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Abstract

Increasing international flows of goods, services, and financial assets have been shown to increase a country's welfare through various channels. This paper studies the interaction between a country's welfare gains from international trade and its sovereign's access to bond markets. We do so by incorporating a sovereign bond market into a simple Armington (1969)'s trade model. While standard trade models suggest surprisingly small gains from trade, our model implies that introducing channels through a sovereign bond market greatly magnifies the gains from trade.

Key Words: Gains from trade, Sovereign debt, Sovereign default, Trade openness, Terms of trade
JEL codes: E16, F14, F60, O19

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1 Introduction

Globalization has two aspects — international trade in goods and services, and international capital mobility. Previous studies have found either of these types of globalization benefits a country. Trade in goods and services leads to greater welfare through, for example, cross-industry or within-industry resource reallocation, increased variety of products, and reduction of consumer prices (e.g., Costinot and Rodríguez-Clare, 2014; and Feenstra, 2018b).[1] Financial integration enhances cross-sectional and intertemporal allocative efficiency, increases international risk sharing, and leads to faster growth and higher standards of living (e.g., Coeurdacier et al., 2018; and Schularick and Steger, 2010).[2]

While previous studies have investigated the effect of international trade or financial integration independently, interactions between the two types of integration have received little attention. The goal of this paper is to improve our understanding on how these two types of globalization interact to shape gains from integration by focusing on international trade and an access to a sovereign bond market. This is an empirically relevant question because the share of world trade to world GDP increased from 38 percent to 54 percent from 1990 to 2016 according to the *World Development Indicators* (World Bank, 2018b). We also observe substantial amount of trade in debt — the median share of external debt stock in GNI is 41 percent in 2016 (World Bank, 2018b).

This paper makes a simple point. As documented in previous empirical works, a loss in endowment caused by a default reduces the sovereign's trade with a foreign country.[3] If a country experiences trade disruption upon default, then one may reasonably think that, all other things being equal, a more open country is less likely to default. If this is the case, a more open sovereign faces a higher price in its bond market, since the bonds are safer for the investors. As a result, an open country receives additional gains from trade stemming from a sovereign bond market.

These mechanisms are rigorously shown using a simple Armington (1969) two-country trade model featuring endogenous sovereign default in incomplete bond markets, following Eaton and Gersovitz (1981), Aguiar and Gopinath (2006), and Arellano (2008). We introduce a one-period sovereign bond that is not state contingent and is subject to limited commitment. The sovereign has an option to default and not pay back its debt at each period, which incurs an exogenous reduction in the endowment. Therefore, a sovereign's incentive to default varies substantially depending on how integrated the country is to the international trade market in which countries trade their endowments.

There are two effects working in different directions to determine a sovereign's incentive to default. First, a destruction of a country's endowment due to a default reduces the two countries' consumption.

[1] Classical gains from trade come from increasing production efficiency according to countries' comparative advantages (David Ricardo; Eaton and Kortum, 2003). Armington (1969) and Krugman (1980) introduce the Dixit-Stigliz preferences, therefore gains from increased variety of consumption goods. Costinot and Rodríguez-Clare (2014) provide a survey of quantitative work on the welfare consequence of international trade. Feenstra (2018b) also discusses a recent literature on sources of gains from trade.

[2] Coeurdacier et al. (2018) consider benefits from financial integration in a two-country neoclassical growth model, which incorporates gains from allocative efficiency and international risk-sharing. Schularick and Steger (2010) investigate the effect of financial integration in the first era of globalization (1880-1914) and find that an increase in capital flows across countries led to higher growth of real GDP per capita.

[3] Gopinath and Neiman (2014) document that imports of Argentina collapsed in the wake of its default from 2000 to 2002. Studying samples of defaults of over 150 countries, Rose (2005) finds that trade declines persistently when a sovereign defaults. Other empirical studies on the impact of defaults on trade flows include Martinez and Sandleris (2011), Zymek (2012), and Asonuma et al. (2016).

We call this the endowment effect and it works to reduce the sovereign's inventive to default. On the other hand, there is a positive terms of trade effect arising from a loss of endowment. A fewer supply of goods from the defaulted country increases the relative price of the home good, which works to increase the defaulted country's welfare.[4] This effect becomes large if the country is larger in terms of size, and mitigates the consumption loss upon default. We demonstrate that under reasonable parameters the former effect dominates the latter, implying that the costs of default are larger under free trade than in autarky. As a result, as the country opens up to international trade, higher costs of default lead to a higher bond price, enabling the sovereign to borrow more.

Therefore, trade openness reduces the sovereign's incentive to default, leading to a lower interest rate charged by the foreign creditors and a higher price of its bond. These mechanisms work to increase a country's gains from trade, because by having access to a sovereign bond market, a greater level of openness makes the country more credible to repay its debt, making it possible to borrow more, leading to a greater level of present value consumption and welfare. We emphasize these channels as a new source of gains from trade.

Previous empirical evidence is consistent with our model's predictions. Rose and Spiegel (2004) investigate the link between bond prices and trade volumes to understand whether countries repay their debt out of the fear that default might lead to trade disruption. They find a positive correlation between trade volumes and the claims of sovereign bonds by the creditor country, when they looked at bilateral trade and international banking claims from 20 creditor and 149 debtor countries in 1986-1999 period. Moreover, Manasse and Roubini (2009) employ a panel dataset of 47 countries from the period 1970-2002 and find that a lower trade openness is one of the main predictors of sovereign debt crises. These previous empirical results seem to suggest that sovereigns have more to lose upon default, when they become more open to trade. Furthermore, an empirical result in Edwards (2004) is consistent with our theoretical result that the terms of trade effect dominates in a large country.[5]

We also conduct empirical analyses to confirm our model's predictions. By using a panel dataset of 144 countries between 1970 and 2013, we find that countries that were more open in 1970 had a fewer number of defaults than less open countries during the sample period. Furthermore, results suggest that an increase in a country's openness reduces the bond's interest rate and the probability of default as consistent with the theory. We also investigate how these openness effects vary depending on the country size measured by GDP. The model suggests that the terms of trade effect is larger for a large country, meaning that larger countries have less to benefit from the interaction of international goods trade and the sovereign bond market. As consistent with the model, the openness effects are greater for small countries than for large countries. These empirical results imply that the model's underlying mechanisms leading to gains from trade are indeed present in reality.

Lastly, we perform a numerical exercise by calibrating the model to quantify the gains from trade. As is conventional in the debt literature, we employ the case of Argentina for this numerical exercise.[6] It also introduces China as a foreign country because Argentina's trade with China have increased substantially

[4] Our model does not include the exchange rates. Therefore, a change in terms of trade only comes from changes in supply and demand of goods.

[5] Kennan and Riezman (1988) also theoretically studies the relationship between the size of a country and the terms of trade effect in the context of the impact of imposing tariffs.

[6] For example, see Arellano (2008), Aguiar and Gopinath (2006), Yue (2010), Asonuma (2014), and Asonuma (2016).

after China's accession to the World Trade Organization in 2001, which is similar to our theoretical considerations comparing the state of autarky with the one under free trade. These countries serve as an excellent case study to quantify the gains from trade. Results imply substantial additional gains from trade when a sovereign has access to a bond market — gains from trade become three percentage points greater with a sovereign bond market.

This paper contributes to the literature on model-based estimation of gains from trade. An influential paper by Arkolakis et al. (2012) shows that, in a large class of trade models, gains from trade are fully described by a couple of statistics — share of home spending on its domestic products and elasticity of trade with respect to variable trade costs.[7] They show that the "new" trade model of heterogeneous firms and its extensions lead to the exact same value of gains from trade as the traditional trade model. Moreover, by applying their simple formula, they show that gains from trade for the U.S. are between 0.7 to 1.4 percent, surprisingly smaller than our intuition.

This led to a search for a realistic value of gains from trade by introducing additional channels through which trade affects a country's welfare.[8] For example, Caliendo and Parro (2015), Melitz and Redding (2014), and Chaney and Ossa (2013) emphasize the importance of introducing input-output linkages or multiple production stages in amplifying gains from trade. Other studies show that a finite upper bound for firm productivity distribution implies greater gains from trade because it makes trade elasticities to differ across markets and trade costs (Melitz and Redding, 2015) and it restores pro-competitive effects of trade (Feenstra, 2018a). Ossa (2015) proposes a model with multiple sectors and shows that sectoral differences in trade elasticities significantly magnifies gains from trade. Ramanarayanan (2018) adds firms' decisions to import intermediate goods from abroad and shows that this extra channel implies greater gains from trade.

This paper stands in this literature on searching for gains from trade. Although these prior studies employ either a monopolistic competition model of trade (Krugman, 1980; Melitz, 2003; and Chaney, 2008) or a perfect competition model (Eaton and Kortum, 2003), we revert to Armington (1969)'s model where gains from trade come from increased variety of products only. We consider a novel channel through which a country gains from trade. We incorporate a sovereign bond market in this simple model and show that interactions between the goods market and the sovereign bond market greatly magnifies gains from trade.

Speaking from the trade literature, we are not the first to consider international trade and financial markets jointly. Prior articles investigate how development of financial markets affects trade flows (Manova, 2013), capital flows (Antràs and Caballero, 2009; Matsuyama, 2005), and comparative advantage (Beck, 2003). However, Manova (2013) and Beck (2003) focus on a *domestic* financial market and they do not consider *international* flows of capital. Antràs and Caballero (2009) and Matsuyama (2005) consider foreign direct investment or foreign portfolio investment and they are silent about international capital flows through a sovereign bond market. One exception is Kletzer and Bardhan (1987) where they examine how cross-country differences in sovereign risk shape patterns of trade using a model with

[7] The class of trade models include Armington (1969), Krugman (1980), Melitz (2003), Chaney (2008), and Eaton and Kortum (2003) where these models feature four micro-level assumptions as well as three macro-level restrictions they summarize.

[8] Again, see Costinot and Rodríguez-Clare (2014) and Feenstra (2018b) for a summary of the literature on gains from trade.

incomplete information.

Speaking from the sovereign debt literature, there is a number of prior studies incorporating international trade in a model of sovereign debt (e.g., Mendoza and Yue, 2012; Cuadra and Sapriza, 2006; Asonuma, 2014; and Gu, 2018). For example, Cuadra and Sapriza (2006) explore the impact of trade openness and terms of trade shocks on a sovereign's incentive to default or repay. While they also focus on the terms of trade effect, their mechanism differs from ours. In their model, an exogenously given terms of trade deterioration triggers a decline in output, leading to a smaller incentive to raise taxes to repay its debt, resulting in a default. Asonuma (2014) and Gu (2018) also propose models to study mechanisms a sovereign default leads to a real exchange rate depreciation and an income loss. Our focus is crucially different from these prior studies. This paper investigates how the interactions between a sovereign bond market and international trade generate additional gains from trade while none of these prior studies focuses on this.

The remainder of this paper is organized as follows. Section 2 presents a simple two period model where a sovereign issues bonds, describing two effects working in different directions to determine the sovereign's default costs. We empirically test the model's theoretical predictions in Section 3. Section 4 provides numerical results. Concluding remarks are in Section 5.

2 Simple two period model

2.1 A closed economy

We start from constructing a two period model with a single endowment economy issuing one period defaultable bonds. The setup follows that of Arellano (2008) except that the model presented in this section has two periods only.

2.1.1 The sovereign

Consider a closed endowment economy with two periods, where a benevolent sovereign maximizes the expected utility of the representative household. The representative household's expected utility in the first period is

$$\mathbb{E}_1 [U] = \frac{C_1^{1-\epsilon}}{1-\epsilon} + \beta \mathbb{E}_1 \left[\frac{C_2^{1-\epsilon}}{1-\epsilon} \right], \tag{1}$$

where β is the discount factor, and ϵ governs intertemporal substitution. In the first period, the household has an endowment of Y_1 and the sovereign agrees with foreign investors on a contract (L, D). A contract (L, D) lets the sovereign borrow L units of consumption goods from risk neutral foreign investors in period one, by promising that it will repay D units of consumption goods in the second period. The implied price of the bond will be $q = L/D$ and gross interest rate $1/q$. In the second period, endowment Y_2 is realized: $Y_2 = \alpha + \varepsilon$, where $\varepsilon \in [-\alpha, \infty]$ is an i.i.d. random variable with a cumulative distribution function denoted as $F(\cdot)$.

Consumption in the first period is $C_1 = Y_1 + L$. In the second period, the sovereign decides either to repay or to default after observing a realized level of endowment. If it decides to repay, the sovereign

will repay D as promised. If it decides to default, the sovereign does not have to repay D but it incurs a loss of a fraction θ of its endowment.[9] One way to interpret this is that a default disrupts the domestic financial sector, by reducing banks' wealth and by reducing banks' access to liquid assets. Previous studies including Perez (2015), Borensztein and Panizza (2009), Brutti (2011), and Asonuma et al. (2018) show that a country's default leads to a substantial decline in domestic production due to a disruption of its domestic financial sector.

Therefore, the level of consumption at the second period becomes $C_2 = \max\{Y_2 - D,\ (1-\theta)Y_2\}$. The sovereign chooses to default if costs of default are smaller than costs of repaying, $\theta Y_2 < D$. Thus, given D at period 1, the probability of default becomes $F(\varepsilon^*)$ where

$$\varepsilon^* = D/\theta - \alpha. \tag{2}$$

2.1.2 Foreign creditors

There are many atomistic risk neutral foreign investors making transactions with the sovereign. They face a world risk free interest rate of $1+r$, and make zero profits. We focus on the representative investor, who takes the price q as given and maximizes its expected consumption by choosing how much to demand credit, D. Therefore, the investor's problem is

$$\max_D \left(-L + \frac{1}{1+r} D(1 - F(\varepsilon^*)) \right).$$

From the zero profit condition, the implied price for the sovereign bond becomes:

$$q = \frac{L}{D} = \frac{1 - F(\varepsilon^*)}{1+r}. \tag{3}$$

2.1.3 Equilibrium

Given $F(\cdot)$, equations (2) and (3) determine demanded repayment amount D, prices $q = L/D$, and the probability of default $F(\varepsilon^*)$ for each L that the sovereign demands in the first period. As shown in Calvo (2014), there are multiple equilibria. The foreign investor can offer two schedules of demanded repayment $\{D_{\text{low}}(L),\ D_{\text{high}}(L)\}$ — the first is with a higher bond price and a lower probability of default and the second is with a lower bond price and a higher probability of default.

Following Calvo (2014), we assume that faced with multiple viable price-debt pairs, the sovereign chooses the lower level of debt.[10] The sovereign takes only the schedule $D_{\text{low}}(L)$ as given, and chooses the L that maximizes its expected present value utility. Risk aversion of the sovereign makes the optimal L to be such that the sovereign smooths its consumption over the two periods, by equating marginal utility of consumption in the first period with expected marginal utility in the repayment states in the second period.

[9] The assumption of proportional endowment loss is key. Having a constant fraction enables us to highlight our main channels when comparing welfare between free trade and autarky.

[10] For example, Arellano (2008) and Stangebye (2016) make similar assumptions.

2.2 An open economy

This section introduces a foreign country to investigate interactions between international trade and the sovereign bond market. The two countries engage in (costly) trade where they incur an arbitrage value of iceberg trade costs $\tau \geq 1$. The state of autarky corresponds to $\tau = +\infty$ and $\tau = 1$ means free trade.

The model consists of two periods where two countries trade goods in both periods. Each of the two countries is endowed with a single tradable intermediate good. Y_t and Y_t^* denote endowments of home and foreign countries in period $t \in \{1, 2\}$. There are foreign investors who reside in a third country or the rest of the world.[11] They lend to the home country, which we call the sovereign.

In the first period, endowments in the two countries $\{Y_1, Y_1^*\}$ are realized. Trade takes place and each country produces a final consumption good using domestic intermediate goods and imported inputs. As a result, a final consumption good is a function of these intermediate goods, $\{c(Y_1, Y_1^*), c^*(Y_1, Y_1^*)\}$. Then the sovereign agrees on a contract of (L, D) with the foreign investors. The bonds are denominated by the final good of the sovereign. Therefore, final consumptions of the two countries at the end of the first period are

$$\begin{cases} C_1 &= c(Y_1, Y_1^*) + L \\ C_1^* &= c^*(Y_1, Y_1^*), \end{cases}$$

where lower case c's denote "pre-transfer" consumption, the amount of final goods of the countries as a result of intermediate good trade; upper case C's indicate consumptions after the sovereign interacts with the investors.

Outputs in the second period $\{Y_2, Y_2^*\}$ are realized in the beginning of the second period. Then the sovereign decides to default or not. If the sovereign repays, its final consumption would be the pre-transfer consumption minus the promised amount D. If the sovereign defaults, a fraction θ of the country's endowment of intermediate goods are destroyed in exchange of relieved of its obligation to repay its debt. As a result, if the sovereign repays, the countries' final consumptions are

$$\begin{cases} C_2 &= c(Y_2, Y_2^*) - D \\ C_2^* &= c^*(Y_2, Y_2^*). \end{cases}$$

On the other hand, if the sovereign defaults, these are

$$\begin{cases} C_2 &= c((1-\theta)Y_2, Y_2^*) \\ C_2^* &= c^*((1-\theta)Y_2, Y_2^*). \end{cases}$$

[11] This simplifying assumption comes from the fact that, in reality, a country's debt is owned by investors in many different countries and a large share of foreign investors comes from countries besides its largest trading partner. For example, in the United States as of 2018, the largest shares of foreign U.S. treasury bill owners come from China (19%), Japan (17%), and Brazil (5%), and other 65 different countries as a whole own 43.56% of foreign-owned U.S. treasury bills (U.S. Department of the Treasury, 2018). In the case of Greece, as of 2015, largest twelve private and official creditors own 267.5 euros of credits to Greece. The largest share comes from Germany (25%), France (16%), and Italy (14%) according to Singh (2015). Our model has two countries for the sake of simplicity and assumes that creditors live in a third country that is not explicitly modeled.

2.2.1 Pre-transfer consumption

We characterize pre-transfer consumptions of the two countries under two regimes: autarky and free trade. Representative consumers in the countries have the following preferences:

$$\begin{cases} c_t &= \frac{1}{\Phi}\left[\lambda(x_t^{HH})^{\frac{\sigma-1}{\sigma}} + (1-\lambda)(x_t^{FH})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \\ c_t^* &= \frac{1}{\Phi^*}\left[\lambda^*(x_t^{FF})^{\frac{\sigma-1}{\sigma}} + (1-\lambda^*)(x_t^{HF})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \end{cases}$$

where $\Phi = \lambda^{\frac{\sigma}{\sigma-1}}$ and $\Phi^* = (\lambda^*)^{\frac{\sigma}{\sigma-1}}$ are parameters. x_t^{ij} denotes the amount of intermediate goods shipped from i to j at time t. $\sigma \in (1, \infty]$ is the elasticity of substitution between the two goods, which gives trade elasticity of $1-\sigma < 0$. Parameters $\lambda \in (0,1)$ and $\lambda^* \in (0,1)$ govern the home bias for home and foreign, respectively.

Goods market clearing conditions are

$$\begin{cases} Y_t &= x_t^{HH} + \tau_t^* x_t^{HF} \\ Y_t^* &= \tau_t x_t^{FH} + x_t^{FF} \end{cases}$$

where iceberg trade costs for goods that enter home and foreign are denoted as τ_t and τ_t^*, respectively. We denote ex-factory prices as p_t and p_t^*, which are endogenously determined taking endowments $\{Y_t, Y_t^*\}$ and trade costs $\{\tau_t, \tau_t^*\}$ as given. Six unknowns $\{x_t^{HH}, x_t^{HF}, x_t^{FF}, x_t^{FH}, p_t, p_t^*\}$ are pinned down by six equations:

$$\begin{cases} \frac{x_t^{FH}}{x_t^{HH}} &= \phi^{-1}\left(\frac{p_t}{\tau_t p_t^*}\right)^{\sigma} \\ \frac{x_t^{HF}}{x_t^{FF}} &= \phi^{*-1}\left(\frac{p_t^*}{\tau_t^* p_t}\right)^{\sigma} \\ Y_t &= x_t^{HH} + \tau_t^* x_t^{HF} \\ Y_t^* &= \tau_t x_t^{FH} + x_t^{FF} \\ \tau_t^* p_t x_t^{HF} &= \tau_t p_t^* x_t^{FH} \\ p_t^* &= 1 \end{cases}$$

where $\phi = (\frac{\lambda}{1-\lambda})^{\sigma}$ and $\phi^* = (\frac{\lambda^*}{1-\lambda^*})^{\sigma}$ are parameters. The ex-factory price of the foreign country is normalized as unity. Solving the system of equations gives the amount of consumption in each country as follows:

$$\begin{cases} c_t(Y_t, Y_t^*) &= Y_t\left[1 + \phi^{-1}\tau_t^{1-\sigma} p_t^{\sigma-1}\right]^{\frac{1}{\sigma-1}} \\ c_t^*(Y_t, Y_t^*) &= Y_t^*\left[1 + \phi^{*-1}(\tau_t^*)^{1-\sigma} p_t^{1-\sigma}\right]^{\frac{1}{\sigma-1}} \end{cases}$$

where terms of trade p_t is determined as

$$p_t = \frac{Y_t}{Y_t^*} = \frac{1}{p_t}\frac{1 + \phi\tau_t^{\sigma-1} p_t^{1-\sigma}}{1 + \phi^*(\tau_t^*)^{\sigma-1} p_t^{\sigma-1}}. \tag{4}$$

Given this general solution with an arbitrage value of trade costs, we compare the level of pre-transfer consumption in two states of the world: autarky and free trade. In a closed economy equilibrium, τ and τ^* are set as infinity. As a result, pre-transfer consumptions would simply be countries' endowments.

$$\begin{cases} c_t^{AUT} & = Y_t \\ c_t^{*AUT} & = Y_t^* \end{cases} \tag{5}$$

Under free trade where we set $\tau = \tau^* = 1$, pre-transfer consumptions are

$$\begin{cases} c_t^{FT}(Y_t, Y_t^*) & = Y_t \left[1 + \phi^{-1} p_t^{\sigma-1}\right]^{\frac{1}{\sigma-1}} \\ c_t^{*FT}(Y_t, Y_t^*) & = Y_t^* \left[1 + \phi^{*-1} p_t^{1-\sigma}\right]^{\frac{1}{\sigma-1}} \end{cases} \tag{6}$$

where p_t is determined by plugging $\tau_t = \tau_t^*$ into equation (4), which suggests that consumption is the product of the endowment and the term that captures gains from trade. Also note that the terms of trade is determined solely by the available endowments of the two countries as shown in equation (4). The sovereign bond contracts (L, D) are denominated in terms of final consumption goods which do not affect the terms of trade p_t.

2.2.2 Default decisions

Consider the second period where the sovereign has outstanding debt D. Because we only focus on the second period, time subscripts t are dropped in this section. We assume that a fraction θ of the country's endowment is destroyed upon default. Under autarky, the sovereign defaults if the loss of consumption upon default, or the difference between the pre-transfer consumption with full endowment and one with partially destroyed endowment is smaller than the outstanding debt D.

$$\begin{aligned} \text{Default in autarky if } \quad & Y - D < (1-\theta)Y \\ & \Leftrightarrow \theta Y < D \end{aligned} \tag{7}$$

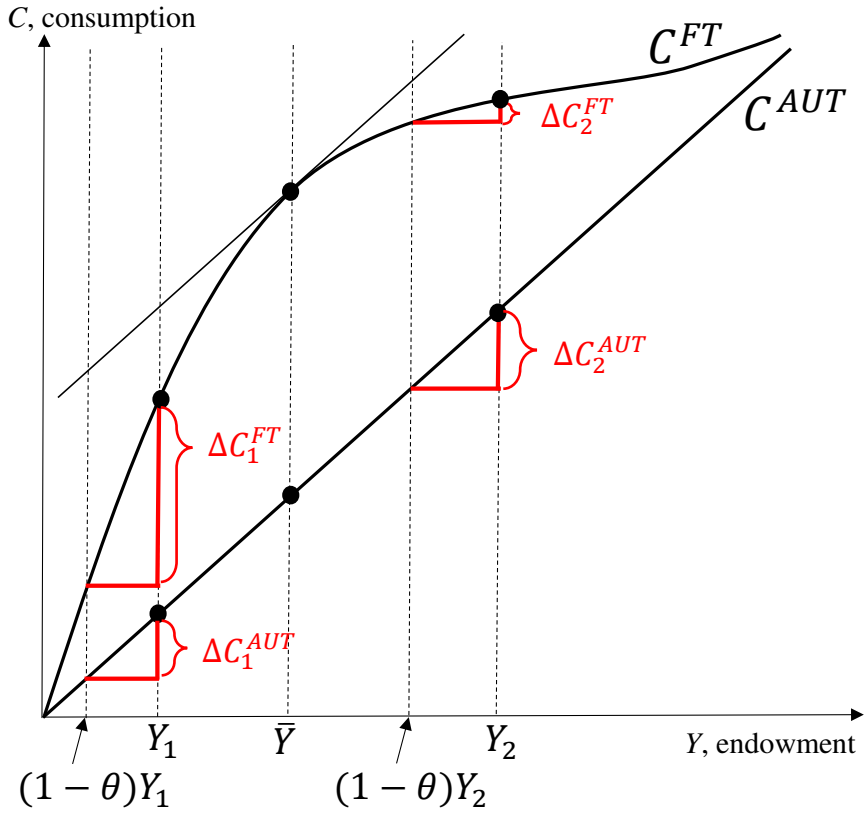
Under free trade, the sovereign makes a similar default decision but an additional channel kicks in. It defaults when the loss of consumption upon default is smaller than outstanding debt D as in the case under autarky. However, each of the two countries' pre-transfer consumptions is now described as a function of their endowments as follows:

$$\begin{aligned} \text{Default in free trade if } \quad & c(Y, Y^*) - D < c((1-\theta)Y, Y^*) \\ & \Leftrightarrow c(Y, Y^*) - c((1-\theta)Y, Y^*) < D. \end{aligned} \tag{8}$$

The left hand sides of equations (7) and (8) express costs of default. If θY is greater than $c(Y, Y^*) - c((1-\theta)Y, Y^*)$, then the costs of default are greater under autarky than free trade, and vice versa.

Figure 1 describes pre-transfer consumption schedules under autarky and free trade, where Y^* is fixed. It shows that, depending on the relative size of the endowments in the two countries, costs of default under autarky can either be greater or smaller than free trade. When the country's endowment is smaller than $\bar{Y}$ where $\frac{\partial C^{FT}}{\partial Y}|_{Y=\bar{Y}} = 1$, an output loss from Y_1 to $(1-\theta)Y_1$ leads to a consumption loss of ΔC_1^{FT} under

Figure 1: Pre-transfer consumption schedules



Notes: The figure shows pre-transfer consumption schedules under autarky and free trade. The autarky consumption schedule corresponds to a 45 degree line and is denoted by C^{AUT}. The consumption schedule under free trade is described by a concave curve and is denoted by C^{FT}. $\bar{Y}$ indicates the level of endowment where the slopes of the consumption schedules dC/dY are the same under autarky and free trade.

free trade while the same amount of output loss is associated with a smaller loss of consumption under autarky, ΔC_1^{AUT}. These imply that, when the level of endowment is less than $\bar{Y}$, it is more costly to default under free trade than autarky.

On the other hand, when the country's endowment is larger than $\bar{Y}$, an output loss from Y_2 to $(1-\theta)Y_2$ leads to a smaller consumption decline under free trade ΔC_2^{FT} while the same amount of output loss induces a greater decline in consumption under autarky, ΔC_2^{AUT}. These theoretical considerations suggest that, when the level of endowment is greater than $\bar{Y}$, it is less costly to default under free trade than autarky.

To understand the mechanism, it is essential to capture the two forces that come into play when the sovereign opens up to trade. In autarky, the destruction of endowment that occurs upon default linearly affects consumption, as can be seen from equation (5). However, under free trade, the same loss of endowment has additional channels through which a loss of endowment affects a sovereign's incentive to default.

A derivative of $c^{FT}(Y)$ with respect to Y clarifies how international trade changes a sovereign's

incentive to default and it is described as follows:

$$\frac{\partial}{\partial Y}c^{FT}(Y) = g(p) + Yg'(p)\frac{\partial p}{\partial Y}$$
$$\text{where} \quad g(p) = \left[1 + \phi^{-1}p^{\sigma-1}\right]^{\frac{1}{\sigma-1}},$$

which shows that the slope of pre-transfer consumption is decomposed in two terms. First, $g(p) > 1$ captures the part coming from the endowment effect where p is determined by equation (4). Due to a default, the sovereign will not only lose consumption linearly, but also it loses the positive gains from trade that were generated from the destroyed endowment.

The second term captures the terms of trade effect. Since $g'(p) > 0$ and $\frac{\partial p}{\partial Y} < 0$, an endowment loss due to default leads to a more favorable terms of trade for the sovereign. The intuition is as follows. A decline in output due to default reduces the supply of the good coming from the defaulted country. This reduction in supply increases the price of that good, leading to a terms-of-trade improvement for the country. This positive terms of trade effect would push consumption up for all range of Y.

This mechanism through the terms of trade effect is in contrast with other papers, for example, that of Cuadra and Sapriza (2006). In their model, an exogenously given terms of trade deterioration reduces a country's output, reducing its sovereign's incentive to increase taxes to repay its debt, resulting in a default. On the other hand, we do not consider changes in terms of trade prior to default. Instead, we focus on the channel through which a default improves the terms of trade, altering a forward-looking sovereign's incentive to default.[12]

Overall incentive to default is determined by the balance between these two forces. Regarding the endowment effect described first, the negative effect on consumption is larger when initial endowment Y is small, which is when gains from trade are greater. Moreover, the terms of trade effect described next works to allocate a larger fraction of total gains from trade of the two countries to a large country. But the endowment destruction effect reduces the size of these total gains from trade. Therefore, under free trade, a sovereign in a small country incurs greater costs of default than that in a large country.

In Appendix A we discuss how $\bar{Y}$ changes with different parameter values of $(\sigma, \lambda, \lambda^*)$. We find that as elasticity of substitution increases, $\bar{Y}$ decreases. This is because a higher elasticity of substitution across goods diminishes gains from trade, thus the terms of trade effects dominate the negative endowment effects. Under reasonable values of the parameters, $\bar{Y}$ becomes a very high value. Therefore, under realistic parameter values, costs of default are higher under free trade than aurarky in most countries.

3 Empirical analysis

The model presented in the previous section shows that international trade and an access to a sovereign bond market jointly benefit a country by raising its welfare. The model also yields several testable hypotheses. This section verifies the model's theoretical predictions using data and provides an empirical evidence that the model's underlying mechanisms leading to gains from trade are present.

[12] One may argue that, in reality, a default leads to a terms-of-trade deterioration due to a depreciation of the nominal exchange rate. However, this paper focuses on real effects rather than nominal effects. Even though a depreciation of the nominal exchange rate works to worsen the terms of trade, our argument still holds true if more open countries have a greater incentive to maintain the value of their currencies to avoid a terms-of-trade deterioration than less open countries.

3.1 Cross-sectional regressions

We first examine the relationship between a country's openness and its likelihood to default. The model suggests that more open countries have a smaller incentive to choose default than less open countries. We directly test this prediction by investigating the association between countries' openness measured by exports plus imports divided by GDP and the number of defaults.

Default episodes come from various sources. Following Furceri and Zdzienicka (2012), we take the data on default episodes from five different sources (De Paoli et al., 2006; Detragiache and Spilimbergo, 2001; Laeven and Valencia, 2008; Levy-Yeyati and Panizza, 2011; Reinhart et al., 2003). In order to follow up more recent studies on sovereign defaults, we also collect default episodes from Asonuma and Trebesch (2016), Trebesch and Zabel (2017), and Kuvshinov and Zimmermann (2017). These data sources cover defaults on their debt to private creditors.[13] Overlapping episodes across data sources are counted as one episode.

Figure 2 shows the average number of defaultsduring the period 1970-2008 for three groups of countries, (1) most open countries — their openness measures are greater than 75th percentile of the distribution in 1970, (2) moderately open countries — openness is between 50th and 75th percentiles, and (3) least open countries — less than 50th percentile.[14] Panel A shows that the least open countries had, on average, 3.6 defaults. On the other hand, the moderately open countries had about two default episodes. The most open countries had less than one default on average. Panel B shows the average level of openness, $(Imports + Exports)/GDP$, to give a sense of how openness varies across the three groups of countries. The most open countries have nearly 100 percent openness on average while it is 38 percent and 13 percent in moderately open and least open countries, respectively.

The default episodes described in Figure 3 are broken into eight bars based on original data sources in order to show that the result does not come from a particular combination of different data sources. It shows that the order of the average number of defaults across the three groups of countries, most open countries $<$ moderately open countries $<$ least open countries, holds true in all different data sources except the ones obtained from Detragiache and Spilimbergo (2001).[15] The observed relationship between the degree of openness and the number of default episodes is consistent with the model's theoretical predictions.

We statistically test this relationship between openness and the number of defaults. The dependent variable is the number of defaults, which takes zeros for many countries in the sample and discrete values for the rest of the sample. Therefore, we assume that the number of defaults of country c, y_c, follows a Poisson distribution:

$$Pr(y_1, ..., y_N | \mathbf{X}_1, ..., \mathbf{X}_N; \boldsymbol{\theta}) = \prod_{c=1}^{N} \frac{\exp(y_c \boldsymbol{\theta}' \mathbf{X}_c) \exp(-e^{\boldsymbol{\theta}' \mathbf{X}_c})}{y_c!},$$

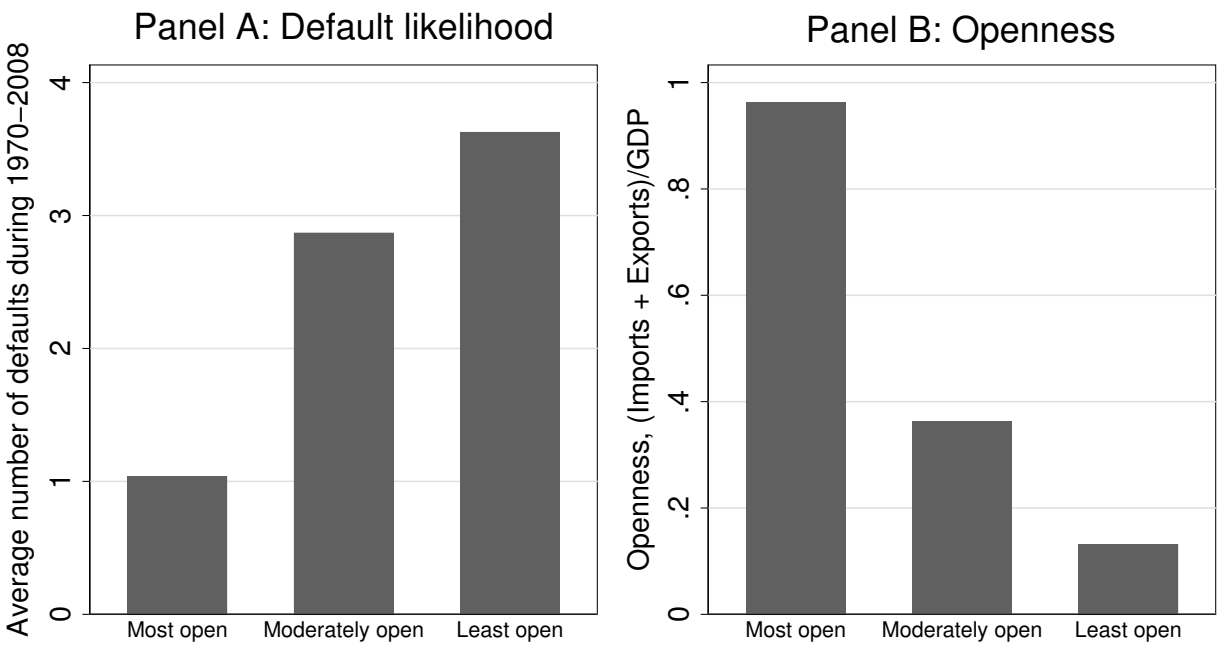
where N denotes the number of countries in the sample; $\mathbf{X}_c$ indicates a vector of explanatory variables

[13] See Appendix D.1 for an analysis regarding Paris Club official debt restructurings. See Appendix E for a list of default episodes in each of these data sources.

[14] See Appendix C for a list of these groups of countries.

[15] Although the order does not hold true for three groups of countries, the largest average number of defaults come from the moderately open countries. The least open countries have the second largest average number of defaults. Therefore, we can still argue that a greater openness is associated with a smaller number of defaults.

Figure 2: Average number of defaults by the degree of openness



Notes: Panel A shows the average number of defaults for countries in each group. The default episodes come from various sources and overlapping episodes across sources are counted as one episode. Panel B describes the average openness. The most open countries are defined as countries where their openness measures are greater than the 75th percentile of distribution in 1970. The moderately open countries are those between the 50th percentile and the 75th percentile. The least open countries are those less than the 50th percentile. See Appendix C for a list of these groups of countries.

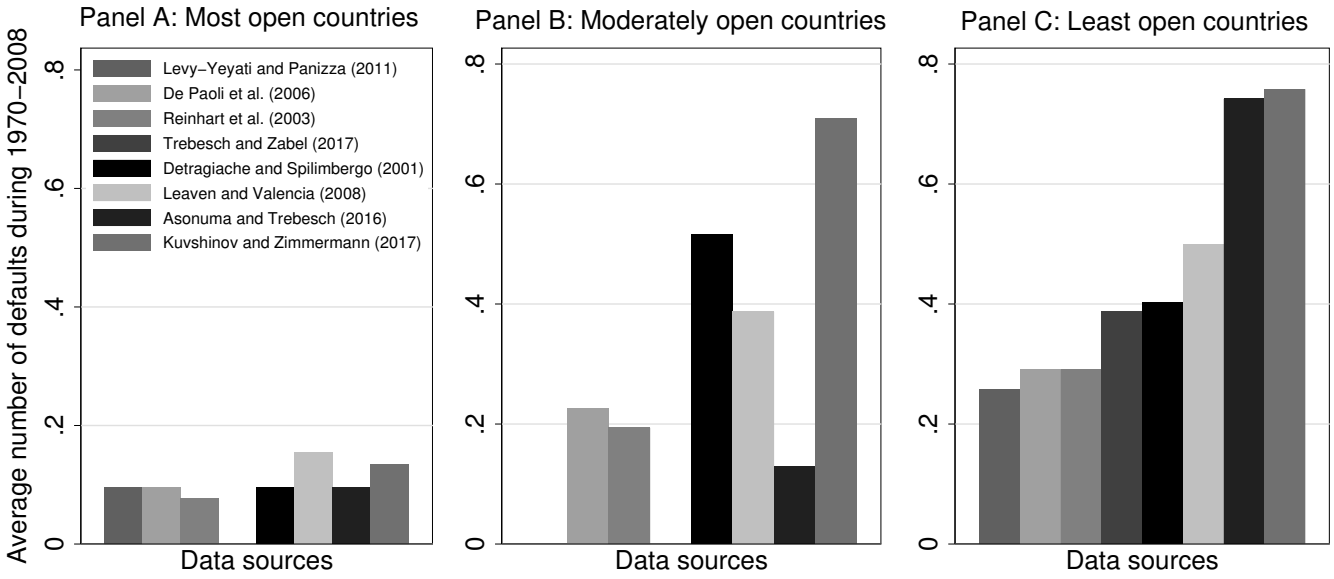
for country c, including openness, natural log of GDP per capita, natural log of GDP, the debt-to-GDP ratio, and the political stability index; $\boldsymbol{\theta}$ is a vector of parameters to be estimated. The conditional probability of observing numbers of defaults for a number N of countries, $y_1, ..., y_N$, given explanatory variables $\mathbf{X}_1, ..., \mathbf{X}_N$ and parameters $\boldsymbol{\theta}$, $Pr(y_1, ..., y_N | \mathbf{X}_1, ..., \mathbf{X}_N; \boldsymbol{\theta})$, is fitted by the Poisson distribution function in the right-hand side.

The dependent variable is the cumulative number of defaults during the period 1970-2008. We use explanatory variables from the initial period of the sample, 1970, because these variables may change endogenously due to defaults. The debt-to-GDP ratio and the political stability index are not available in 1970 and their earliest observations come from 1980 and 1984, respectively. Therefore, observations from these years are used for these two variables. This Poisson regression model estimates the relationship between the initial level of openness in 1970 and the number of defaults in subsequent years, controlling for other economic and political conditions. We argue that the initial level of openness and other economic and political conditions are exogenous.

The level of openness is measured as a share of GDP, $Open_c = (Imports_c + Exports_c)/GDP_c$, for each country c. Our theoretical model assumes balanced trade and does not yield different predictions regarding the impact of imports and exports. Therefore, imports and exports are symmetrically treated in this empirical analysis.

Table 1 reports the results. Because coefficients from the Poisson model do not have quantitative

Figure 3: Average number of defaults by the degree of openness and by data source



Notes: The most open countries are defined as countries where their openness measures are greater than the 75th percentile of distribution in 1970. The moderately open countries are those between the 50th percentile and the 75th percentile. The least open countries are those less than the 50th percentile. See Appendix C for a list of these groups of countries.

meaning, in the bottom of the table we report marginal effects of a 100 percentage points increase in openness on the number of defaults. Column (1) regresses the number of defaults on openness only. It shows that, as expected, openness has a negative coefficient and significantly significant at the 1 percent level. Marginal effects are economically sizable. A 100 percentage points increase in openness reduces the number of defaults by 2.5.

Column (2) controls for countries' income levels because low-income countries are more likely to have defaults and the level of income seems an important determinant of the propensity to have defaults. Adding log of GDP per capita reduces the marginal effects of openness but it is still statistically less than zero. Column (3) introduces log of GDP, controlling for market size. Column (4) further adds the debt-to-GDP ratio because the model suggests that a more open country has less incentive to choose to default for the same level of debt. The last column includes the political stability index in order to control for political conditions. Either of these shows that openness has significantly negative effects — a 100 percentage point rise in openness reduces the number of defaults by 1.6 to 3.5, depending upon the set of control variables. Again, these results are consistent with the model's theoretical prediction.

3.2 Panel regressions

The regressions in the previous sub-section use cross-sectional variations in the data only to examine the link between initial levels of openness and subsequent number of defaults. This section runs panel regressions to estimate the impact of a change in a country's openness on the likelihood of defaults bonds' interest rates in the same country. Employing a panel dataset makes it possible to examine how openness effects vary depending on the size of countries because we have a large enough number of observations.

Table 1: Openness and the number of defaults, Poisson

Dependent variable = the number of defaults during 1970-2008

	(1)	(2)	(3)	(4)	(5)
Openness	-1.647***	-0.651*	-0.925**	-0.992**	-1.320***
	(0.325)	(0.349)	(0.402)	(0.409)	(0.452)
ln(GDP per capita)		-0.281***	-0.193**	0.037	0.069
		(0.064)	(0.087)	(0.090)	(0.101)
ln(GDP)			-0.079	0.025	-0.107*
			(0.051)	(0.054)	(0.063)
Debt-to-GDP ratio				0.009***	0.005**
				(0.002)	(0.002)
Political stability index					-0.009
					(0.112)
Constant	0.914***	2.847***	4.107***	-0.049	3.156**
	(0.107)	(0.427)	(0.912)	(1.160)	(1.387)
Observations	124	87	87	67	56
Pseudo R-sq.	0.071	0.111	0.118	0.103	0.098
Log-likelihood ratio	35.13	40.48	42.92	29.37	23.37
p-value	0.000	0.000	0.000	0.000	0.000
Marginal effects of a 100 percentage points increase in openness					
Openness	-2.5***	-1.2*	-1.6**	-2.3**	-3.5***
	(0.5)	(0.6)	(0.7)	(1.0)	(1.2)

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Standard errors are in parentheses. The dependent variable is the number of defaults during 1970-2008, which takes zeros for a large fraction of the sample and takes a discrete value for the rest of the sample. Therefore, we employ a Poisson model. The explanatory variables come from 1970 except for the debt-to-GDP ratio and the political stability index where these variables from 1970 are not available. The debt-to-GDP ratio comes from 1980 and the political stability index comes from 1984. The marginal effects of a 100 percentage points increase in openness on the number of defaults are reported in the bottom of the table. Delta-method standard errors are in parentheses.

First, the openness effects on the bond's interest rates are tested by estimating the following equations:

$$i_{c,t} = \alpha_c + \alpha_1 Open_{c,t} + \mathbf{X}_{c,t}\boldsymbol{\alpha}_2 + u_{c,t}, \tag{9}$$

$$i_{c,t} = \beta_c + \beta_1 Open_{c,t} + \beta^{Medium}(Open_{c,t} \times D_c^{Medium}) + \beta^{Large}(Open_{ct} \times D_c^{Large}) + \mathbf{X}_{c,t}\boldsymbol{\beta}_2 + D_c^{Medium}\theta_t + D_c^{Large}\theta_t + e_{c,t}, \tag{10}$$

where $i_{c,t}$ denotes the government bond interest rate for private creditors in country c in year t[16]; $\mathbf{X}_{c,t}$ is a vector of control variables including the interest payments-to-GDP ratio, GDP growth rates, natural log of GDP per capita, the debt-to-GDP ratio, the inflation rates, and the default dummy where we closely follow the literature in choosing these control variables (Bellas et al., 2010; Cimadomo et al., 2016); α_c and β_c indicate country fixed effects; and $u_{c,t}$ and $e_{c,t}$ are error terms. Each of α_1, $\boldsymbol{\alpha}_2$, β_1, and $\boldsymbol{\beta}_2$ denotes a scalar (or a vector) of parameters to be estimated.

D_c^{Large} and D_c^{Medium} are constructed based on country size measured by GDP in 1995. Large countries

[16]We also estimate the same regression by replacing the dependent variable with the bonds' interest rates for official creditors. See Appendix D.1 for results.

are defined as those where their GDPs are greater than the 75th percentile of the distribution in 1995 and medium-sized countries are those between the 25th and the 75th percentiles. Small countries are the rest. Country groups do not change over time.[17] Because an interaction term with the large country dummy is introduced, the parameter β_1 measures the effect of openness on the bond interest rates in small countries. Linear combinations of coefficients, $(\beta_1 + \beta^{Medium})$ and $(\beta_1 + \beta^{Large})$, capture the effect of openness on the bond interest rates in medium-sized countries and large countries, respectively. The model suggests $\beta_1 < (\beta_1 + \beta^{Medium}) < (\beta_1 + \beta^{Large}) < 0$.

Second, we estimate the relationship between openness on the likelihood of default. The regression equation is

$$Pr(Default)_{c,t} = \Lambda(\gamma_1 Open_{c,t-1} + \mathbf{X}_{c,t-1}\boldsymbol{\gamma}_2 + \tilde{u}_{c,t}), \tag{11}$$

where $Pr(Default)_{c,t}$ is the probability of default in country c in year t and we have openness and other control variables in the right-hand side. γ_1 and $\boldsymbol{\gamma}_2$ are parameters to be estimated. $\tilde{u}_{c,t}$ indicates an error term. $\Lambda(.)$ denotes a logistic distribution used to fit the probability of default. Due to the fact that there are many countries experienced no default and there is no time-series variation in the dependent variable for those countries, introducing country fixed effects drops those countries. As a result, we lose a large number of observations. In order to cover as many countries as possible, we do not introduce country fixed effects. Furthermore, in order to partially address endogeneity between default and openness, the right-hand side variables are lagged variables.[18] We fully address this potential endogeneity issue by employing a 2SLS in Appendix D.2.

This logit model is not linear. Therefore, we are unable to introduce interaction terms between openness and country size dummies since such interaction terms would not capture different slope parameters contrary to a linear model. In order to allow different openness effects across groups of countries, we simply estimate equation (11) for each of the three groups of countries — small countries, medium-sized countries, and large countries.

We obtain data from various sources. The interest rates on external debt are obtained from the *International Financial Statistics* (IMF, 2018b). The data on interest payments come from the *Global Financial Development Database* (World Bank, 2018a). The data on GDP and the inflation rate are retrieved from the *World Development Indicators* (World Bank, 2018b). The data on openness are based on exports-to-GDP ratios and imports-to-GDP ratios from the *Penn World Table 9.0* (Feenstra et al., 2015).

Table 2 presents the results from estimating equations (9) and (10). The dependent variable is expressed in percentage (e.g., 1.2 means that the interest rate is 1.2 percent). The openness variable represents $(Imports_c + Exports_c)/GDP_c$. As a result, the estimated coefficients represent the impact of a 100 percentage points increase in openness on the bonds' interest rates, expressed in percentage. Column (1) regresses the bonds' interest rates on openness only. It shows that a 100 percentage points increase

[17] See Appendix C for list of countries in the country groups. We choose the year 1995 to define the country groups because it is in the middle of the sample period. Our results do not depend upon this choice.

[18] A number of studies find that a sovereign default reduces trade. See, for example, Rose (2005), Martinez and Sandleris (2011), Zymek (2012), Gopinath and Neiman (2014), and Asonuma et al. (2016). Equations (9) and (10) examine the contemporaneous relationship between openness and the interest rate because we argue there is virtually no reverse causality from the bond interest rate to openness.

Table 2: Openness effects on the bonds' interest rates

Dependent variable = the bonds' interest rates

	(1)	(2)	(3)	(4)	(5)
Openness	-2.421***	-3.288**	-8.407***	-7.785***	-5.407***
	(0.330)	(1.600)	(2.139)	(2.285)	(1.828)
$D^{Medium}\times$ Openness		1.442	3.659	4.021	0.976
		(2.450)	(2.766)	(2.889)	(3.891)
$D^{Large}\times$ Openness		4.231**	9.229*	7.179	3.373
		(1.946)	(5.376)	(4.653)	(6.756)
$D^{Medium}\times f_t$ and $D^{Large}\times f_t$		✓	✓	✓	✓
R-squared	0.007	0.110	0.194	0.203	0.251
Observations	2,943	2,943	1,718	1,626	1,027
Countries	70	70	57	57	55
Controls					
Interest payments-to-GDP ratio			X	X	X
GDP growth rate				X	X
ln(GDP per capita)				X	X
Debt-to-GDP ratio					X
Inflation rate					X
Default dummy					X
Linear combination of coefficients					
Medium-sized countries		-1.847	-4.748***	-3.763**	-4.432
		(1.855)	(1.748)	(1.818)	(3.496)
Large countries		0.943	0.822	-0.606	-2.034
		(1.107)	(4.924)	(4.099)	(6.607)

Notes: The dependent variable is the bonds' interest rates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Standard errors, clustered at the country-level, are in parentheses. All regressions include a constant term and country fixed effects. Columns (2)-(5) introduce interaction terms year fixed effects f_t and D^{Medium} (or D^{Large}) in order to identify the openness effects in medium-sized countries (or large countries). See Appendix C for a list of these groups of countries.

openness reduce the bonds' interest rates by 2.4 percent and it is significant at the 1 percent level.

Column (2) introduces interaction terms between openness and D^{Medium} and D^{Large}, respectively, in order to allow different openness effects across countries depending upon their country size. It shows that a greater openness reduces the interest rates only in small countries — the estimated coefficient is -3.3. The openness effects in medium-sized and large countries are -1.8 and 0.9, respectively, but these are statistically insignificant. These results are consistent with the model's theoretical prediction that the openness has greater effects in smaller countries than larger countries. Column (3) introduces the interest payments-to-GDP ratio. Column (4) further adds the GDP growth rate and natural log of GDP per capita. Moreover, the debt-to-GDP ratio, the inflation rate, and the default dummy are added in column (5) as controls. Introducing these controls does not change our result that the openness effects are greater in small countries than larger countries.

Table 3 presents results from estimating equation (11) for each group of countries — the first, second and third rows report the openness effects for small countries, medium-sized countries, and large countries,

Table 3: Openness effects on the probability of default, Logit

Dependent variable = the default dummy

	(1)	(2)	(3)	(4)	(5)
Openness, small countries	-0.068***	-0.136***	-0.128***	-0.130***	-0.407**
	(0.022)	(0.044)	(0.044)	(0.050)	(0.197)
Observations	1,446	959	944	944	295
Countries	35	29	29	29	14
Openness, medium-sized countries	-0.098***	-0.090***	-0.081***	-0.088***	-0.164*
	(0.018)	(0.028)	(0.028)	(0.031)	(0.091)
Observations	2,787	1,621	1,592	1,575	548
Countries	69	59	59	58	27
Openness, large countries	-0.077***	-0.061	-0.066	-0.199**	-0.119
	(0.022)	(0.057)	(0.056)	(0.095)	(0.135)
Observations	1,674	535	526	451	184
Countries	40	26	26	26	14
Controls					
Interest payments-to-GDP ratio		X	X	X	X
GDP growth rate			X	X	X
ln(GDP per capita)				X	X
Debt-to-GDP ratio					X
Inflation rate					X
Arrears-to-GNI ratio					X

Notes: The table reports marginal effects of a 100 percentage point increase in openness. Delta-method standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. See Appendix C for a list of these groups of countries.

respectively. The table shows marginal effects of a 100 percentage points increase in openness and delta-method standard errors are in parentheses. Column (1) regresses the default dummy on openness without introducing any controls. The result shows that a greater level of openness reduces the probability of default in all groups of countries. A 100 percentage points increase in openness reduces the default probability by 6.8 percent, 9.8 percent, and 7.7 percent in small, medium-sized, and large countries, respectively.

Following columns incrementally introduce additional control variables — column (2) includes the interest payments-to-GDP ratio; column (3) adds the GDP growth rate; column (4) further incorporates GDP per capita, and the inflation rate and the arrears-to-GNI ratio are included in column (5). By controlling for these variables, the openness effect becomes greater, especially in small countries. For example, column (5) shows that a 100 percentage points increase in openness reduces the default probability by 40.7 percent, 16.4 percent, and 11.9 percent in small, medium-sized, and large countries, respectively. Statistical significance only comes from small countries.

Overall, the empirical results confirm the model's theoretical prediction that a greater level of openness is associated with a lower frequency of defaults and a lower interest rate charged by foreign creditors. The magnitude of these openness effects is also shown to be different depending on the size of countries measured by GDP. As is consistent with the theory, the effects of openness are greater for smaller countries than larger countries.

4 Numerical analysis

This section calibrates the model to quantify gains from trade when a country has access to a sovereign bond market. In so doing, the two-period model presented in Section 2 is extended to a general infinite horizon model. The infinite horizon model is used to calibrate the model's parameters and then a numerical simulation is performed to quantify gains from trade.

4.1 Infinite horizon model

4.1.1 Sovereign government's problem

Key features in the two period model remain the same in this section. The two countries receive stream of intermediate goods endowments $\{Y_t, Y_t^*\}$ that they trade with each other. Also, the sovereign has access to contracts (L_t, D_{t+1}) with the foreign investors who reside in a third country. The contracts are one period state non-contingent bonds that give L_t unit of consumption goods to home's representative household at period t, with the promise of paying back D_{t+1} units in period $t+1$. The price of the contract is thus $q_{t+1} = L_t/D_{t+1}$.

Home's expected utility in the initial period is

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\epsilon}}{1-\epsilon}.$$

The pre-transfer consumption of the two countries in each period are the same as in the previous section. In each period, given the endowments $\{Y_t, Y_t^*\}$, the two countries obtain pre-transfer consumption schedules denoted in equations (6) and (4). In each period, the state of the economy is described by outstanding government debt and the two countries' endowment $\{D_t, Y_t, Y_t^*\}$. Given these, the sovereign has the option to default or to repay its debt in each period. Thus the sovereign's value at period t is:

$$V(D_t, Y_t, Y_t^*) = \max\left(V^R(D_t, Y_t, Y_t^*), V^D(Y_t, Y_t^*)\right),$$

where $V^R(D_t, Y_t, Y_t^*)$ is the value of the sovereign if it repays the debt, which is described as:

$$\begin{aligned} V^R(D_t, Y_t, Y_t^*) = \max_{D_{t+1}} & \left(\frac{C_t^{1-\epsilon}}{1-\epsilon} + \beta \mathbb{E}_t[V(D_{t+1}, Y_{t+1}, Y_{t+1}^*)]\right) \\ \text{s.t.} \quad & C_t = c_t(Y_t, Y_t^*) + q_{t+1} D_{t+1} - D_t, \end{aligned}$$

and $V^D(Y_t, Y_t^*)$ is the value of the sovereign if it decides to default. In that case, a fraction θ of Y_t is destroyed and the sovereign is excluded from the foreign bond market. From the next period, the sovereign repays its debt with probability π with zero outstanding debt. As a result, the value function becomes:

$$\begin{aligned} V^D(Y_t, Y_t^*) = & \frac{C_t^{1-\epsilon}}{1-\epsilon} + \beta\left\{\pi \mathbb{E}_t[V(0, Y_{t+1}, Y_{t+1}^*)] + (1-\pi)\mathbb{E}_t[V^D(Y_{t+1}, Y_{t+1}^*)]\right\}, \\ \text{s.t.} \quad & C_t = c_t((1-\theta)Y_t, Y_t^*). \end{aligned}$$

Note that in this infinite horizon model, the sovereign incurs not only direct output costs upon default but also costs from being excluded from the international capital market. Thus, in each period, the sovereign makes a default decision by considering the balance between the present value costs of paying its debt and the present value costs of an output loss and costs from not being able to smooth consumption.

4.1.2 Foreign investors' problem

Foreign investors reside outside the two economies, and they are small and large in numbers. Taking the bond price q_{t+1} as given, the investors maximize their profits:

$$\max_{D_{t+1}} \left(-q_{t+1} D_{t+1} + \frac{1}{1+r} D_{t+1} \mathbb{1}\{\text{Repay}\} \right),$$

which is zero in equilibrium. $\mathbb{1}\{\text{Repay}\}$ is an indicator function takes 1 if the sovereign repays its debt and zero otherwise. The implied price for the sovereign bond is

$$q_{t+1} = \frac{L_t}{D_{t+1}} = \frac{\text{Prob(Repay)}}{1+r}.$$

4.1.3 Recursive equilibrium

We assume that the endowment processes of the two countries follow a log-normal AR(1) process. Shocks to the two streams are uncorrelated. The processes are described as follows:

$$\begin{cases} \log(Y_t) & = \log(\bar{Y}_t) + \rho(\log(Y_{t-1}) - \log(\bar{Y}_t)) + \varepsilon_t \\ \log(Y_t^*) & = \log(\bar{Y}_t^*) + \rho^*(\log(Y_{t-1}^*) - \log(\bar{Y}_t^*)) + \varepsilon_t^* \end{cases} \tag{12}$$

where

$$\begin{pmatrix} \varepsilon_t \\ \varepsilon_t^* \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \Sigma \right), \quad \Sigma = \begin{pmatrix} \sigma^2 & 0 \\ 0 & (\sigma^*)^2 \end{pmatrix}$$

and $(\bar{Y}_t, \bar{Y}_t^*)$ are mean incomes of the two economies.

Summing all up, exogenous parameters of the model are $\{\beta, r, \epsilon, \lambda, \lambda^*, \sigma, \theta, \pi\, \rho, \rho^*, \sigma, \sigma^*\}$ and the state of the economy is described by three variables $\{D_t, Y_t, Y_t^*\}$. The recursive equilibrium of this economy is a set of policy functions for (a) home and foreign's pre-transfer consumption; (b) sovereign's default decision and bond issuance; and (c) bond price functions, such that (i) Taking the price of bonds and the relative price of goods as given, both the sovereign and foreign pre-transfer consumption satisfy their optimization problem; (i') When faced with multiple viable debt-price schedules, the sovereign chooses the one with lower debt; (ii) The good market clears; (iii) Taking the bond price as given, the sovereign's default decision satisfies its dynamic problem; (iv) The bond price reflects the sovereign's default probability and is consistent with the investors' maximization problem.

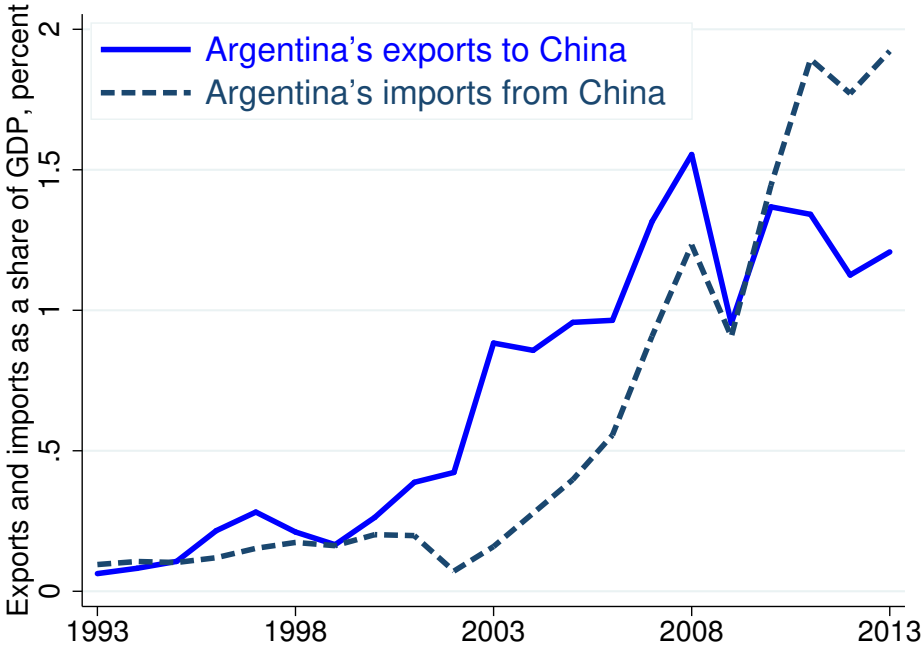
4.2 Calibration and simulation

We consider a two-country world where there are Argentina and China because these countries provide an excellent example of the model's theoretical set up — one country, Argentina, benefits from access

to a sovereign bond market while it opens up with another country, China.[19] Figure 4 shows bilateral trade flows between Argentina and China (as shares of Argentina's GDP) from 1993 to 2013. It shows that Argentina's exports to China and its imports from China increased drastically after 2001, China's accession to the World Trade Organization. We employ Argentina's opening up to trade with China as an ideal case to study its gains from trade.

In this experiment, we compare the two states of the world as in the previous sections. The first is analogous to the autarky economy in previous theoretical analyses. We estimate the endowment shock process from the real GDP sequence of Argentina from 1993 to 2013, and compute the recursive equilibrium defined in the previous section, but with infinite trade costs. The second is analogous to the free trade economy with two countries. We also estimate the Chinese endowment process using the Chinese real GDP data from 2002 to 2013, and consider China as Argentina's trading partner in the model. Then we compute the recursive equilibrium where the two countries have trade with zero trade costs.

Figure 4: Argentina's exports to China and its imports from China as shares of Argentina's GDP, 1993-2013



Notes: The figure shows bilateral trade flows between Argentina and China as shares of Argentina's GDP. The data on bilateral trade flows come from the *Direction of Trade Statistics* (IMF, 2018a) and the data on GDP are obtained from the WDI (World Bank, 2018b).

In the numerical analysis, we modify the endowment costs that the sovereign has to incur upon default. Instead of assuming that an uniform fraction of endowment is destroyed upon default, we assume that

[19] Previous articles conducting calibration analyses by employing Argentina's case to study sovereign debt include Arellano (2008), Aguiar and Gopinath (2006), Yue (2010), Asonuma (2014), and Asonuma (2016).

the level of endowment upon default is determined as follows:

$$Y_t^{\text{default}} = \begin{cases} \gamma \mathbb{E}(Y_t) & \text{if } Y_t > \gamma \mathbb{E}(Y_t) \\ Y_t & \text{if else} \end{cases}$$

which implies that the fraction of destroyed endowment is weakly increasing in the endowment size. This construction is the same as Arellano (2008). When a realized output level is low, the sovereign does not suffer any output destruction and is only deprived of its ability to smooth consumption. But when a realized level of endowment is greater than a certain threshold, the sovereign starts to suffer from an increasing fraction of direct output loss upon default.

We need this assumption that default costs are larger in "good times" than in "bad times" in order to match empirical observations that a country is more likely to default when it is facing with a lower level endowment or a lower GDP growth rate (e.g., Kuvshinov and Zimmermann, 2017). This assumption is also consistent with models with endogenous production. Mendoza and Yue (2012) assume that domestic firms lose access to world credit markets upon sovereign default, thus cannot finance working capital to import a certain fraction of intermediate goods. Under this setup, they find that a GDP loss upon default is increasing in the size of a negative TFP shock.

4.2.1 Data and parameters

Argentinian and Chinese quarterly GDP data are taken from the National Institute of Statistics and Censuses (INDEC) and the National Bureau of Statistics of China (NBS), respectively.[20] We estimate parameters governing the endowment processes in equation (12) using a maximum log-likelihood method.[21] Estimated parameters are $\rho = 0.91$, $\rho^* = 0.81$, $\sigma = 0.015$, and $\sigma^* = 0.016$, where Argentina is the Home country and China is the Foreign country. Given the estimated endowment processes, we then discretize the process into a finite state Markov chain using the procedures described in Hussey and Tauchen (1991).

Table 4 summarizes parameter specifications. The discount rate $\beta = 0.86$ follows Asonuma (2014), which is set to match Argentina's average default frequency documented in Sturzenegger and Zettelmeyer (2007). Risk free rate r is set to be 0.017 as in Arellano (2008). The coefficient of risk aversion is assumed to be 2 following the literature.[22] The endowment threshold γ also follows Arellano (2008) and set to be 0.969. The probability of reentry π is set as 0.282 which is consistent with empirical findings in Gelos et al. (2011).

4.2.2 Results

Figure 5 shows bond price schedules under autarky and free trade. The price schedules show that the sovereign faces higher prices for the same amount of debt under free trade, reflecting a lower probability of default. Though the basic structure of the model remains the same as the two period model, the size of

[20] The data on Argentinian GDP are converted to constant 2005 USD prices using inflation and exchange rates from US Bureau of Economic Analysis (BEA) and Central Bank of Argentina. The data on Chinese GDP are converted to constant 2005 USD prices using inflation and exchange rates from the *World Development Indicators* (World Bank, 2018b), and the People's Bank of China. It is also seasonally adjusted by X-12-ARIMA Seasonal Adjustment Program by the US Census Bureau.

[21] We detrend the data with Hodrick-Prescott filter using smoothing parameter of 1600.

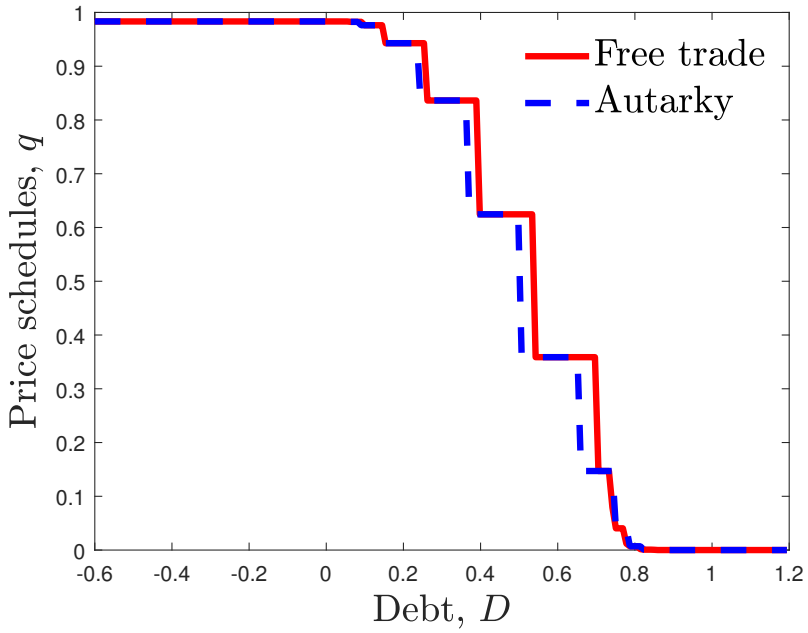
[22] Asonuma (2014), Asonuma (2016), and Kollmann (1996) also set their risk aversion coefficients to the same number.

Table 4: Specifications of parameters

Parameter	Value	Source
Discount rate	$\beta = 0.86$	Asonuma (2014)
Risk free rate	$r = 0.017$	Arellano (2008)
Risk aversion	$\epsilon = 2$	RBC literature
Weights of x_{HH} and x_{FF}	$\lambda = 0.5,\ \lambda^* = 0.5$	Asonuma (2014)
Elasticity of substitution	$\sigma = 5$	Simonovska and Waugh (2014)
Endowment threshold	$\gamma = 0.969$	Arellano (2008)
Probability of reentry	$\pi = 0.282$	Gelos et al. (2011)
AR(1) persistence	$\rho = 0.91,\ \rho^* = 0.81$	Estimated
AR(1) standard deviation	$\sigma = 0.016,\ \sigma^* = 0.015$	Estimated

the changes in prices due to trade seems smaller in this infinite horizon model. This comes from the fact that we make a slightly different assumption on an output loss due to default. Previously we assumed an uniform two percent reduction in endowment. In this section, however, output declines only when the level of endowment is higher than 97 percent of its mean value. Thus, for endowments in the lower half of the distribution, default costs are zero. This reduces the difference of default costs between free trade and autarky, resulting in smaller bond price differences.

Figure 5: Pricing schedules under autarly and free trade



Notes: The figure shows pricing schedule under autarky and free trade. See Table 4 for parameter values.

There are two sources that a sovereign gains from trade. One is traditional gains from trade coming from "love of variety" features in the CES utility function. The other comes from a country's ability to smooth out consumption by issuing bonds. This second channel of consumption smoothing is affected by two forces creating incompleteness of the bond market.

The first is the fact that sovereign bonds are state non-contingent. By issuing state non-contingent

bonds, the sovereign tries to smooth consumption paths as in Mendoza (1991). But since the sovereign's discount rate β is smaller than the world discount rate $1/(1+r)$, an impatient sovereign will always borrow. Moreover, endogenous bond prices make it easier to borrow when the level of endowment is greater. This is because the probability of default is lower in such situation. As a result, the sovereign borrows more in a good time than in a bad time.

Second, bonds are defaultable. By defaulting when endowments are low and there is large outstanding debt, the sovereign mitigates the negative effects on consumption due to a low endowment shock. Since it is harder for the sovereign to borrow when the endowment is low, it defaults even with smaller outstanding debt in low endowment periods. Therefore this defaulting channel works as a consumption smoothing mechanism, which is similar to the notion explained in Zame (1993).

Table 5: Simulation result (in quarterly frequency)

	Autarky	Free trade
Average interest rate spread, $1/q - 1$ (%)	3.25	2.66
Pre-default interest rate spread (%)	3.48	2.85
Average default probability (%)	3.10	2.55
Average debt-to-output ratio (%)	4.81	3.96

Notes: The table summarizes simulation results on various variables under the benchmark parameter assumption $\sigma = 5$. See Table 4 for other parameter values.

Given these equilibrium features, we present simulation results. To examine the effect of moving from autraky to free trade on bond prices and on welfare, we simulate the model for 1000 times, given the obtained policy functions. Each trial of the simulations is run for 2000 periods, and the last 200 periods are taken to analyze the steady state distribution. In analyzing bond prices, we exclude the periods when the sovereign is in default because bond prices are not well defined in those periods. Following the literature, we consider the 74 periods prior to default events when we analyze pre-default statistics.

Table 5 reports simulation results along with other statistics. The first column, which reports statistics where trade is not allowed, is comparable to those from Arellano (2008). By having trade with another country, the sovereign's default probability decreases, which in turn increases its sovereign bond price. It shows that the average debt-to-output ratio is smaller under free trade. The sovereign's capacity to accumulate debt expands when it moves from autarky to free trade. However, output also increases due to trade. As a result, the debt-to-output ratio declines.

Facing more favorable bond prices, the sovereign benefits from not only traditional gains from trade but also an additional intertemporal gains from trade. Table 6 reports additional percentage increase in present value welfare at steady state, $100 \times (W^{FT} - W^{AUT})/W^{AUT}$ where W^{FT} and W^{AUT} denote the present value welfare under free trade and autarky, respectively, with and without a sovereign bond market.

An increase in welfare without bond issuance is calculated using the corresponding endowment sequences that are used in the simulation. The welfare gains from trade are around 16 percent in the baseline case where we assume $\sigma = 5$, and it is consistent with the present value of the static gains from trade. On the other hand, the gains from opening up to trade when the sovereign is issuing bonds become 19 percent. The difference between these two gains — around three percentage points — comes from

Table 6: Gains from trade

	Benchmark	Robustness checks	
	$\sigma = 5$	$\sigma = 3$	$\sigma = 7$
$100 \times (W^{FT} - W^{AUT})/W^{AUT}$, without bond issuance	16.3	29.3	10.9
$100 \times (W^{FT} - W^{AUT})/W^{AUT}$, with bond issuance	19.4	41.5	12.3
Additional gains from trade			
Percentage point difference (% points)	3.1	12.2	1.4
With bond issuance/without bond issuance	1.19	1.42	1.13

Notes: The table summarizes the home country's additional increase in welfare due to free trade relative to the welfare level under autarky, $100 \times (W^{FT} - W^{AUT})/W^{AUT}$ where W^{FT} and W^{AUT} denote the level of welfare under free trade and autarky, respectively. Gains from trade are computed for three different values of elasticity of substitution σ. See Table 4 for other parameter values.

the fact that the sovereign has more capacity to borrow, and faces higher bond price. Therefore, the sovereign enjoys additional gains from trade from the sovereign bond market, which is around one fifth of the traditional gains from trade.

Results from the robustness checks show that gains from trade change by assuming different values of elasticity of substitution: $\sigma = 3$ and $\sigma = 7$. As expected, a higher substitutability reduces gains from trade. But it also diminishes additional gains from an access to a sovereign bond market. Recall Figure 1 in Section 2.2.2. In the static version of the model, a higher substitutability reduces the region of the home country's endowment where default cost is higher under free trade than in autarky. In other words, a higher σ decreases $\bar{Y}$. This means that for Y that is less than $\bar{Y}$, the slope of the consumption schedule in free trade diminishes and becomes closer to that of the consumption schedule in autarky. Costs of default are still higher than under autarky, but the costs diminish as the elasticity of substitution increases. The difference in gains from trade between free trade and autarky becomes smaller, which works to reduce additional gains by opening up to trade. Nevertheless, we find that the additional gains that come from the sovereign bond market are substantial in magnitude.

Though the source of the additional gains from trade is different, we find that our estimates on additional gains from trade are in the same ballpark as those from other papers. Melitz and Redding (2015) perform a numerical exercise to quantify the gains from trade. They compare the gains from trade based on the welfare formula in Arkolakis et al. (2012) (hereafter the ACR formula) and the one based on their model with a truncated Pareto distribution. In their experiment of reducing the of iceberg trade costs from 3 to 1.25, the gains from trade are around three percentage points larger. Ramanarayanan (2018) finds that introducing linkages from imported inputs increases the gains from trade by around 7 percentage points. Ossa (2015) quantifies Argentina's gains from trade by using his multi-sector model of trade. He compares changes in real income moving from autarky to the year 2007 level of trade. He shows that the gains from trade are around 20 percentage points larger than those implied from the ACR formula.

Note that the results do not exactly reveal Argentina's actual gains from trade with China. Obviously, the results are limited given the stylized setup of the model. Nevertheless, they are informative in grasping the magnitude of how much a sovereign gains through the bond market by opening up to trade.

5 Conclusion

We have investigated how interactions between international trade and access to the sovereign bond market shape a country's gains from trade by using an Armington (1969)'s model of trade with a sovereign bond market a la Arellano (2008). As is conventional in the literature, the model assumes that a default reduces a country's output, which in turn reduces the country's imports and exports. As a result, a greater openness of a country makes a default more costly because the country loses a greater amount of consumption due to a default. Therefore, a greater openness reduces a likelihood of default, reducing the interest rate charged by foreign creditors.

These mechanisms are confirmed by a cross-sectional regression as well as a panel regression. Indeed, more open countries have a fewer defaults than less open countries and an increase in a country's openness reduces the country's bond interest rate. The regression results also imply that the effect of openness on the probability of default and the bonds' interest rate depends on its country size measured by GDP, which is consistent with the model's theoretical predictions.

These empirical results confirm that the model's underlying mechanisms leading to gains from trade are present. By opening up to trade, the country reduces the probability of default because it becomes more costly to default, leading to a lower interest rate and a higher price of its sovereign bond. This results in a greater level of consumption, therefore a higher level of welfare. As a result, an access to sovereign bond market works to magnify gains from trade. Our numerical exercise shows that gains from trade become about three parentage points greater by introducing a sovereign bond market. This suggests one reason why conventional trade models, which do not have a sovereign bond market, lead to surprisingly small gains from trade as shown by Arkolakis et al. (2012).

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Appendix

A Pre-transfer consumption schedules in autarky and free trade

This section shows that there is a threshold value of Y such that if the endowment is below that amount, costs of default would be greater under free trade than under autarky. We also show numerically that the threshold is very large under reasonable parameter values.

Figure 1 illustrates the pre-transfer consumption schedules under autarky and free trade, as functions of Y. It assumes that Y^* is fixed. The two schedules are as defined in equations (5) and (6):

$$\begin{cases} c^{AUT}(Y) & = Y \\ c^{FT}(Y) & = Y\left[1+\phi^{-1}p^{\sigma-1}\right]^{\frac{1}{\sigma-1}} \\ & = Y \cdot g(p) > Y. \end{cases}$$

Given these schedules, the costs of default are represented by the slope of the consumption schedules. If the slope is greater, then the loss of consumption due to a default is greater.

We know that both consumptions will be zero when the endowment Y is zero.

$$\begin{cases} c^{AUT}(0) & = 0 \\ \lim\limits_{Y \xrightarrow{+} 0} c^{FT}(Y) & = 0. \end{cases}$$

Also, as Y goes to infinity, gains from trade will disappear ($g(p) \to 1$), and the two consumption schedules will converge as described as follows:

$$\lim_{Y \to \infty} (c^{FT}(Y) - c^{AUT}(Y)) = 0.$$

In addition, positive gains from trade, $g(p) > 1$, assure that consumption under free trade is greater than that under autarky.

$$c^{FT}(Y) > c^{AUT}(Y) \quad \forall\, Y \in (0, \infty).$$

Therefore, using the mean value theorem, there exists at least one $Y \in (0, \infty)$ such that the slope of the free trade consumption is equal to that under autarky.

$$\exists\, \bar{Y} \in (0, \infty) \text{ s.t. } \frac{\partial c^{FT}(Y)}{\partial Y} = \frac{\partial c^{AUT}(Y)}{\partial Y} = 1. \tag{A.1}$$

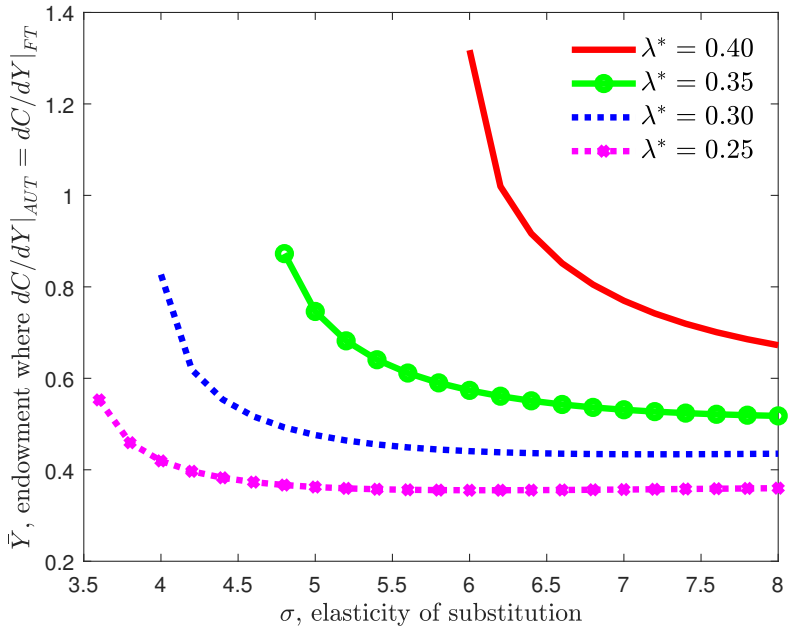
Take a sequence of $\{\bar{Y}\}$ that satisfies equation (A.1), and order them as $\{\bar{Y}^i\}$, $i = 1,2,...$ so that $\bar{Y}^i < \bar{Y}^{i+1}$ for all i. For all values of Y such that $Y < \bar{Y}$, the slope of the consumption schedule is greater under free trade than autarky, meaning that default costs are also greater.

Figure A1 plots numerically determined $\bar{Y}$'s, relative to $\bar{Y}^*$. As elasticity of substitution increases, the gains from trade diminish thus the terms of trade effects dominate. This lowers the value of $\bar{Y}$. Also, as foreign bias increases, the terms of trade deteriorates since the foreign country values home's good less. This pushes up the value of $\bar{Y}$. Lastly, a change in the sovereign's home bias has an ambiguous effect on $\bar{Y}$. An increase in home bias improves its terms of trade, but at the same time the sovereign values imported goods less.

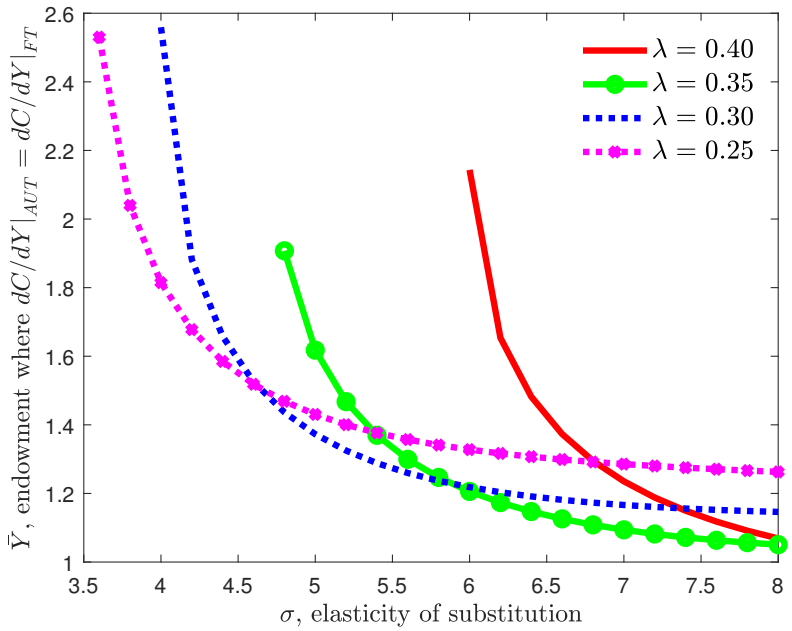
Nevertheless, one can see from these plots that, under reasonable parameters — $\sigma \approx 5$, and the home bias parameter is greater than 0.5 — the value of $\bar{Y}$ is very large. In the numerical exercise in Section 4, the variable space comfortably fits into the region where $Y < \bar{Y}$.

Figure A1: The level of endowment $\bar{Y}$ with different parameter values

Panel A: $\bar{Y}$ when $\lambda = 0.5$



Panel B: $\bar{Y}$ when $\lambda^* = 0.5$



Notes: The figure shows the relationship between $\bar{Y}$, the level of endowment with $\partial C/\partial Y|_{AUT} = \partial C/\partial Y|_{FT}$, and the elasticity of substitution σ for different values of λ and λ^*.

B Data

B.1 Data sources

Variables	Data sources
• Default episodes	Asonuma and Trebesch (2016) De Paoli et al. (2006) Detragiache and Spilimbergo (2001) Kuvshinov and Zimmermann (2017) Furceri and Zdzienicka (2012) Levy-Yeyati and Panizza (2011) Laeven and Valencia (2008) Reinhart et al. (2003) Trebesch and Zabel (2017)
• Paris Club debt restructuring episodes	Das et al. (2012)
• Interest rates on external debt (private creditors)	*International Financial Statistics* (IMF, 2018b)
• Interest rates on external debt (official creditors)	*International Financial Statistics* (IMF, 2018b)
• Openness	*Penn World Table* (Feenstra et al., 2015)
• GDP (constant USD)	*World Development Indicators* (World Bank, 2018b)
• GDP per capita (constant USD)	*World Development Indicators* (World Bank, 2018b)
• GDP growth rate (constant USD)	*World Development Indicators* (World Bank, 2018b)
• Total interest payments-to-GDP ratio	GFDD (World Bank, 2018a)
• Public debt-to-GDP ratio	GFDD (World Bank, 2018a)
• Political stability index	International Country Risk Guide, The PRS Group, Inc.
• Inflation rates	*World Development Indicators* (World Bank, 2018b)
• Tariffs applied (weighted average of all products)	*World Development Indicators* (World Bank, 2018b)
• Credit ratings	*Institutional Investor Magazine*

Notes: GFDD indicates the *Global Financial Development Database*. The data on default episodes in De Paoli et al. (2006), Detragiache and Spilimbergo (2001), Levy-Yeyati and Panizza (2011), Laeven and Valencia (2008), and Reinhart et al. (2003) are retrieved from a summary table in Furceri and Zdzienicka (2012). The political stability index is the mean of seven political stability indices including government stability, socioeconomic conditions, investment profiles, internal conflicts, external conflicts, corruption, and military in politics.

B.2 Summary statistics

Table A1 presents summary statistics of variables used in Table 1. Table A2 presents summary statistics of variables used in Tables 2 and 3. Summary statistics of additional variables for robustness checks in Appendix D are presented in Table A3. These summary statistics are for the sample used in column (1) of each of the regression tables. Therefore, the sample sizes are the same for some variables.

Table A1: Summary statistics for the sample in Table 1

	Obs	Mean	Std. dev.	Min	Max
Number of defaults	124	1.52	1.94	0	7
Openness	124	0.37	0.36	0	1.98
ln(GDP per capita)	87	7.74	1.52	4.97	10.22
ln(GDP)	87	23.42	2.29	18.81	29.10
Debt-to-GDP ratio	84	29.23	30.38	0	152.05
Political stability index	102	3.96	2.34	0	7.75

Table A2: Summary statistics for the sample in Tables 2 and 3

	Obs	Mean	Std. dev.	Min	Max
Interest rates on external debt (private creditors)	2,943	4.02	4.12	0	20.28
Openness	2,943	0.49	0.44	0	2.77
Medium-sized country dummy × Openness	2,943	0.24	0.41	0	2.44
Large country dummy × Openness	2,943	0.14	0.31	0	2.77
Short-term interest payments	1,731	0.21	0.28	0	1.85
GDP growth rate	2,869	0.04	0.09	-0.54	1.09
ln(GDP per capita)	2,622	8.00	1.61	4.74	11.36
Debt-to-GDP ratio	1,584	0.54	0.43	0	2.22
ln(1+Inflation rate/100)	2,681	0.15	0.39	-0.32	4.92
Arrears/GNI ratio	2,499	0.00	0.02	0	0.20
Default dummy	2,943	0.03	0.16	0	1

Table A3: Summary statistics for additional variables for robustness checks

	Obs	Mean	Std. dev.	Min	Max
Paris Club debt restructuring dummy	1,342	0.03	0.18	0	1
Total number of Paris Club debt restructurings	124	1.44	1.97	0	7
Interest rates on external debt (official creditors)	1,052	3.20	3.28	0	13.87
Credit ratings (100 = best, 0 = worst)	1,342	33.31	22.33	0	95.87
Tariffs, $\ln(1 + T_c/100)$	1,342	0.08	0.08	0	1.65
Tariffs imposed by other countries, $\ln(1 + T_c^{Other}/100)$	1,342	0.01	0.01	0	0.10

C Sample countries

C.1 Sample countries for Figures 2 and 3

Figures 2 and 3 are based on 125 countries where openness data are available. The least open countries (openness is less than the 50th percentile) are the following 62 countries:

> Albania, Angola, Argentina, Australia, Benin, Brazil, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Central African Rep., Chile, China, Colombia, Congo, Ecuador, Egypt, Ethiopia, France, Gambia, Greece, Guinea, India, Indonesia, Iraq, Japan, Lao People's Dem. Rep., Lebanon, Malawi, Maldives, Mexico, Mongolia, Morocco, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Paraguay, Peru, Philippines, Poland, Portugal, Rep. of Korea, Romania, Rwanda, Seychelles, South Africa, Spain, Sri Lanka, Thailand, Togo, Turkey, Uganda, United Arab Emirates, United Rep. of Tanzania, Uruguay, USA, Vietnam, and Zimbabwe.

The moderately open countries (openness is between the 50th and the 75th percentiles) are the following 31 countries:

> Algeria, Austria, Bolivia, Cameroon, Canada, Macao SAR (China), Costa Rica, Côte d'Ivoire, Cyprus, Denmark, El Salvador, Finland, Germany, Guatemala , Honduras, Hungary, Israel, Italy, Jamaica, Jordan, Madagascar, Mauritania, Mauritius, Mozambique, New Zealand, Panama, Saudi Arabia, Senegal, Switzerland, Tunisia, and the United Kingdom.

The most open countries (openness is greater than the 75th percentile) are the following 32 countries:

> Antigua and Barbuda, Aruba, Bahamas, Bahrain, Barbados, Belgium, Belize, Bermuda, Botswana, Brunei Darussalam, Hong Kong SAR (China), Dominican Rep., Fiji, Iceland, Ireland, Kuwait, Luxembourg, Malaysia, Malta, Namibia, Netherlands, Norway, Oman, Qatar, Saint Kitts and Nevis, Saint Lucia, Sierra Leone, Singapore, Suriname, Sweden, Trinidad and Tobago, and Zambia.

C.2 Sample countries for Table 2

Regressions in Table 2 are based on 70 countries and introduce dummy variables for large countries and medium-sized countries based on GDP data from 1995. The large countries (GDP is greater than the 75th percentile) are the following 21 countries:

> Brazil, Canada, Hong Kong SAR (China), Colombia, France, India, Jamaica, Japan, Maldives, Mexico, Myanmar, Netherlands, Norway, Poland, Portugal, Russia, South Africa, Spain, Switzerland, Thailand, and Turkey

The medium-sized countries (GDP is between the 25th and the 75th percentiles) are the following 32 countries:

> Angola, Azerbaijan, Bahamas, Bahrain, Bolivia, Botswana, Cameroon, Chile, Costa Rica, Cyprus, Egypt, Estonia, Ethiopia, Guatemala, Ireland, Kazakhstan, Kuwait, Luxembourg, Malta, Morocco, Pakistan, Peru, Philippines, Serbia, Sri Lanka, Tunisia, Uganda, Ukraine, Uruguay, Yemen, Zambia, and Zimbabwe

The small countries (GDP is less than the 25th percentile) are the following 17 countries:

> Armenia, Aruba, Belize, Bermuda, Central African Rep., Gambia, Guinea, Madagascar, Malawi, Mauritius, Mongolia, Nicaragua, Niger, Rep. of Moldova, Rwanda, Saint Kitts and Nevis, and Suriname

C.3 Sample countries for Table 3

Regressions in Table 3 are based on 144 countries and introduce dummy variables for large countries and medium-sized countries based on GDP data from 1995. The large countries (GDP is greater than the 75th percentile) are the following 35 countries:

> Antigua and Barbuda, Armenia, Aruba, Barbados, Belize, Benin, Bermuda, Bosnia Herzegovina, Burkina Faso, Burundi, Cabo Verde, Cambodia, Central African Rep., Fiji, Gambia, Georgia, Guinea, Lao People's Dem. Rep., Madagascar, Malawi, Mauritania, Mauritius, Mongolia, Mozambique, Nicaragua, Niger, Rep. of Moldova, Rwanda, Saint Kitts and Nevis, Saint Lucia, Seychelles, Sierra Leone, Suriname, Togo, and United Arab Emirates

The medium-sized countries (GDP is between the 25th and the 75th percentiles) are the following 69 countries:

> Albania, Algeria, Angola, Azerbaijan, Bahamas, Bahrain, Belarus, Bolivia, Botswana, Brunei Darussalam, Bulgaria, Cameroon, Chile, Macao SAR (China), Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czechia, Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Guatemala, Honduras, Hungary, Iceland, Iraq, Ireland, Israel, Jordan, Kazakhstan, Kuwait, Latvia, Lebanon, Luxembourg, Malaysia, Malta, Morocco, Namibia, Nepal, New Zealand, Nigeria, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Romania, Senegal, Serbia, Slovakia, Slovenia, Sri Lanka, Macedonia, Trinidad and Tobago, Tunisia, Uganda, Ukraine, United Rep. of Tanzania, Uruguay, Viet Nam, Yemen, Zambia, and Zimbabwe

The small countries (GDP is less than the 25th percentile) are the following 40 countries:

> Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Hong Kong SAR (China), Colombia, Denmark, Finland, France, Germany, Greece, India, Indonesia, Italy, Jamaica, Japan, Lithuania, Maldives, Mexico, Montenegro, Myanmar, Netherlands, Norway, Poland, Portugal, Qatar, Rep. of Korea, Russia, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, and USA

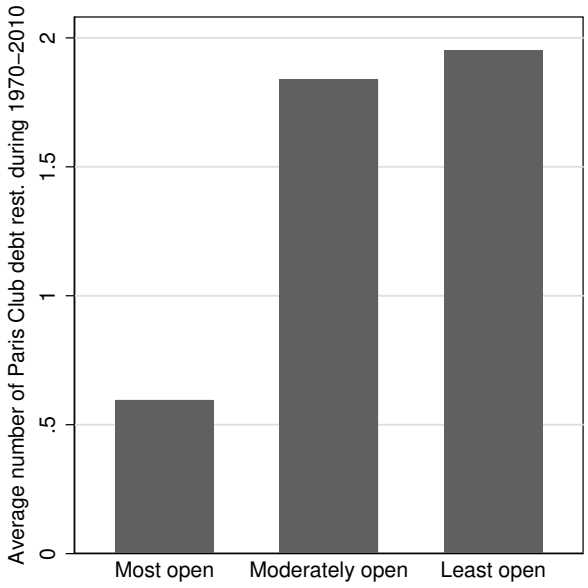
D Robustness checks

D.1 Paris Club debt restructurings

Section 3 in the main text examines the openness effects on countries' defaults on their debt owned by, and the bond interest rates for, private creditors. This is because our theoretical model implicitly assumes that a country's debt is owned by private creditors — due to the assumption that there are many and animistic creditors. However, it is important to consider debt restructurings with official creditors in the empirical context because official creditors have played a critical role in debt restructurings (Cheng et al., 2018). As explained in Das et al. (2012) and Cheng et al. (2018), since 1956 the Paris Club has conducted debt rescheduling negotiation with creditors in an organized manner.

The purpose of this section is to show our empirical results presented in the main text also hold true even if we consider creditors in the public sector. We examine the effect of openness on Paris Club debt restructurings, which are debt negotiations with creditors from the public sector, and the bond interest rate for official public sector creditors.

Figure A2: Average number of Paris Club debt restructurings by the degree of openness



Notes: The figure shows the average number of defaults for countries in each group. The default episodes come from Das et al. (2012). The most open countries are defined as countries where their openness measures are greater than the 75th percentile of distribution in 1970. The moderately open countries are those between the 50th percentile and the 75th percentile. The least open countries are those less than the 50th percentile. Because there are serial Paris Club debt restructurings that should be considered as one episode, the figure drops episodes occurred in the following years of another Paris Club debt restructurings in the same country. See Appendix C for a list of these groups of countries.

We employ the data on Paris Club debt restructurings from Das et al. (2012), covering episodes during 1950-2010. We only use the data after 1970, covering 411 episodes. See Das et al. (2012) for a list of debt restructuring episodes. Figure A2 shows the average number of Paris Club debt restructurings between 1970 and 2010 for three groups of countries — most open countries (openness is greater than the 75th percentile), moderately open countries (between the 50th and the 75th percentiles), and least open countries (less than the 50th percentile) based on the openness data in 1970. It indicates that the least open countries experienced, on average, almost two Paris Club debt restructurings during the period. On the other hand, the most open countries had only 0.5 debt restructurings on average. The moderately open countries are in the middle of the two groups of countries in terms of its average number of debt

restructurings. These results suggest that Paris Club debt restructurings are mainly conducted in less open countries.

We also use a panel dataset to investigate the relationship between openness and the bond's interest rate charged by official creditors and to examine if the openness effects vary by country size. Table A4 summarizes results from estimating equations (9) and (10) by employing the bonds' interest rate for official creditors as the dependent variable. Column (5), introducing the largest number of control variables, shows that a 100 percentage points increase in openness reduces the bonds' interest rate by 2.18 percent in small countries. Estimated marginal effects of openness, reported in the bottom of the table, are insignificant for middle-sized countries and large countries. However, the size of the coefficients are consistent with the theory — the openness effects are smaller for larger countries. The results are qualitatively similar to the ones presented in Table 2.

Table A4: Openness effects on the bonds' interest rates for official creditors

Dependent variable = the bonds' interest rates for official creditors

	(1)	(2)	(3)	(4)	(5)
Openness	-1.101*	-1.411**	-4.439***	-4.001***	-2.180*
	(0.568)	(0.695)	(0.907)	(1.026)	(1.291)
$D^{Medium}\times$ Openness		-0.302	-0.464	-0.274	1.033
		(1.086)	(1.417)	(1.485)	(1.330)
$D^{Large}\times$ Openness		3.628***	4.219	3.604	4.652
		(1.126)	(3.508)	(3.940)	(4.041)
$D^{Medium}\times f_t$ and $D^{Large}\times f_t$		✓	✓	✓	✓
R-squared	0.107	0.111	0.198	0.199	0.214
Observations	2,943	2,943	1,701	1,613	1,100
Countries	70	70	57	57	55
Controls					
Interest payments-to-GDP ratio			X	X	X
GDP growth rate				X	X
ln(GDP per capita)				X	X
Debt-to-GDP ratio					X
Inflation rate					X
Default dummy					X
Linear combination of coefficients					
Medium-sized countries		-1.713	-4.903***	-4.275***	-1.147
		(0.835)	(1.055)	(1.046)	(1.498)
Large countries		2.216**	-0.220	-0.398	2.472
		(0.886)	(3.369)	(3.759)	(4.038)

Notes: The dependent variable is the bonds' interest rates. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Standard errors, clustered at the country-level, are in parentheses. All regressions include a constant term and country fixed effects. Columns (2)-(5) introduce interaction terms year fixed effects f_t and D^{Medium} (or D^{Large}) in order to identify the openness effects in medium-sized countries (or large countries). See Appendix C for a list of these groups of countries.

Table A5 shows results from estimating equation (11) by replacing the private-sector default dummy with the Paris Club debt restructuring dummy. The table is presented in the same manner as for Table 3. Column (5) shows that a 100 percentage increase in openness reduces the probability of Paris Club debt restructuring by 40.7 percent in small countries. The same change in openness reduces the probability of debt restructuring by 16.4 percent and 11.9 percent in medium-sized and large countries, respectively.

Again, the results summarized in Table A5 are essentially the same as the ones in Table 3.

Overall, the empirical analyses presented in this section show that the model's theoretical predictions are consistent with the data even if we consider countries' debt restructurings with official creditors — Paris Club debt restructurings — and the interest rates on external debt for creditors from the public sector. To summarize, a greater openness reduces the probability of debt restructurings and the bonds' interest rate. Also, these openness effects are greater for small countries than larger countries.

Table A5: Openness effects on the probability of Paris Club debt restructurings, Logit

Dependent variable = the Paris Club debt restructuring dummy

	(1)	(2)	(3)	(4)	(5)
Openness, small countries	-0.068***	-0.136***	-0.128***	-0.130***	-0.407**
	(0.022)	(0.044)	(0.044)	(0.050)	(0.197)
Observations	1,446	959	944	944	295
Countries	35	29	29	29	14
Openness, medium-sized countries	-0.098***	-0.090***	-0.081***	-0.088***	-0.164*
	(0.018)	(0.028)	(0.028)	(0.031)	(0.091)
Observations	2,787	1,621	1,592	1,575	548
Countries	69	59	59	58	27
Openness, large countries	-0.077***	-0.061	-0.066	-0.199**	-0.119
	(0.022)	(0.057)	(0.056)	(0.095)	(0.135)
Observations	1,674	535	526	451	184
Countries	40	26	26	26	14
Controls					
Interest payments-to-GDP ratio		X	X	X	X
GDP growth rate			X	X	X
ln(GDP per capita)				X	X
Debt-to-GDP ratio					X
Inflation rate					X
Arrears-to-GNI ratio					X

Notes: The table reports marginal effects of a 100 percentage point increase in openness. Delta-method standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. See Appendix C for a list of these groups of countries.

D.2 Addressing potential endogeneity of openness

Openness is potentially subject to endogeneity. A sovereign default reduces imports and exports as documented in a number of articles (e.g., Rose, 2005; Martinez and Sandleris, 2011; Zymek, 2012; and Asonuma et al., 2016). Therefore, countries that experienced a default in the past may have a lower degree of openness. Moreover, as shown in Asonuma (2016), a previously defaulted country is more likely to have a default in the following years for the same value of debt-to-GDP ratio. As a result, a combination of these facts results in a spurious negative relationship between openness and the default likelihood — therefore the bonds' interest rate — because a smaller openness caused by a previous default would seem to be related with the next default that is actually caused by serial defaulters' other characteristics. This section addresses this potential issue by using a 2SLS.

D.2.1 Identification strategy

Our identification strategy is similar to Romalis (2007) where he examines the effect of trade openness on countries' GDP growth rates by instrumenting openness by tariffs. A reduction of tariffs increases imports of the country, which increases its openness. One may argue that tariffs do not satisfy the exclusion restriction because it directly affects the likelihood of default by changing the country's tariff revenue, therefore its overall fiscal revenue. However, countries' tariff revenue accounts for a small share of the overall fiscal revenue. As of 1970, for example, the medium share of tariff revenue in total fiscal revenue is eight percent according to the *World Development Indicators* (World Bank, 2018b). Therefore, we argue that tariffs do not have a statistically significant direct effect on our dependent variables. Also, statistical tests suggest that tariffs are indeed a valid instrument (see Sargan statistics in Tables A6 and A7).

We also employ the average tariff rate applied by all other countries besides the country as instrument. The variable is defined as follows: $T_c^{Other} = \sum_{k \neq c}^{N} T_k/(N-1)$ where T_c denotes tariff rates applied by country c and N is the number of countries that tariff data are available. A reduction of tariffs applied by all other countries increases exports from the country, which increases openness. However, changes in tariffs applied by all other countries do not affect the country's default likelihood and the bond interest rate other than through openness. Therefore, this variable is a valid instrument. These tariffs variables are introduced to regression as $\ln(1 + T_c/100)$ and $\ln(1 + T_c^{Other}/100)$, respectively.

Regressions in the main text introduce interaction terms between openness and country size dummy variables in order to investigate if the openness effects vary across countries. However, instead of introducing interaction terms, in this section we split the sample into two groups — small countries and larger countries (medium-sized and large countries) — because it is hard to instrument both openness and its interaction terms. We divide the sample to two groups (instead of three groups) in order to keep the sample size as great as possible because IV estimates lose consistency for a small sample. Small countries are classified as one group because we are particularly interested in openness effects in small countries.

D.2.2 The bonds' interest rate

Table A6 shows results from estimating the openness effects on the bonds' interest rates. It uses the same sets of controls as for Table 2. Panel A shows results with a full sample, suggesting that a 1 percentage point increase in openness reduces the bonds' interest rates by 0.11 to 0.21 percent. The openness effects are statistically significant at the 1 percent level in all columns. Results from small countries and medium-sized & large countries are presented in Panels B and C, respectively. These show that small countries have greater openness effects than larger countries. A 1 percentage point increase in openness reduces the bonds' interest rates by 0.16 to 0.40 percent in small countries. On the other hand, the same increase in openness reduces the bond interest rates by 0.10 to 0.14 percent only in larger countries. These results are qualitatively similar to the ones in Table 2.

D.2.3 Countries' credit ratings

We are also interested in the effect of openness on the default likelihood. However, it is hard find the instrumented effect of openness on the default probability because the dependent variable is a default dummy, which takes either 0 or 1, and it is not a continuous variable. Note that the instrumented openness effects are the local average treatment effect of changes in openness caused by changes in tariffs. If the dependent variable were a dummy taking 1 only if there is a default, we observe an event of default at an extreme situation that a country cannot repay its debt. A change in tariffs alters openness, which in turn affects the default probability but we do not observe a default event unless the change in the default probability is extreme. As a result, the local average treatment effect of changes in openness caused by tariffs would be seriously biased. Therefore, we employ countries' credit ratings as a proxy of default

probability. Data on credit ratings are retrieved from the *Institutional Investor Magazine*. It takes a value between 0 and 100 and a greater value means that its credit rating is better.

Table A6: Openness effects on the bonds' interest rate for private creditors, 2SLS

Dependent variable = the bonds' interest rate for private creditors

	(1)	(2)	(3)	(4)
		Panel A: Full sample		
Openness	-0.113***	-0.133***	-0.142***	-0.213***
	(0.021)	(0.027)	(0.033)	(0.064)
Observations	1,051	698	668	472
Countries	69	46	44	43
Cragg-Donald Wald F-stat.	10.58	15.76	13.14	2.71
Sargan stat.	0.407	0.241	0.278	0.001
p-value of Sargan stat.	0.524	0.623	0.598	0.980
		Panel B: Small countries		
Openness	-0.166***	-0.160***	-0.157***	-0.402**
	(0.053)	(0.051)	(0.056)	(0.188)
Observations	255	202	201	136
Countries	17	13	13	13
Cragg-Donald Wald F-stat.	48.87	33.32	21.89	9.15
Sargan stat.	0.446	2.181	2.481	1.023
p-value of Sargan stat.	0.504	0.140	0.115	0.312
	Panel C: Medium-sized and large countries			
Openness	-0.094***	-0.122***	-0.139***	-0.128**
	(0.021)	(0.033)	(0.041)	(0.065)
Observations	796	496	467	336
Countries	52	33	31	30
Cragg-Donald Wald F-stat.	52.27	49.49	33.77	11.39
Sargan stat.	0.153	0.000	0.005	0.060
p-value of Sargan stat.	0.695	0.988	0.942	0.806
Controls				
Interest payments-to-GDP ratio		X	X	X
GDP growth rate			X	X
ln(GDP per capita)			X	X
Debt-to-GDP ratio				X
Inflation rate				X
Default dummy				X

Notes: The table shows the effect of a 1 percentage point increase in openness on the bonds' interest rate for private creditors. Openness is instrumented by the tariff rate applied by a country and the average tariff rate applied by all other countries besides that country. All regressions include a constant term and country fixed effects. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Standard errors are in parentheses. See Appendix C for a list of these groups of countries.

Table A7 shows results from estimating regressions employing countries' credit ratings as the dependent variable. A greater openness raises the country's credit rating. Therefore, we expect positive coefficients for openness. Panel A describes results from using a full sample. It shows that a 1 percentage point increase in openness raises credit ratings by 0.74 to 0.95. The openness effects are statistically significant at the 1 percent level in all columns.

Results from using small countries and medium-sized & large countries are presented in Panels B and C, respectively. These show that the openness effects are greater for small countries than larger countries. A 1 percentage point increase in openness raises credit ratings by 0.9 to 1.1 in small countries. On the other hand, the same increase in openness raises credit ratings by 0.56 to 0.89 only in larger countries. Overall, these results suggest the estimated effects of openness are consistent with the model's theoretical predictions.

Table A7: Openness effects on countries' credit ratings, 2SLS

Dependent variable = credit ratings (100 = best, and 0 = worst)

	(1)	(2)	(3)	(4)
	Panel A: Full sample			
Openness	0.737***	0.954***	0.800***	0.820***
	(0.063)	(0.102)	(0.111)	(0.140)
Observations	1,327	943	922	905
Countries	107	77	74	74
Cragg-Donald Wald F-stat.	85.30	53.37	35.21	23.77
Sargan stat.	0.007	0.015	0.063	0.030
p-value of Sargan stat.	0.932	0.903	0.802	0.862
	Panel B: Small countries			
Openness	0.906***	1.145***	1.047***	1.129***
	(0.204)	(0.255)	(0.275)	(0.367)
Observations	363	299	299	289
Countries	29	24	24	24
Cragg-Donald Wald F-stat.	12.58	10.08	7.68	4.94
Sargan stat.	0.003	0.042	0.026	0.045
p-value of Sargan stat.	0.955	0.838	0.871	0.833
	Panel C: Medium-sized and large countries			
Openness	0.686***	0.885***	0.632***	0.560***
	(0.059)	(0.103)	(0.105)	(0.116)
Observations	964	644	623	616
Countries	78	53	50	50
Cragg-Donald Wald F-stat.	85.98	49.73	30.62	22.67
Sargan stat.	0.048	0.492	0.405	0.471
p-value of Sargan stat.	0.827	0.483	0.524	0.493
Controls				
Interest payments-to-GDP ratio		X	X	X
GDP growth rate			X	X
ln(GDP per capita)			X	X
Debt-to-GDP ratio				X
Inflation rate				X
Default dummy				X

Notes: The table shows the effect of a 1 percentage point increase in openness on countries' credit ratings (100 = best, and 0 = worst). Openness is instrumented by the tariff rate applied by a country and the average tariff rate applied by all other countries besides that country. All regressions include a constant term and country fixed effects. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. Standard errors are in parentheses. See Appendix C for a list of these groups of countries.

E Default episodes

Table A8: Default episodes

No.	Country name (ISO)	Year	No.	Country name (ISO)	Year	No.	Country name (ISO)	Year
Asonuma and Trebesch (2016)			41	Madagascar (MDG)	1981	82	Tanzania (TZA)	1981
1	Albania (ALB)	1991	42	Madagascar (MDG)	1982	83	Togo (TGO)	1987
2	Algeria (DZA)	1993	43	Madagascar (MDG)	1985	84	Togo (TGO)	1991
3	Argentina (ARG)	1982	44	Madagascar (MDG)	1987	85	Turkey (TUR)	1976
4	Argentina (ARG)	1988	45	Malawi (MWI)	1987	86	Uganda (UGA)	1979
5	Argentina (ARG)	2001	46	Mauritania (MRT)	1992	87	Venezuela, RB (VEN)	1983
6	Bolivia (BOL)	1980	47	Moldova (MDA)	2001	88	Venezuela, RB (VEN)	1989
7	Bolivia (BOL)	1988	48	Morocco (MAR)	1983	89	Vietnam (VNM)	1982
8	Bosnia and H. (BIH)	1992	49	Mozambique (MOZ)	1983	90	Yemen, Rep. (YEM)	1983
9	Brazil (BRA)	1986	50	Nicaragua (NIC)	1978	91	Zaire (COD)	1975
10	Brazil (BRA)	1989	51	Nicaragua (NIC)	1983	92	Zaire (COD)	1982
11	Bulgaria (BGR)	1990	52	Nicaragua (NIC)	1985	93	Zaire (COD)	1983
12	Cameroon (CMR)	1985	53	Niger (NER)	1986	94	Zaire (COD)	1984
13	Congo, Rep. (COG)	1983	54	Nigeria (NGA)	1982	95	Zaire (COD)	1985
14	Congo, Rep. (COG)	1988	55	Nigeria (NGA)	1983	96	Zaire (COD)	1986
15	Costa Rica (CRI)	1981	56	Nigeria (NGA)	1986	97	Zaire (COD)	1987
16	Costa Rica (CRI)	1984	57	Nigeria (NGA)	1987	98	Zambia (ZMB)	1983
17	Costa Rica (CRI)	1986	58	Nigeria (NGA)	1989	De Paoli et al. (2006)		
18	Cote d'Ivoire (CIV)	1983	59	Pakistan (PAK)	1998	1	Albania (ALB)	1991
19	Cote d'Ivoire (CIV)	2000	60	Panama (PAN)	1987	2	Argentina (ARG)	1983
20	Croatia (HRV)	1992	61	Paraguay (PRY)	1986	3	Bulgaria (BGR)	1991
21	Dominican Rep. (DOM)	1982	62	Peru (PER)	1984	4	Bolivia (BOL)	1982
22	Dominican Rep. (DOM)	1987	63	Philippines (PHL)	1983	5	Brazil (BRA)	1983
23	Dominican Rep. (DOM)	2004	64	Poland (POL)	1981	6	Chile (CHL)	1983
24	Ecuador (ECU)	1986	65	Poland (POL)	1982	7	Cote d'Ivoire (CIV)	1987
25	Ecuador (ECU)	1999	66	Poland (POL)	1983	8	Congo, D.R. (COD)	1970
26	Ecuador (ECU)	2008	67	Poland (POL)	1986	9	Congo, D.R. (COD)	1983
27	Ethopia (ETH)	1990	68	Poland (POL)	1988	10	Costa Rica (CRI)	1985
28	Gabon (GAB)	1986	69	Poland (POL)	1989	11	Dominican R. (DOM)	1984
29	Gabon (GAB)	1989	70	Romania (ROU)	1981	12	Algeria (DZA)	1994
30	Gambia, The (GMB)	1984	71	Russia (RUS)	1991	13	Ecuador (ECU)	1987
31	Guinea (GIN)	1985	72	Russia (RUS)	1998	14	Georgia (GEO)	1994
32	Guinea (GIN)	1991	73	Russia (RUS)	1999	15	Grenada (GRD)	1987
33	Honduras (HND)	1981	74	Sao Tome & P. (STP)	1984	16	Guatemala (GTM)	1985
34	Honduras (HND)	1990	75	Senegal (SEN)	1981	17	Guyana (GUY)	1979
35	Iraq (IRQ)	1986	76	Senegal (SEN)	1992	18	Haiti (HTI)	1983
36	Jamaica (JAM)	1990	77	Serbia and M. (SRB)	1992	19	Indonesia (IDN)	1998
37	Jordan (JOR)	1989	78	Seychelles (SYC)	2008	20	Jordan (JOR)	1989
38	Kenya (KEN)	1992	79	Sierra Leone (SLE)	1980	21	Sri Lanka (LKA)	1990
39	Liberia (LBR)	1980	80	Slovenia (SVN)	1992	22	Morocco (MAR)	1983
40	Macedonia (MKD)	1992	81	Sudan (SDN)	1975	23	Mexico (MEX)	1982

No.	Country name (ISO)	Year	No.	Country name (ISO)	Year	No.	Country name (ISO)	Year
24	Nigeria (NGA)	1987	27	Kenya (KEN)	1990	13	Cote d'Ivoire (CIV)	1983
25	Nicaragua (NIC)	1978	28	Korea, Rep. (KOR)	1998	14	Cote d'Ivoire (CIV)	2000
26	Nicaragua (NIC)	1985	29	Sri Lanka (LKA)	1992	15	Cameroon CMR)	1985
27	Panama (PAN)	1987	30	Lesotho (LSO)	1990	16	Congo, D.R. (COD)	1976
28	Peru (PER)	1983	31	Morocco (MAR	1985	17	Congo, Rep. (COG)	1983
29	Philippines (PHL)	1984	32	Madagascar (MDG)	1990	18	Costa Rica (CRI)	1981
30	Paraguay (PRY)	1983	33	Mexico (MEX)	1982	19	Dominican R. (DOM)	1982
31	Russia (RUS)	1990	34	Malawi (MWI)	1982	20	Algeria (DZA)	1991
32	Syria (SYR)	1986	35	Malawi (MWI)	1987	21	Ecuador (ECU)	1982
33	Togo (TGO)	1978	36	Niger (NER)	1984	22	Ecuador (ECU)	1999
34	Togo (TGO)	1991	37	Nigeria (NGA)	1972	23	Gabon (GAB)	1986
35	Trinidad and T. (TTO)	1989	38	Nigeria (NGA)	1986	24	Gabon (GAB)	1999
36	Venezuela (VEN)	1984	39	Nicaragua (NIC)	1978	25	Ghana (GHA)	1987
37	Zambia (ZMB)	1981	40	Panama (PAN)	1987	26	Guinea (GIN)	1986
Detragiache and Spilimbergo (2001)			41	Peru (PER)	1983	27	Guinea (GIN)	1991
1	Argentina (ARG)	1983	42	Philippines (PHL)	1984	28	Gambia, The (GMB)	1986
2	Burundi (BDI)	1986	43	Paraguay (PRY)	1984	29	Guinea-Bissau (GNB)	1983
3	Burkina Faso (BFA)	1986	44	Sudan (SDN)	1976	30	Guatemala (GTM)	1986
4	Bangladesh (BGD)	1978	45	Senegal (SEN)	1984	31	Guatemala (GTM)	1989
5	Bangladesh (BGD)	1991	46	Senegal (SEN)	1989	32	Guyana (GUY)	1979
6	Brazil (BRA)	1983	47	Sierra Leone (SLE)	1972	33	Guyana (GUY)	1982
7	Chile (CHL)	1973	48	El Salvador (SLV)	1984	34	Honduras (HND)	1981
8	Chile (CHL)	1983	49	El Salvador (SLV)	1995	35	Haiti (HTI)	1982
9	Cote d'Ivoire (CIV)	1987	50	Thailand (THA)	1998	36	Indonesia (IDN)	1998
10	Cameroon (CMR)	1979	51	Trinidad and T. (TTO)	1988	37	Jamaica (JAM)	1978
11	Cameroon (CMR)	1985	52	Tunisia (TUN)	1991	38	Jamaica (JAM)	1981
12	Congo, D.R. (COD)	1975	53	Venezuela (VEN)	1984	39	Jamaica (JAM)	1987
13	Colombia (COL)	1985	54	Zambia (ZMB)	1978	40	Jordan (JOR)	1989
14	Costa Rica (CRI)	1981	Kuvshinov and Zimmermann (2017)			41	Kenya (KEN)	1994
15	Dominican R. (DOM)	1976	1	Argentina (ARG)	1982	42	Kenya (KEN)	2000
16	Dominican R. (DOM)	1982	2	Argentina (ARG)	1989	43	Liberia (LBR)	1981
17	Algeria (DZA)	1991	3	Argentina (ARG)	2001	44	Morocco (MAR)	1983
18	Ecuador (ECU)	1983	4	Burkina Faso (BFA)	1983	45	Morocco (MAR)	1986
19	Egypt (EGY)	1986	5	Bulgaria (BGR)	1990	46	Moldova (MDA)	1998
20	Ethiopia (ETH)	1987	6	Bolivia (BOL)	1980	47	Madagascar (MDG)	1981
21	Guatemala (GTM)	1985	7	Bolivia (BOL)	1986	48	Mexico (MEX)	1982
22	Honduras (HND)	1976	8	Bolivia (BOL)	1989	49	Myanmar (MMR)	1997
23	Honduras (HND)	1983	9	Brazil (BRA)	1983	50	Mauritania (MRT)	1992
24	Haiti (HTI)	1983	10	Central Af. Rep. (CAF)	1981	51	Malawi (MWI)	1982
25	Indonesia (IDN)	1998	11	Central Af. Rep. (CAF)	1983	52	Malawi (MWI)	1988
26	Jordan (JOR)	1989	12	Chile (CHL)	1983	53	Niger (NER)	1983

No.	Country name (ISO)	Year	No.	Country name (ISO)	Year	No.	Country name (ISO)	Year
54	Nigeria (NGA)	1982	4	Dominican R. (DOM)	1982	23	Guinea (GIN)	1985
55	Nigeria (NGA)	2001	5	Dominican R. (DOM)	1999	24	Gambia, The (GMB)	1986
56	Nicaragua (NIC)	1979	6	Ecuador (ECU)	1999	25	Grenada (GRD)	2004
57	Pakistan (PAK)	1998	7	Indonesia (IDN)	1998	26	Guyana (GUY)	1982
58	Panama (PAN)	1983	8	Mexico (MEX)	1982	27	Honduras (HND)	1981
59	Panama (PAN)	1987	9	Nigeria (NGA)	1983	28	Indonesia (IDN)	1999
60	Peru (PER)	1976	10	Nigeria (NGA)	1986	29	Iran (IRN)	1992
61	Peru (PER)	1978	11	Pakistan (PAK)	1997	30	Jamaica (JAM)	1978
62	Peru (PER)	1980	12	Peru (PER)	1980	31	Jordan (JOR)	1989
63	Peru (PER)	1984	13	Peru (PER)	1983	32	Liberia (LBR)	1980
64	Philippines (PHL)	1983	14	Philippines (PHL)	1983	33	Morocco (MAR)	1983
65	Paraguay (PRY)	1986	15	Russia (RUS)	1991	34	Moldova (MDA)	2002
66	Romania (ROU)	1981	16	Russia (RUS)	1998	35	Madagascar (MDG)	1981
67	Romania (ROU)	1986	17	Ukraine (UKR)	1998	36	Mexico (MEX)	1982
68	Russia (RUS)	1998	18	Uruguay (URY)	1990	37	Mozambique (MOZ)	1984
69	Sudan (SDN)	1979	19	Uruguay (URY)	2003	38	Malawi (MWI)	1982
70	Senegal (SEN)	1981	20	South Africa (ZAF)	1985	39	Nicaragua (NIC)	1980
71	Senegal (SEN)	1990	21	South Africa (ZAF)	1989	40	Panama (PAN)	1983
72	Senegal (SEN)	1992	Laeven and Valencia (2008)			41	Peru (PER)	1978
73	Sierra Leone (SLE)	1983	1	Angola (AGO)	1988	42	Philippines (PHL)	1983
74	Sierra Leone (SLE)	1986	2	Albania (ALB)	1990	43	Poland (POL)	1981
75	Togo (TGO)	1979	3	Argentina (ARG)	1982	44	Paraguay (PRY)	1982
76	Togo (TGO)	1982	4	Argentina (ARG)	2001	45	Romania (ROU)	1982
77	Togo (TGO)	1988	5	Bulgaria (BGR)	1990	46	Russia (RUS)	1998
78	Togo (TGO)	1991	6	Bolivia (BOL)	1980	47	Sudan (SDN)	1979
79	Turkey (TUR)	1978	7	Brazil (BRA)	1983	48	Senegal (SEN)	1981
80	Turkey (TUR)	1982	8	Chile (CHL)	1983	49	Sierra Leone (SLE)	1977
81	Tanzania (TZA)	1984	9	Cote d'Ivoire (CIV)	1984	50	Togo (TGO)	1979
82	Uganda (UGA)	1980	10	Cote d'Ivoire (CIV)	2001	51	Trinidad and T. (TTO)	1989
83	Ukraine (UKR)	1998	11	Cameroon (CMR)	1989	52	Turkey (TUR)	1978
84	Uruguay (URY)	1983	12	Congo, D.R. (COD)	1976	53	Tanzania (TZA)	1984
85	Uruguay (URY)	1987	13	Congo, Rep. (COG)	1986	54	Uganda (UGA)	1981
86	Uruguay (URY)	1990	14	Costa Rica (CRI)	1981	55	Ukraine (UKR)	1998
87	Venezuela (VEN)	1983	15	Dominica (DMA)	2002	56	Uruguay (URY)	1983
88	Venezuela (VEN)	1990	16	Dominican R. (DOM)	1982	57	Uruguay (URY)	2002
89	Zambia (ZMB)	1983	17	Dominican R. (DOM)	2003	58	Venezuela (VEN)	1982
90	Zimbabwe (ZWE)	2000	18	Ecuador (ECU)	1982	59	Vietnam (VNM)	1985
Levy-Yeyati and Panizza (2011)			19	Ecuador (ECU)	1989	60	South Africa (ZAF)	1985
1	Argentina (ARG)	1982	20	Egypt (EGY)	1984	61	Zambia (ZMB)	1983
2	Argentina (ARG)	2001	21	Gabon (GAB)	1986			
3	Chile (CHL)	1983	22	Gabon (GAB)	2002			

No.	Country name (ISO)	Year	No.	Country name (ISO)	Year
	Reinhart et al. (2003)		8	Dominican R. (DOM)	1982
1	Albania (ALB)	1990	9	Dominican R. (DOM)	2004
2	Argentina (ARG)	1982	10	Algeria (DZA)	1991
3	Bulgaria (BGR)	1990	11	Ecuador (ECU)	1982
4	Bolivia (BOL)	1980	12	Ecuador (ECU)	1999
5	Brazil (BRA)	1983	13	Ecuador (ECU)	2008
6	Chile (CHL)	1972	14	Jordan (JOR)	1989
7	Costa Rica (CRI)	1981	15	Morocco (MAR)	1983
8	Dominican R. (DOM)	1982	16	Mexico (MEX)	1982
9	Ecuador (ECU)	1982	17	Nigeria (NGA)	1982
10	Ecuador (ECU)	1989	18	Pakistan (PAK)	1998
11	Ecuador (ECU)	1999	19	Panama (PAN)	1983
12	Egypt (EGY)	1984	20	Peru (PER)	1983
13	Guyana (GUY)	1982	21	Philippines (PHL)	1991
14	Honduras (HND)	1981	22	Poland (POL)	1991
15	Iran (IRN)	1992	23	Romania (ROU)	1981
16	Jamaica (JAM)	1978	24	Romania (ROU)	1986
17	Jordan (JOR)	1989	25	Russia (RUS)	1991
18	Morocco (MAR)	1983	26	Turkey (TUR)	1981
19	Mexico (MEX)	1982	27	Ukraine (UKR)	1983
20	Panama (PAN)	1983	28	Ukraine (UKR)	2003
21	Peru (PER)	1978	29	Uruguay (URY)	1983
22	Peru (PER)	1984	30	Uruguay (URY)	2003
23	Philippines (PHL)	1983	31	Venezuela (VEN)	1982
24	Poland (POL)	1981	32	Venezuela (VEN)	2004
25	Romania (ROU)	1982	33	South Africa (ZAF)	1985
26	Russia (RUS)	1991	34	South Africa (ZAF)	1989
27	Russia (RUS)	1998	35	South Africa (ZAF)	1993
28	Trinidad and T. (TTO)	1989			
29	Turkey (TUR)	1978			
30	Uruguay (URY)	1983			
31	Venezuela (VEN)	1982			
32	Venezuela (VEN)	1995			
	Trebesch and Zabel (2017)				
1	Albania (ALB)	1991			
2	Argentina (ARG)	1982			
3	Argentina (ARG)	2001			
4	Bulgaria (BGR)	1990			
5	Brazil (BRA)	1983			
6	Chile (CHL)	1983			
7	Costa Rica (CRI)	1981			