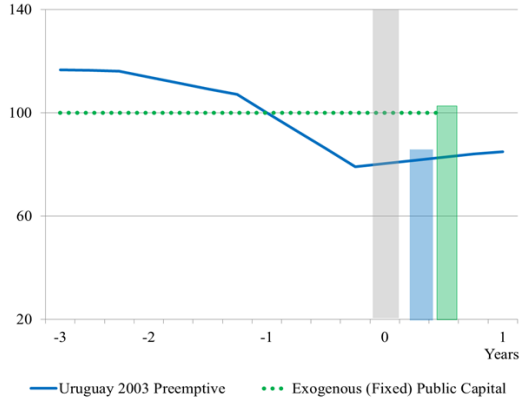
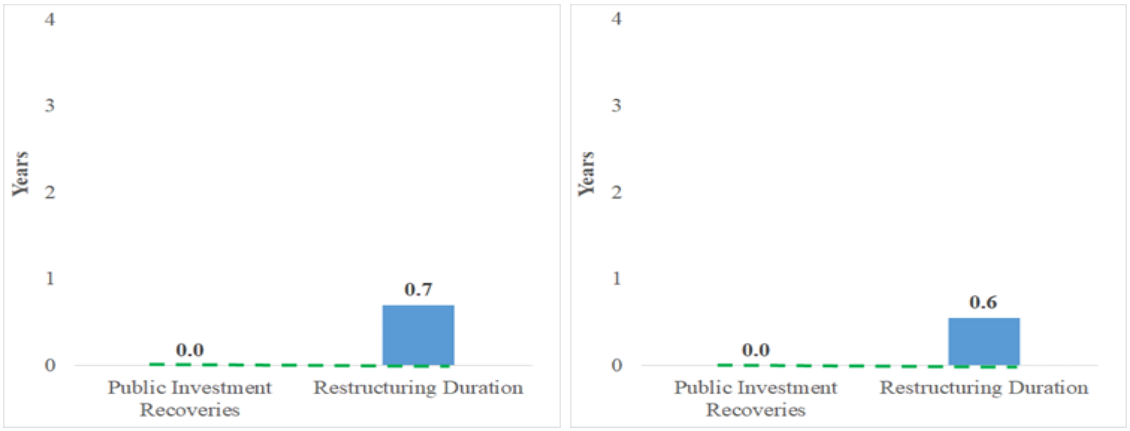


Figure F3: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings, Public Investment, and Public Consumption and Transfers in Model of Exogenous Public Capital

(iii) Public Investment Recoveries and Restructuring Duration

(a) Post-default Restructuring (Argentina 2001–05) (b) Preemptive Restructuring (Uruguay 2003)



(iv) Public Consumption and Transfers around Debt Restructurings (Level)

(a) Post-default Restructuring (Argentina 2001–05) (b) Preemptive Restructuring (Uruguay 2003)

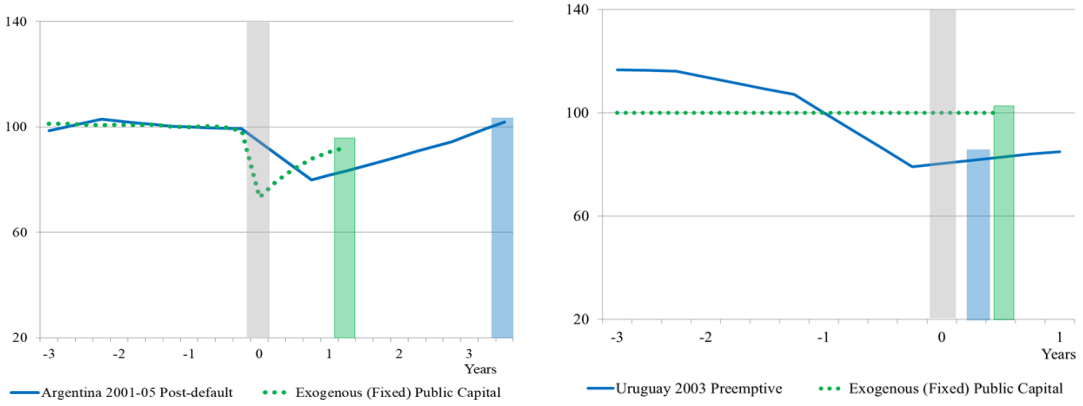
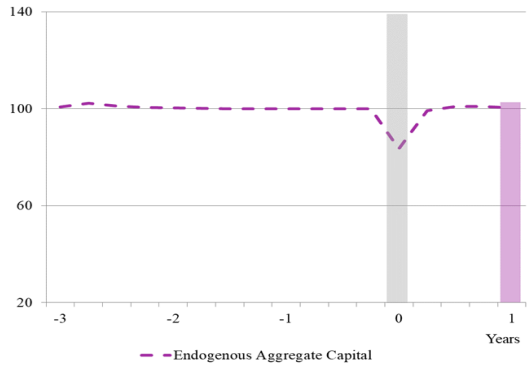


Figure F4: Choice of Fiscal Expenditure Consolidation and Sovereign Debt Restructurings, Public Investment, and Public Consumption and Transfers in Model of Endogenous Aggregate Capital [1/]

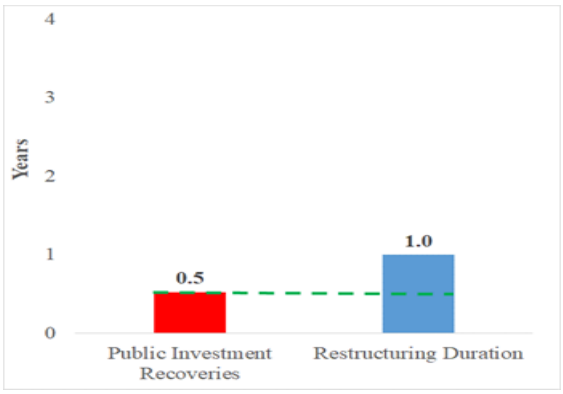
(ii) Public Investment around Debt Restructurings (Level) [2/]

(a) Post-default Restructuring (Argentina 2001–05)

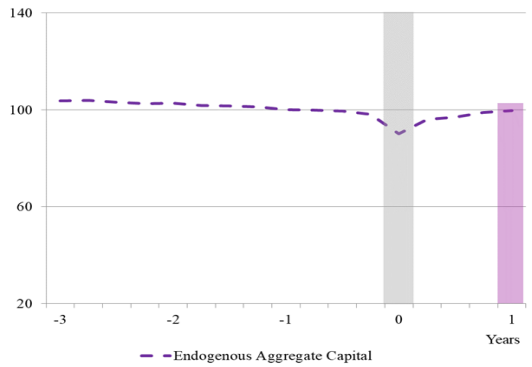


(iii) Public Investment Recoveries and Restructuring Duration [2/]

(a) Post-default Restructuring (Argentina 2001–05)



(iv) Public Consumption and Transfers around Debt Restructurings (Level)



1/ There is no "fiscal" expenditure consolidation, but "aggregate" consolidation in the model of endogenous aggregate capital.
2/ In the model of endogenous aggregate capital, there is no much preemptive restructuring choice (i.e., a very rare event).

F.4 Robustness check

Table F4: Sensitivity Analysis: Argentina Post-default Restructuring 2001–05

	Adjustment Costs			Depreciation Rate			Risk Aversion		
	5	10	15	0.025	0.04	0.075	2	3	4
Target statistics									
Pre-restructuring period									
Average public consumption & transfers/GDP ratio (%)	22.0	21.4	22.0	21.1	21.4	20.8	20.5	21.4	21.7
Public investment (std. dev.)/output (std. dev.)	5.1	2.90	2.20	3.10	2.90	3.00	2.55	2.90	3.10
Restructuring period									
Average output standard deviation ratio (preemptive/post-default)	0.30	0.40	0.40	0.42	0.40	0.50	0.42	0.40	0.55
Non-target statistics									
Pre-restructuring period									
Public sector									
Public consumption & transfers (std. dev.)/output (std. dev.)	1.78	1.90	1.92	2.00	1.90	2.25	2.40	1.90	1.65
Corr.(public consumption & transfers, output)	0.35	0.30	0.50	0.32	0.30	0.45	0.40	0.30	0.25
Average public investment/GDP ratio (%)	2.83	2.50	2.70	2.20	2.50	3.20	2.60	2.50	2.21
Average public expenditure/GDP ratio (%)	24.6	23.9	24.7	23.3	23.9	24.1	23.1	23.9	23.9
Average public investment/public expenditure ratio (%)	11.5	10.4	10.9	9.4	10.4	13.3	11.2	10.4	9.2
Fiscal expenditure consolidation	No	No	No	No	No	No	No	No	No
Restructuring period									
Public sector									
Public consumption & transfers (std. dev.)/output (std. dev.)	2.40	2.50	2.61	2.80	2.50	3.10	2.90	2.50	2.15
Corr.(public consumption & transfers, output)	0.75	0.78	0.53	0.75	0.78	0.82	0.79	0.78	0.70
Average public consumption & transfers/GDP ratio (%)	21.4	21.3	22.1	20.6	21.3	20.5	20.8	21.3	21.5
Average public investment/GDP ratio (%)	2.30	2.20	2.62	1.90	2.20	3.00	2.45	2.20	1.90
Average public expenditure/GDP ratio (%)	23.1	23.5	24.7	22.5	23.5	23.5	23.3	23.5	23.4
Average public investment/public expenditure ratio (%)	10.0	9.3	10.6	8.4	9.3	12.7	10.5	9.3	8.1
Fiscal expenditure consolidation	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)	Yes (ex post)

Source: Authors' computation

Table F4 shows robustness checks on our key parameter values for Argentina default/post-default restructuring in 2001–05. We only change one specific parameter value leaving other parameter values unchanged, and see how non-target statistics are affected. When adjustment costs on public capital are lower, public investment becomes more volatile because the sovereign accumulates and reduces public capital more frequently due to lower adjustment costs.

When depreciation rate is lower, average public investment becomes lower in both pre-restructuring and restructuring periods. The sovereign only needs to spend less on public investment. When the sovereign is more risk averse, it opts to spend more public consumption and transfers and reduce the volatility of public consumption and transfers. As a result, it reduces average public investment and makes public investment more volatile.