Sovereign Default and International Trade

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Evidence suggests that sovereign defaults disrupt international trade. As a consequence, countries that are more open have more to lose from a sovereign default and are less inclined to renege on their debt. In turn, lenders should trust more open countries and charge them lower interest rate. In most cases, the country should also borrow more debt the more open it is. This paper formalizes this idea in a simple sovereign debt model *à la* Eaton and Gersovitz (1981). It also provides evidence using gravitational instrumental variables from Frankel and Romer (1999) and Feyrer (2019) as a source for exogenous variation for trade openness.

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1 Introduction

The main peculiarity of sovereign debt contracts is that repayments are not easily enforceable by the lender: a sovereign country with a strong enough army and divided enough lenders can default without expecting dire consequences. In the absence of enforceable contracts, a good borrower is someone with whom the lender has frequent business relations, as suggested by the repeated game literature. A borrower afraid of paying the cost of losing those relationships would be incentivized to repay debt (for an early version of this argument, see Hume). From the point of view of sovereign borrowing, a form of relation with the outside world can serve as a commitment device. An obvious form of such a reputational cost is the interruption of sovereign borrowing. However, Bulow and Rogoff (1989) proved an theorem about impossibility of sovereign debt if the only cost of default is the impossibility of borrowing in the future. We must therefore assume that some kind of relation with the outside world gets interrupted after a sovereign default, making it worth for a sovereign debtor repaying its debt under normal circumstances.

What kind of relationship with the outside world gets interrupted after a sovereign default exactly? Does it get interrupted for external reasons (other countries deciding to sanction defaulters) or internal reasons (destruction of the financial local markets, relying on sovereign debt)? The answer is not entirely clear from historical precedents nor from the literature, but an obvious candidate is international trade, because it summarizes relations with the outside world from a static point of view. As we show in figure 1, periods of decreasing commercial integration have coincided with global default waves since 1800. It suggests that during defaults, international trade decreases or vice-versa.

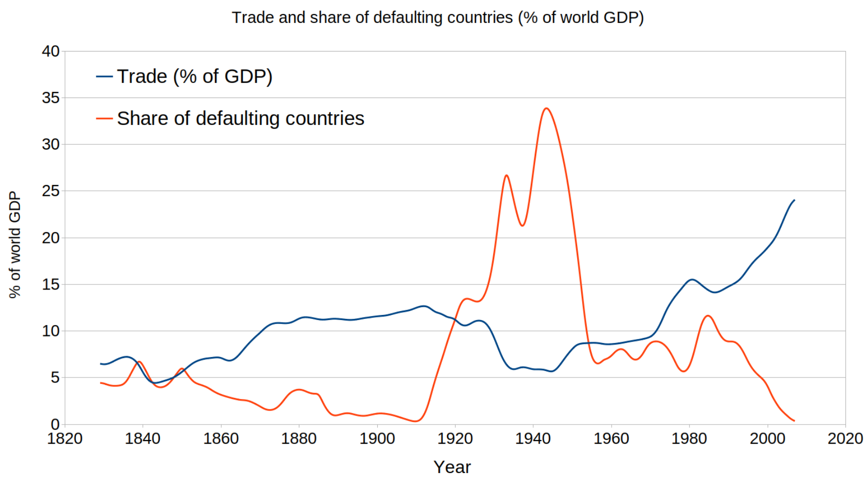

Figure 1.1: Trade and default from 1815 to 2007 (HP-filtered). Sources: Reinhart and Rogoff (2009), Fouquin and Hugot (2016)

This paper argues that international trade is an important component of non-reputational default costs. It argues that trade gets interrupted partially in the wake of a sovereign default. As a consequence, default is more costly for large traders. Indeed, larger gross trade flows imply that more is at stake when a government decides to go into financial autarky and to default. The defaulting country's inhabitants and firms can face tighter international constraints or trust issues which can affect their ability to trade internationally. Thus, governments in countries more open to trade should find it easier to borrow from international lenders: trade acts as a commitment device for these borrowers. We argue in favor of this mechanism with a simplified Eaton and Gersovitz (1981) model and provide empirical evidence in favor of it with cross-country regressions using instrumental variables for trade inspired by Frankel and Romer (1999) and Feyrer (2019) .

This paper completes our understanding of sovereign default costs but it also has important normative consequences. Indeed, a direct consequence of this paper's argument is that protectionist policies restricting both imports and exports should deteriorate government's ability to borrow.[1] Moreover, the large decrease in transport costs that has been observed since World War 2 can explain the development of sovereign debt markets: easier transport means more trade and more sensitivity to autarky as a result, therefore more commitment.

Section 2 starts with motivating evidence that sovereign defaults lead to a shrinkage in trade. It revisits the findings in Rose (2005) with updated data and more general controls. It finds that periods of default seem to coincide with declines in trade. It also finds that during a sovereign default, bilateral trade between a defaulter and its partners decreases by 10-50% depending on the specification.

Section 3 formalizes the idea with a simple model inspired by Eaton and Gersovitz (1981) where trade autarky is the cost of sovereign default. It finds that openness, defined as lower trade costs, improves a government's ability to borrow and also its actual borrowings in most cases.

Section 4 presents empirical results. Because of endogeneity concerns that trade variations depends on sovereign debt finance, we need to use instrumental variables, inspired by Frankel and Romer (1999) and Feyrer (2019). We define them using geographical predictors of trade and time variation in the relative importance of trade and sea distances and exploit them for regression analysis. They confirm the results Section 3: more openness leads to cheaper credit costs and to larger levels of debt as well. An increase in total volume of trade by 10% is shown to lead up to a 40 b.p. decrease in CDS spreads, and to a 3% increase in debt.

Literature Review One of the questions in the sovereign debt literature is why a sovereign should repay when there is no clear mechanism to enforce either repayment or punishment from the point of view of investors. Private firms may be constrained to

[1] Assuming these policies are suboptimal from a static point of view and there are no dynamic externalities: in this case, a protectionist policy is seen as a self-inflicted damage. Therefore, the cost of this kind of policies increases when one takes into account its effects on sovereign debt crises. The existence of an optimal positive tariff could change the direction of our claim. We do not explore these issues in this paper.

go bankrupt and their assets are then shared between their debtors when they default in developed financial markets. Direct invasions of defaulting countries by creditors have not been frequent since 1945, although they used to be frequent, as shown in Mitchener and Weidenmier (2010).[2] Government's assets cannot be seized easily. In that case, why should a sovereign borrower ever repay debt at any moment? Our suggestion to that old question is that international trade is a casualty of sovereign default, either because of sanctions or because of reliance of trade on sovereign debt finance (we stay agnostic about this mechanism).

Eaton and Gersovitz (1981), in a seminal paper, argue that reputation concerns may explain government's willingness to borrow. But Bulow and Rogoff (1989) that we cited earlier proved that the own model of Eaton and Gersovitz (1981) was not consistent with positive levels of borrowing, and one assume that there is direct cost for defaulting apart from financial autarky. Bulow and Rogoff (1989), like Kaletsky (1985) or Cole and Kehoe (1998), suggested the risk of trade wars or trade interruption, either because of retaliation, trade finance interruption or reputational spillovers was such a direct penalty of default. Mendoza and Yue (2012) directly used trade interruption as the cost of default, and they attributed it to trade credit, but focused on the dynamic implications of this assumption. In their model, trade finance deteriorates in bad times and the commercial interest rate is equal to the sovereign debt interest rate. As consequence, incentives to default in bad times get amplified. They did not study the effect of trade openness on sovereign debt finance as we do in this paper and focused more on the dynamic aspects of this assumption.

Most other sovereign debt papers took this cost of default as a given black box and rather focused on net trade flows rather than gross trade flows: current account and its relation to business cycles should indeed matter for sovereign debt, as underscored by Aguiar and Gopinath (2007) or Aguiar and Gopinath (2006). But relations between debtor country and the rest of the world is not summarized by debt or net trade flows. It also relies on *gross* trade flows. There are more general reputation concerns that are not about *intertemporal* trade, but also about *intratemporal* trade: Cole and Kehoe (1998) argued there might be reputation spillovers on other activities, such as trade, but they have not been studied widely. There has also been a trade literature focused on the links between intertemporal and intratemporal trade: Eaton et al. (2016), Reyes-Heroles (2016). Kikkawa and Sasahara (2020) study more explicitly the relation between trade and sovereign default. In their model, default is associated with a negative productivity shock, as in Arellano (2008). This negative productivity shock limits countries' incentives' to default. In the presence of trade, Kikkawa and Sasahara (2020) note that the same productivity is also associated with terms-of-trade effects that affect both the value of a country's endowment as well as the value of its debt and, in turn, its probability to default. In contrast, default in our model is associated with a demand rather than a supply shock: countries that default lose foreign demand, while their endowments remain unchanged. This implies, in particular, that more openness to trade always creates less

[2] For example, the small state of Newfounland, as a consequence of its default in 1933, lost its sovereignty to Canada.

incentives to default in our model.

Fitzgerald (2012) also studied the link between risk sharing between countries and trade costs, following a suggestion made by Obstfeld and Rogoff (2000) that international macroeconomic puzzle might be attributed to trade costs. However, these papers do not feature defaultable sovereign debt.

The trade disruption occurring after sovereign default has been documented in several papers, prominently in Rose (2005), whose evidence we replicate later; similar contributions include Manasse and Roubini (2009). Martinez and Sandleris (2011), Kohlscheen and OâConnell (2008), Borensztein and Panizza (2009), Zymek (2012) found similar results, arguing that trade credit was the driver of this effect, rather than direct sanctions. On the microeconomic level, Gopinath and Neiman (2014), Borensztein and Panizza (2010), Arteta and Hale (2008) , Hébert and Schreger (2017) found in different contexts that exporting firms were disproportionately hurt by sovereign default, which is quite consistent with our hypothesis.

2 Motivational Evidence: Trade Collapse After Default

In this Section, we update findings in Rose (2005) including more recent years, with a different method: instead of defining default as an event, we are going to distinguish default phrases (from default to the end of restructuring) as in Reinhart and Rogoff (2009). We are also going to use more data points and to allow for more general controls: for example, a bilateral pair fixed effect and time-varying regional fixed effects, instead of geographical predictors of trade and simple year fixed effects.

2.1 Data and Specification

To define sovereign defaults, we use data by Reinhart and Rogoff (2009), available on their website and updated up to 2012. Their data starts in 1800 and allows use to include some early sovereign defaults. In their data, a country is considered defaulting as long as it did not find an agreement with creditors (on average, this period lasted 7 years). Therefore, restructuring to date the end of default has a broader end than Rose (2005) who used Paris debt renegotiations to define defaulting countries. Rose (2005) found lasting effects that were similar from one year to the other: however, the size of the effect of default on trade did not vary significantly in his findings, so that we do not study the dynamic effects of default. We also use CEPII data from Fouquin and Hugot (2016) that give historical series of bilateral trade data and allow us to go far as back as 1800 to estimate the effect of sovereign default on bilateral trade data.

We test the following equation with different sets of controls for all pairs of countries (i, j) and all years t:

$$\ln Exports_{i,j,t} = \gamma^e D_{i,t} + \gamma^i D_{j,t} + \beta Controls_{i,j,t} + \varepsilon_{i,j,s,t} \tag{2.1}$$

where $Exports_{i,j,t}$ is exports from country i to country j at year t, of which we take the log, except when we want to include null observations, in which case we use inverse hyperbolic sine, equivalent to log for large values but equal to 0 in 0^3. $D_{i,t}$ is a dummy variable indicating whether a country is still defaulting, $Controls_{i,j,t}$ is a set of controls including at least a pair fixed effect $\alpha_{i,j}$ taking into account all possible fixed predictors of trade and a year fixed effect α_t taking into account variation. We allow for several other types of controls, as a time varying pair fixed effect $\alpha_{i,j,c(t)}$ defined for different bins of data (every 20 years), regional year fixed effects $\alpha_{R(i),t}$ and $\alpha_{R(j),t}$ for large regions.[4] We also allow for more flexibility to the structure by including the possibility of time-varying bilateral trade functions: if p is a function that associates a period to each year (for example, decades, every 20 years), we can control for time-varying pair fixed effects $\alpha_{i,j,p(t)}$ and still find significant effect of default on imports.

2.2 Results

We run equation 2.1 with different covariates and specifications and show our results in table 1. We find results similar to those in Rose (2005). The decrease of imports after default is between 10% and more than 50%. We observe the effect of default on imports is larger than on exports but exports still decrease significantly after default, even in not favorable conditions (time-varying fixed effect).

One important question for significance is whether we should include observations of 0 bilateral trade as literally meaning 0 trade or as a mistake. Not including these observations reduces the size of the effect, which would make sense if null observations indeed corresponded to no trade: defaults seem to impact the extensive margin of trade).[5] When we include null observations, we use the inverse hyperbolic sine of exports rather than the log, to include more easily null observations.

[3]Fouquin and Hugot (2016), who provide the CEPII dataset, claim that null bilateral trade data correspond when bilateral trade data could indeed be estimated to be 0, although it might in some cases also be due to lack of evidence. We allow both interpretations as we either include or exclude observations where bilateral trade flow is "null" in the results below. Including null observations lessens the effect of default but does not change our effect qualitatively. We include regressions with null observations to stay conservative.

[4]The regions we define are Europe, Asia, Middle East, Atlantic Ocean, Africa, North America, Latin America.

[5]This macroeconomic evidence would be the macroeconomic equivalent of what Gopinath and Neiman (2014) find at the firm level in Argentina after 2001 default in Argentina: a large number of firms completely stopped importing certain kinds of inputs. It would mean that defaulting countries stop importing from some trade partners with whom they were trading less before.

Table 1: Effect of sovereign default on bilateral trade

	Dependent variable: Exports (log or hyperbolic arcsine)					
	(1)	(2)	(3)	(4)	(5)	(6)
Default (origin)	-0.643^{***}	-0.438^{***}	-0.447^{***}	-0.126^{***}	-0.117^{***}	-0.027^{***}
	(0.016)	(0.017)	(0.018)	(0.009)	(0.018)	(0.009)
Default (destination)	-0.904^{***}	-0.534^{***}	-0.521^{***}	-0.149^{***}	-0.195^{***}	-0.108^{***}
	(0.014)	(0.016)	(0.016)	(0.008)	(0.017)	(0.009)
		Controls				
GDP (log, destination)	No	Yes	Yes	Yes	Yes	Yes
GDP (log, origin)	No	Yes	Yes	Yes	Yes	Yes
Pair F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time-Varying Pair F.E.	No	No	No	No	Yes	Yes
Data Before 1950	Yes	Yes	No	No	No	No
Null=0	Yes	Yes	Yes	No	Yes	No
Observations	837,067	686,030	637,316	427,185	637,316	427,185
R^2	0.736	0.748	0.750	0.836	0.839	0.895

Note: *p<0.1; **p<0.05; ***p<0.01

3 Two-Period Model

In this Section, we present a model where a small open economy that trades with the rest of the world and borrows from it. In case of default, the country enters into financial autarky (which should not matter in the two-period case, but results can easily be extended to include the cost of financial autarky), and more importantly, partial trade autarky: as a consequence of default, trade costs increase. To make the exposition simpler, we assume the cost of default is going to be complete trade autarky.

The timing of the model is as follows:

- In the first period, government chooses how much to borrow. The price of bonds q it emits depends on its probability of default, which depends on debt B: government takes as given the price of bonds as a function of debt, $q : B \mapsto \mathbb{R}_+$. Government then spends its income and the amount borrowed in goods' consumption.

- In the second period, government learns the new value of GDP and uncertainty is solved out. At this point, it decides whether to default or not. If it defaults, it cannot benefit from international trade any more but debt burden is alleviated. If it repays, it can trade and benefit from commercial integration as before.

In this simple model, default is associated with an increase in the trade costs to infinity, but we see it as a simplification: in a more general setting, there would be a proportional increase in trade costs. This is the reduced form version of the assumption that the disruption in trade finance makes trade more costly after a sovereign default. The amount of disruption is likely to be increasing in the total volume trade.

We choose a 2-period model for the sake of simplicity: the 2-period model is the simplest possible way to capture debt accumulation, default risk and repayment conditions. Although consumption smoothing motives and reputational concerns are not very strong in a 2-period model - they are absent in the second period - the 2-period setting still captures the elements of sovereign debt we care about in this paper. Some of our results are still valid in a version of the model with infinite periods however.

Moreover, even in dynamic calibrations, non-reputational default costs matter a lot: for example, Arellano (2008), often cited as a benchmark for sovereign debt calibrations, managed to get satisfying quantitative results mainly through specific assumptions on non-reputational default costs. It is therefore interesting to study default cost for itself in the most direct framework, in view of the calibration literature.

3.1 Assumptions and Primitives

- Static Consumption and Gains from Trade There are two periods $t = 1, 2$. Aggregate consumption C_t at each period t is given by:

$$C_t := A(c_t, c_t^\star)$$

where A is an aggregator with constant returns to scale.[6] Trade is motivated by the inability of the country to produce foreign varieties of consumption goods as in Armington (1969). However, it could indifferently be motivated by comparative advantage motives, as in Ricardian trade models.

We make this assumption for the sake of simplicity, but it does not matter: the only relevant point for our results is that gains from trade can be inferred from the variation in imports, as in Arkolakis, Costinot, and Rodriguez-Clare (2012). Therefore, all trade models embedded in the results of Arkolakis, Costinot, and Rodriguez-Clare (2012) would work in our framework[7] for the first basic proposition: more open countries can borrow a larger amount of debt.

- Utility There are two periods $t = 1, 2$. The small open economy with a representative agent takes all prices as given and maximizes utility:

$$U_i = u(C_1) + \frac{1}{1+\rho}\mathbb{E}u(C_2)$$

[6] The most common example of such an aggregator would be CES: $A(c_t, c_t^\star) = (\alpha^{\frac{1}{\sigma}} c_{t,D}^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} c_{t,F}^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}$

[7] It includes Eaton and Kortum (2002) and Melitz (2003) among others.

given the budget constraints and default constraints we are defining below. We are going to assume for the sake of simplicity that the representative agent is also the government, which is the most common assumption in the sovereign debt literature. From a decentralized market perspective where the inhabitants of the country would take the quantity of sovereign debt as given, it is equivalent to assuming that government subsidizes or taxes borrowing to make agents internalize, as it was proved in Na et al. (2018).

- Budget constraint and trade costs Domestic good is assumed to be the *numéraire*. It is produced with an inelastic effective labor supply (alternatively, endowment or output) Y_t in t. The price of the foreign good, as perceived by the domestic country, $p(\tau, Y_t)$ is assumed to depend on endowment and trade costs. We assume our economy is small relative to the rest of the world and can take the macroeconomic international conditions as certain.[8] We shall assume that:

$$\frac{\partial p(\tau, Y)}{\partial \tau} > 0$$

In other words, the price of the foreign goods increases in trade costs. In some of our results, we will be more radical and assume that there are no terms of trade: in this case, $p = p(\tau)$ depends on trade costs (for example, $p(\tau) = \tau^2 p_0$ for some exogenoux p_0) but not on output. This simplifying assumption is useful for our results about borrowing decisions of the government, because it spares us involved considerations about terms of trade.[9] Reciprocally, the perceived domestic selling price of the good is $\frac{1}{\tau}$, but we still assume that the domestic price is the *numéraire* - the perceived good price should translate into terms of trade effects.[10] Y_1 and τ_1 are given, but Y_2 is random and τ should depend on default's decision as we are going to specify.

The budget constraint for government that repays debt at period t writes:

$$p(\tau, Y_t)c_{t,F} + c_{t,D} + B_{t-1} = Y_t + q_t(B_t, \tau)B_t$$

where B_{t-1} is debt inherited from the previous period, B_t is the face value of newly emitted bonds and q_t the actual price of those new bonds. The price of bonds q_t is a function of their face value B_t because the price of bonds depend on government's incentives to default in the next period and therefore on τ, which is a structural parameter of the analysis.

[8]The only purpose of this assumption is for the clarity of exposition and avoid the accumulation of state variables. Most results are, at least quantitatively, robust to the addition of foreign shocks.

[9]In other words, we will in some cases (propositions 2 and 3) exclude from the analysis foreign exchange crises and terms of trade effects.

[10]This should simplify notations but the results are robust to several specifications about the *numéraire*. However, the choice of the *numéraire* matters for the analysis however because it determines the quantity on which debt is indexed. In this context, this assumption is equivalent to the assumption that a country borrows in its own currency.

- Timing of the Model and Default Decision Bond schedule q_t and inherited debt B_{t-1} are considered given at the beginning of period t by the government. Price q_t of government bonds is determined by the financial markets. If there are only 2 periods, $q_2 \equiv 0$: no money should be borrowed before the end of the world. However, the model can easily be extended to infinity.

At the beginning of period t, government learns the value of Y_t. It chooses whether to default or to repay debt. If the government defaults, then it does not pay debt, but cannot borrow any more, and faces larger trade costs $\tau_D > \tau$. Budget constraint becomes:

$$p(\tau^D, Y_t)c_t^\star + c_t = Y_t$$

The rest of this Section will consider the simplifying extreme case where $\tau^D = +\infty$, so that $p(\tau^D, Y_t) = +\infty$. In this case, the country enters into trade autarky when it defaults:

$$\begin{aligned} c_t &= Y_t \\ c_t^\star &= 0 \end{aligned}$$

Based on the utility it gets from defaulting or repaying debt, government chooses whether to default or not. If initial debt is 0, then government should choose how much to borrow at the first period and decide whether or not to default based on the realization of GDP Y_2 in period 2.

- Financial Markets We assume that investors are risk-neutral.[11] This assumption can be considered acceptable however, if we assume that the economy is small and open: if so, then the economy's endogenous risks should be inconsequential to the lenders' portfolio risks. In other words, matters regarding risk diversification can be considered incorporated in an exogenous safe rate $r^\star$.

Because financial markets are competitive, the price $q(B_1)$ of a government bond depends on new debt B_1 only and is computed according to the corrected probability of default:

$$q(B_1) = \frac{1 - \mathbb{P}(C_{j,2}^R < C_2^{aut})}{1 + r^\star}$$

Here, the assumption that investors are risk-neutral can be lifted with no harm to our results to the case where there is a risk-aversion factor φ:

$$q(B) = \frac{1 - \varphi\mathbb{P}(\text{Default})}{1 + r^\star}$$

[11] Sovereign debt literature mostly considers risk-neutral investors. However, some models take into account time-varying risk-aversion. Since the effects of risk aversion can be considered GDP shocks or shocks on default cost, their inclusion is an issue for calibrations mostly. It should not matter too much for our study as we are interested in the local effect of a decrease in trade costs. In this case, risk aversion can be considered a simple multiplier φ to apply on the probability of default when we compute bonds' price.

which does not modify the results of the paper. More generally, one could adopt:

$$q(B) = f(\mathbb{P}(\text{Default}))$$

where f is a positive decreasing function. We will stick to the first case for our exposition although many results are robust to this general formulation.

- **Equilibrium Definition** With all the elements above, we implicitly presented the definition of an equilibrium in the 2-period model, which can be extended to N periods. For the sake of generality, we present the definition of an equilibrium in $N \in \mathbb{N} \cup \{+\infty\}$ periods.

Definition. Let $N \in \mathbb{N}$, $(Y_t)_{t\in[0,N]}$ be a Markov process, $p(\tau, Y)$ be a value for price function and τ be a value for trade costs. A competitive equilibrium associated with trade costs τ is given by a sequence of value functions $(V_t(B,Y), V_t^R(B,Y), V_t^D(Y))_{t\in[0,N]}$, policy function for borrowing $(b_t(B,Y))_{t\in[0,N]}$, policy function for default $(D_t(B,Y))_{t\in[0,N]}$, and lending functions $(q_t(B,Y))_{t\in[0,N]}$ such that:

- The value functions solve the recursive equations:

$$\begin{aligned} V_t^R(B,Y) &= \max_{B', c_t, c_t^\star \text{ s.t. } p(\tau,Y)c_t^\star + c_t + B = Y + q_t(B',Y)B'} u(A(c_t, c_t^\star)) + \beta\mathbb{E}(V_{t+1}(B',Y)) \end{aligned}$$

$$\begin{aligned} V_t(B,Y) &= \max\{V_t^R(B,Y), V_t^D(Y)\} \\ V_t^D(Y) &= u(Y \times A(1,0)) + \beta\mathbb{E}(V_{t+1}^D(Y_{t+1})|Y_t = Y) \end{aligned}$$

$$\begin{aligned} q_t(B',Y) &= \frac{\mathbb{P}(D_t(B',Y_{t+1}) = 0|Y_t = Y)}{1+r} \\ b_t(B,Y) &\in \arg\max_{B', c_t, c_t^\star \text{ s.t. } p(\tau,Y)c_t^\star + c_t + B = Y + q_t(B',Y)B'} u(A(c_t, c_t^\star)) + \beta\mathbb{E}(V_{t+1}(B',Y)) \end{aligned}$$

- Policy functions solve the government's optimization problem::

$$\begin{aligned} D_t(B,Y) &= \mathbb{I}\{V_t^R(B,Y) < V_t^D(Y)\} \\ b_t(B,Y) &\in \arg\max_{B', c_t, c_t^\star \text{ s.t. } p(\tau,Y)c_t^\star + c_t + B = Y + q_t(B',Y)B'} u(A(c_t, c_t^\star)) + \beta\mathbb{E}(V_{t+1}(B',Y)) \end{aligned}$$

- Financial markets are competitive:

$$q_t(B',Y) = \frac{\mathbb{P}(D_t(B',Y_{t+1}) = 0|Y_t = Y)}{1+r}$$

We used the convention that $V_{N+1} \equiv V_{N+1}^R \equiv V_{N+1}^D \equiv 0$.

In the model where $N = +\infty$, the definition is the same except that none of the value, policy and lending functions depend on time.

3.2 Trade Costs, Probability of Default and Debt

In this Section, we are going to look at the effect of trade costs (hence trade openness by contraposition) on the probability of default and on the level of debt. We prove that the probability of default is going to decrease in trade openness.[12] We easily show it to be true for a fixed level of debt, but also when we do not control for debt: countries should adopt a safer behavior as they get more open. We also discuss whether a similar kind of results can apply to debt levels: does face value of debt increase in the total value of debt? While we cannot conclude unambiguously on this level, we show that under some plausible technical conditions about the distribution of GDP shock, debt should increase as a country gets more open (that is, debt should decrease as trade costs increase).

3.2.1 Trade Costs, Probability of Default

In the second period of the model, government has borrowed B_1 at the previous period (negative B_t would mean net savings). It now learns Y_2, which was distributed according to a given probability distribution with density f.

After learning Y_2 , government chooses whether to default or not.[13] If the country chooses to default, the cost for defaulting is the interruption of international trade. A defaulting government is stuck in autarky and it can only consume its own good, so that:

$$\begin{aligned} C_2^{aut} &= A(Y_2, 0) \\ &= Y_2 A(1, 0) \end{aligned}$$

Not defaulting yields the following aggregate consumption:

$$C_{j,2}^{R} = (Y_2 - B_j) v(1, p(\tau, Y_2))$$

where $\nu(.,.)$ is the indirect aggregate consumption function for given prices: $\nu(x, y) = \max_{c^D} A(c^D, \frac{1-xc^D}{y})$

Let us assume for example that preferences are CES. In this case, government should default whenever debt is more than:

$$B_2 := Y_2\big(1 - (1 - IM^{\star})^{\frac{1}{\sigma-1}}\big) \tag{3.1}$$

[12] Equivalently, the probability of default should be increasing in trade costs.

[13] Here, the large size and the low volatility of productivity in country F that faces no productivity shock guarantee that it will not default. Indeed, the economy is deterministic from its point of view. This assumption may be interpreted as the simplification of a world in which wealthy entrepreneurs who buy a lot of insurances invest in sovereign bonds. A default of this country would be problematic since it would entail a global disaster for world trade: in the absence of specialization between small islands, all indebted countries would immediately default if trade with the central country were interrupted. Another way to rule that possibility out would simply be to assume that the central country is more patient than all the islands, as measured by the discount rate: $\rho_F < \inf_{i\in[0,1]} \rho_i$. We explore collective incentives to default in a companion paper.

where B_2 is the debt stock at the end of the first period, when the economy is still open (so that international prices determine the value of GDP) and IM the share of imports in GDP that would correspond to balanced trade or, equivalently, the share of imports in the final consumption:

$$IM^{\star} = IM/(1-x)$$

where IM is imports in value as a share of GDP and x is trade balance (equivalently in the model, current account) at time t.

Note that this computation was possible to reach using the result that $\Delta \ln W = -\ln(1 - IM^{\star})/\varepsilon$, where $\Delta \ln W$ is the difference between welfare in free trade and welfare in autarky, ε is the inverse elasticity of substitution.This result is established in Arkolakis, Costinot, and Rodriguez-Clare (2012). This result is equivalent for any aggregator A with a non-unitary elasticity of substitution: it would also apply to a non-Armington context. It should also hold as we allow terms of trade (as defined by price p) to vary.

Then, conditional on having a trade model embedded in Arkolakis, Costinot, and Rodriguez-Clare (2012), more open countries should be able to sustain a larger debt-to-GDP ratio, *ceteris paribus* (including the level of debt).

We can deduce from this result that more open countries should have lower costs of borrowing, everything else equal. Indeed, in line with sovereign debt models as Eaton and Gersovitz (1981), competitive financial markets with risk-neutral preferences lend money to a sovereign government.

Because bonds' price is determined by the probability of default, we can immediately deduce the following proposition:

Proposition 1. *Assume that the economy is a sovereign debt model in $T \in \mathbb{N}$ periods as described above where gains from trade can be computed as in Arkolakis, Costinot, and Rodriguez-Clare (2012). Conditional on the level of debt B, a more open country, that is a country with higher import share in final consumption, should be charged with a lower interest rate. Any change in trade costs that makes a country more open should improve also decrease the interest rate it faces. The result stays true for $T = +\infty$ if we assume that number of states for GDP is finite.*

We should test this proposition later in the empirical part. One can ask a more general question: what would happen to default probability as trade cost vary, without fixing the level of debt? As we are going to see it in section 3.2.2, debt should vary as the cost of default decreases. For example, if the government is very impatient, it could not care about next period consumption and borrow as much as possible in the current period. In this case, an increase in trade costs would allow this government to borrow more today, without decreasing the probability to default. While this extreme case is possible, can also prove that in general, the probability of default should not increase as trade costs decrease if utility is concave and if the discount factor is positive. However, our analytic proof applies only to the case with constant returns to scale.

Proposition 2. *Assume that we are a two-period sovereign debt model as described above with exogenous prices. Assume that government maximizes its utility and that instantaneous utility function is concave. As a country gets more open, it should face a lower interest rate, unconditional on the level of debt B.*

These two results have a direct corollary about trade tariffs. Let us consider an Armingtonian context, in which the government can impose a tariff on its trade: it should affect its ability to borrow. However, the role of trade tariffs is subtler than the role of trade costs and depend on whether tariffs are below or above the optimal rate. Assume that a country increases its tariffs. If the tariffs are above the optimal tariff, any increase in tariff should diminish the country's ability to borrow, but the results would reverse with tariffs below the optimal level: increasing trade tariffs to the optimal level could increase a government's capacity to borrow sovereign debt because it would improve its ability to trade. However, the optimal tariff is 0 whenever terms of trade effects are non-existent, which we assume in proposition 2 (but not in proposition 1). These results are also more sensitive to some of the specific assumptions we made: for example, we made the assumptions that debt did not impact terms of trade and that debt was indexed on the price of the domestic goods. If one those assumptions broke, then tariff and borrowing policy of the government could potentially interact in a non-intuitive manner.

3.2.2 Borrowing

At the beginning of the model, government chooses how much to borrow so as to maximize utility after inheriting debt B_0:

$$\begin{aligned} &\max u\big(A(c_1, c_1^\star)\big) + \beta \mathbb{E} u\big(A(c_2, c_2^\star)\big) \\ p(\tau, Y_1)c_1^\star + c_1 + B_0 &= Y_1 + q(B_1)B_1 \\ p(\tau, Y_2)c_2^\star + c_2 + B_1 &= Y_2 \text{ or } \Big\{c_2 = L_2 \text{ and } c_2^\star = 0\Big\} \end{aligned}$$

In a deterministic model, government should be interested in borrowing if and only if we assume $\frac{\beta-1}{\beta} =: \rho < r + \gamma \frac{L_2}{L_1}$ where γ is local relative risk aversion. In quantitative exercises, authors always assume that $\rho < r$. In other words, emerging countries' governments are assumed to be impatient:[14] otherwise, they would prefer to save at a better safe rate. We therefore assume that β is low enough to create positive borrowing.

To simplify notations, denote:

$$1 + g(\tau) := \frac{v(1, p(\tau, Y))}{A(1, 0)}$$

and also assume that terms of trade are not affected by the domestic country's GDP. Here, $g(\tau)$ summarizes gains from trade. The problem then writes:

$$\max_B V(B, g(\tau)) := u\Big((1+g(\tau))(1+q(B, g(\tau))B)\Big) + \beta \mathbb{E} u\Big(\max((1+g(\tau))(L-B); L)\Big)$$

[14]Or, alternatively, governments are assumed to expect high enough future growth so that consumption smoothing would imply borrowing.

We want to see what happens to the level of debt as trade costs decrease. Given the framing of the model, a decrease in trade cost is equivalent to an increase in default cost. In standard calibrations of the infinite-period version of this problem such as Arellano (2008), the average level of debt increases when the cost of default increases. This problem does not allow a simple analytic characterization of solutions without further specification. Using the implicit function theorem, we give a local condition for debt to be decreasing in trade costs at the optimum in the appendix but it does not allow straightforward conclusions. However, if we assume that utility function is linear, we can establish the following result.

Proposition 3. *Let f be the density associated with the distribution of next period GDP shock. Let B_τ be the optimal level of borrowing corresponding to a given level of trade costs τ. If f is such that $x := \frac{Bg(\tau)}{1+g(\tau)}$, f is locally continuously differentiable around x and:*

$$(2 - (1 + r)\beta)f(x) + xf'(x) > 0 \tag{3.2}$$

Then a local decrease in trade costs τ involves an increase in the optimal level of debt B.

The condition above, although it looks technical, makes economic sense. Indeed, one can prove that revenue function $B \mapsto q(B, \delta) \times B$ has the following double derivative:

$$\frac{\partial^2 (q(B, \tau)B)}{\partial B \partial \tau} =^{\text{sign}} -(2f(x) + xf'(x))$$

It means that the condition above is simply related to the Laffer curve of bond supply: does the revenue-maximizing level of bonds increase or decrease in τ? In the proposition above, this is simply corrected by discount factor, because more debt today implies less consumption tomorrow (in cases when debt are repaid at least). Then, this parametric assumption seems natural: it simply states that the revenue-maximizing level of debt decreases in the cost of default.

In the more general case with non-linear utility, formulas are more complicated (see appendix). However, whether debt increases as trade costs decrease depends on the interaction between three effects that we can summarize below:

- The direct price effect or substitution effect, the same as in the linear utility case: it is $\frac{\partial^2 q(B,\tau)}{\partial B \partial \tau}$ times marginal utility. Under the same kind of technical assumption as in the proposition, this term should be positive and push debt to be decreasing in trade costs.

- Contemporaneous consumption smoothing or income effect: larger price of government bonds increases consumption. Thus it reduces contemporaneous marginal utility and encourages more savings for tomorrow.

- Future consumption smoothing : this term is the marginal utility in the second period discounted by the discount factor. If default cost increases, there are more states of the world where government repays debt tomorrow, therefore government should be more reluctant to borrow. This is the effect we would get if default cost increased but the borrowing function stood the same.

The negative effects of trade costs on debt should be stronger as the government is risk-averse or values future consumption (high β) or has low growth expectations. Overall, which effects dominate is an open empirical question, although simulations suggest that debt decrease in trade costs in most cases.

4 Data and Instruments

In this Section, we are going to test propositions 1, 2 and 3 the data. In Section 4.2, using data from 2007 and 2019, we find some evidence suggestive that probability of default comoves with trade openness in the short run and in the long run: we use direct regression and instrumental regression with geographical variation in the relevant distance (air sea and trade sea) as an instrument for series on debt. In Section 4.3, we find some evidence in line with proposition 3 that debt increases when a country gets more open, using variation in the effect of geography as in Feyrer (2019). In Section 4.1, we present the data we are going to use first.

4.1 Data

In the following empirical analysis, we use sovereign Credit Default Swap (CDS) data collected by Datastream on a daily basis, for 69 countries, from 2007 to the end of 2018. CDS are an insurance for bond holders against default. The main kind of events is default or restructuring of debt. CDS holders pay an insurance fee, called CDS premium every semester and, if the corresponding entity defaults, CDS sellers pay back the bonds, up to what the entity does not pay back. More precisely, CDS give insurance against "credit events", more general than debt, as defined by the International Swaps & Derivatives Association. For example, when Greece restructured its debt in 2011 and 2012, Greece did not officially default but holders of former bonds lost some of their value and the CDS holders got reimbursed after a period of institutional hesitation in 2012. In this case, CDS covered 3.2 billion dollars insured against a Greek default (to compare to more than 400 billion dollars of Greek debt). When they are activated, CDS take into account partial repayments from government, that they do not cover.

The interest of using CDS data rather than bond yields, besides its large availability, is that CDS markets are more liquid and more precise indicators or risks perceived in financial markets. We excluded from the data a few suspicious time series with very low availability of data: Iraq, Ukraine, Malaysia and Singapore (two of them being involved in a military conflict over the period). Including the spare available data from these countries did not change our results.

Thanks to CDS wide availability, we can successfully average spreads over each year and get good estimates of risks. The corresponding estimate of the associated sovereign risk should be more precise. While the CDS is priced on secondary market and may not reflect the cost of borrowing the country faces, due to maturation mismatch and strategic timing of borrowing, it reflects the probability of default. If the probability of default of the sovereign is constant and equal to P, and with a null recovery rate, then the relation between CDS premium λ and the instantaneous probability of default should be given by:

$$\lambda = -\ln(1 - P)$$

This is a simplification and more sophisticated models take into account maturity and more complicated risk functions. We abstract from them as we sense they should not affect our results: using 1-year or 10-year maturities did not affect our results.

We exclude from the analysis countries whose CDS spreads went above a 5,000 threshold because they are synonymous with near default and we want to avoid reciprocal causality issues in our analysis. In some regressions, we used a 500 b.p. threshold and got similar results.

Total flows of trade (including services) and debt are collected on yearly basis by the IMF and World Penn in publicly available data. We use World Penn Database for other general macroeconomic indicators. World Penn includes all countries and years included in IMF Global Debt Database. IMF Global Debt Database, that we completed with other debt indicators from IMF and World Bank for years when data was missing, includes data for 175 countries for years spanning from 1950 to 2018, including most countries from the CDS database. Bilateral flows of trade come from CEPII, given in Fouquin and Hugot (2016).

Because the mechanism at stake in the cost is assumed to be channeled by finance, we take into account total government debt rather than just debt owed to foreigners. Indeed, even a purely internal default might disrupt external finance and we do not attempt to discriminate both experiences.

4.2 Instruments

In Section 5, we want to show that more trade openness leads to a decrease in CDS premium. Besides direct OLS, we construct a gravitational instrument for trade, inspired by Frankel and Romer (1999) as described below, in Section 4.2.1. It should help us avoid some of the most obvious issues with the direct use of trade in the regression, although it is not immune to critics made by Rodrik, Subramanian, and Trebbi (2004)[15]. To address them, we will also use the instrument by Feyrer (2019) that we are going to present in Section 4.2.2

4.2.1 Frankel-Romer Instrument

To reconstruct the Frankel-Romer and Feyrer modified instruments, we used CEPII's data with bilateral trade in merchandises between countries from Fouquin and Hugot

[15]The most common critic is that this indicator is correlated with distance to equator, supposedly reflecting other causes. As we use GDP in control rather than , it should not be as much of a matter as in the original paper by Frankel and Romer (1999).

(2016). We also used geographical (distance between countries, area, borders, language) and demographic data from Head, Mayer, and Ries (2010) to reconstitute the geographical variables.

As we want to directly address the question to whether a change in trade policy in the long run would affect a country's ability to borrow funds from the sovereign markets, we use the same instrument as in Frankel and Romer (1999) to evaluate the impact of trade on the terms of direct borrowing as measured by CDS spreads. This instrument relies on the intuition, given by gravitational models and almost universally observed in trade data, that bilateral trade between two countries depends on their distance and on their size. As a consequence, a small country surrounded by large and rich neighbors such as the Netherlands should trade more than a large country in an isolated island such as Australia, although both countries are rich. Frankel and Romer (1999) build their geographical instrument based on gravitational theories, prevalent in trade models.

More precisely, bilateral trade $T_{i,j}$ (as measured by the sum of imports and exports) between country i and j is assumed to behave that way:

$$\begin{aligned}\ln(\frac{T_{i,j}}{Y_i}) &= a_0 + a_1 \ln d_{i,j} + a_2 \ln N_i + a_3 \ln N_j + a_4 B_{i,j} + a_5 B_{i,j} \ln d_{i,j} \\ &+ a_6 B_{i,j} \ln N_i + a_7 B_{i,j} \ln N_j + a_8 l_{i,j} + a_9 A_i + a_{10} A_j + \varepsilon_{i,j}\end{aligned}$$

where $d_{i,j}$ is the bilateral distance between countries i and j[16], N_i the population of country i, A_i the area of country i, $B_{i,j}$ a dummy indicating whether they share a common border, $l_{i,j}$ a dummy indicating that countries i and j share a common language. The results of this regression are summarized in table 6 (see appendix). Without surprise, distance matters a lot to explain bilateral trade. The total R^2 is less than 50%, in part because we did not include GDP of trade partners in the regression to avoid potential biases in the next regressions, since level of development may be an explanatory variable.

Using the predictors given by this last regression, one can therefore predict the total trade level of one country using only the geographical variables:

$$\widehat{Trade}_i^{FR} := \sum_{j \neq i} \frac{\widehat{Trade}_{i,j,t_0}^{FR}}{GDP_{i,t_0}} = \sum_{j \neq i} \exp(\hat{a}_0 \log d_{i,j} + \hat{\beta} X_{i,j})$$

To compute the instrument, we use only one year: we use 2007 as a reference point, before the beginning of our CDS series to ensure the instrument is exogenous.

4.2.2 Feyrer Instrument

The problem of the previous instrument is that it is fixed for each country. Then, it cannot be used for diff-in-diff regressions or with country fixed effects. To avoid that

[16] Distance between countries i and j is measured as the distance between the capitals of the two countries.

issue, we will also use the same time-varying gravitational instrument as in Feyrer (2019): this instrument is based on the idea that there are changes over time in the importance of geographical variables for trade. Indeed, sea distance matters relatively less today than in 1950, at least relative to air distance: the greater availability of planes for trade changes the impact of geography over time, as Feyrer (2019) explains in his paper: some goods, especially electronics and luxury leather goods, are often exchanged through air distance, which can represent 20% of the trade for some countries. This change in the importance of air trade heterogeneously impacted countries over time. A country such as the United States did not greatly benefit from air travel from the point of view of trade: to give the most salient example, sea distance between the US and most countries in the world coincides with air distance, while this would not be true between Europe and Eastern Asia: there are also significant variations within large regions.

We exclude neighbor countries to compute bilateral trade, and the distance from any country to a country with no maritime borders is computed through the closest port. Using total bilateral trade flows in goods, we estimate the following panel regression:

$$\log(Trade_{i,j,t}) = a_{i,j} + a_t + \beta_t^{sea} dist_{i,j}^{sea} + \beta_t^{air} dist_{i,j}^{air} + u_{i,j}$$

where $dist_{i,j}^{sea}$ is sea distance as computed by Feyrer (2019), $dist_{i,j}^{air}$ is the air population-weighted distance between countries (see Mayer and Zignago (2011)). The bilateral fixed effect $a_{i,j}$ takes into account all the constant determinants of trade a gravitational equation would normally control for, while a_t controls for time changes. The time-varying parameters on sea distance and air distance give some variation to the instrument. We can compute the instrument:

$$\widehat{Trade}_{i,t}^{Feyrer} = \sum_{j \neq i} \exp(\hat{a}_{i,j} + \hat{a}_t + \hat{\beta}_{c(t)}^{sea} dist_{i,j}^{sea} + \hat{\beta}_{c(t)}^{air} dist_{i,j}^{air})$$

where $c(t)$ defines a time bin (decades). Therefore, the instrument exhibits some time variance for each country, which can be attributed to partial shift of trade from sea to air travel. As a consequence, this instrument is compatible with country fixed effects, unlike the previous one, which makes it more robust to critics.

5 Results

In this Section, we are going to test propositions 1, 2 and 3 using the data and the instruments presented in the previous Section. In Section 5.1, using data from 2007 to 2019, we find some evidence suggestive that probability of default comoves with trade openness in the short run and in the long run: we use direct regression and instrumental regression with geographical variation in the relevant distance (air sea and trade sea) as an instrument for series on debt. In Section 5.2, we find some evidence in line with proposition 3 that debt increases when a country gets more open, using variation in the effect of geography as in Feyrer (2019).

5.1 Trade and CDS Spreads

In this Section, we test for the result of proposition 1: *Conditional on the level of debt B, a more open country should face better a lower interest rate* and of proposition 2 as well: *a more open country should face a lower interest rate.* As a proxy for interest rates, we are going to use CDS premia. More precisely, we are going to test for:

$$CDS_{i,t} = -\gamma \log Trade_{i,t} + \gamma X_{i,t} + u_{i,t} \tag{5.1}$$

where i is an index for country i, t for year t, $Trade_{i,t}$ trade openness (as a percentage of GDP), $X_{i,t}$ a set of controls including fixed effects and possibly debt-to-GDP ratio, $u_{i,t}$ an error term. We are also going to test for This precise functional form can be derived from a two-period model with specific assumptions regarding the distribution (see appendix).

We first directly run 5.1 with some additional controls: we add a time fixed effect which reflects the importance of global trade at the period of the regression, and a country fixed effect which captures the fact that countries have different growth processes (and might reflect other characteristics that are absent in the model). In the regression, it should more generally capture other institutional or macroeconomic aspects of the country that may be important to determine the threshold of default. We use trade openness ratio to compute $IM^{\star}$.

We run the following regression in the first column of table 2 and in the appendix for more complete controls:

$$CDS = \alpha \log IM_{i,t} + \beta X_{i,t} + \delta_j + \delta_t + u_{j,t} \tag{5.2}$$

The first two columns of table 2 gives the result of the regression suggested by equation 5.2 and confirms our expectations. Because we have country and year fixed effects, the regression measures the effect of short-run variation in trade on CDS spreads. To deal with long-run variations, we are going use a gravitational instrument for trade.

We give the results of this regression in 7.

The results are in line with our expectations for the sign: debt has a positive impact on CDS premia (larger debt implies larger cost of borrowing), while larger trade flows as measured by trade openness are correlated with lower CDS premia, that is better credit ratings.

Long Run: Frankel-Romer Instrument In the previous paragraph, we showed that in the short run, variations in trade seem to create betters terms of credit. in this paragraph, we answer two concerns from the previous paragraph: does trade also favor terms of borrowing in the long run? Is the previous result due to endogeneity issues that may occur, such as reverse causality? Then, we use Frankel-Romer's trade predictor as an instrument for trade in the following way:

$$CDS_{i,t} = \gamma Trade_{i,t} + \delta \log Debt_{i,t} + \beta GDP_{i,t} + \alpha_t + +\varepsilon_{i,t}$$
$$Trade_{i,t} = c.\widehat{Trade}_i^{FR} + d \log Debt_{i,t} + b.GDP_{i,t} + a_t + u_{i,t}$$

where the first equation is the reduced form of the IV and the second equation is the first stage, $D_{i,t}$ is debt-to-GDP ratio of country i at time t, $GDP_{i,t}$ is output.

If one assumes that the geographical variables determining trade affect financial institutions and countries' credibility only through their effect of trade, this predicted trade share can therefore be an instrument for trade in this paper's analysis. The identification assumption is that variations in $Tr\hat{a}de_i^{FR}$ are not correlated with institutional quality otherwise than through GDP (and other covariates). Frankel and Romer (1999) used this instrument to evaluate the benefits of trade on growth[17]. We show the results of this IV regression in table 2. We cannot include country fixed effects because the instrument is time-invariant for each country, as for the original Frankel-Romer instrument. For the same reason, we cluster by year only, and not by countries[18]. The estimates given by this instrument are very close to the direct OLS ones, which might attenuate reverse causality concerns: indeed, the instrument is defined only thanks to 2007 data.

In columns 1, 2, 4 and 5, we add a control for oil countries, thanks to specific time fixed effects for oil-producing countries, as listed by the Direction of Trade of Statistics (DOTS) of the International Monetary Fund (IMF)[19]. We do it to deal with variations in commodities' prices that affects gains from trade in a (oil is an easy to trade good that might be affected by default differently from non-commodity goods). We also control for trade balance in some specifications. These controls do not seem to matter as much as restriction to "safe" countries: we restrict the specification of column 5 to "safe countries" whose CDS never exceeded 500 b.p. This specification allows us to partly deal with the worry that some results might be driven by reverse causality.

In our estimation, the effect of trade is more important than the effect of debt (when we measure it), which is striking as debt is the first motive invoked in sovereign debt crises,

[17] We will use the same proxy as Frankel and Romer (1999), substracting a few variables that we think may cause endogeneity issue such as regions, or the fact that a country is landlocked: indeed, they are likely to be directly correlated with financial institutions. Also, unlike Frankel and Romer (1999), we include area in the bilateral trade regression and not in our direct regressions. we run the regressions defining the proxy in 2007, which is the beginning of the period for the rest of the empirical analysis. Therefore, the proxy should not capture any variation posterior to 2007.

[18] However, clustering by year and country gave significant results at the 5% threshold.

[19] These countries are Algeria, Angola, the Republic of Azerbaijan, the Kingdom of Bahrain, Brunewe Darussalam, Chad, the Republic of Congo, Ecuador, Equatorial Guinea, Gabon, the Islamic Republic of Iran, Iraq, Kazakhstan, Kuwait, Libya, Nigeria, Oman, Qatar, Russian Federation, Saudwe Arabia, the Republic of South Sudan, Timor-Leste, Trinidad and Tobago, Turkmenistan, United Arab Emirates, the RepúbliCurrent AccountBolivariana de Venezuela and the Republic of Yemen. See http://datahelp.imf.org/knowledgebase/articles/516096-which-countries-comprise-export-earnings-fuel-a.

for example by rating agencies. In these estimations, a 10% increase in trade leads to a 15 to 40 b.p. (basis points) decrease in spreads: the doubling of trade-to-GDP ratio through trade agreements could have large effects on sovereign borrowing according to this estimation;, up to 400 basis points. For example, in 2014, Italy trades twice as much of its GDP as Argentina. Then, according to our estimate, if Argentina traded as much as Italy in the beginning of 2014, its CDS premium could have been up to 400 b.p. lower (more than a fifth of the difference, although Argentina has a very peculiar institutional setting). The results are robust to a restriction of the regression to one given year.

Table 2: CDS and Frankel-Romer's instrument: reduced form IV. Standard errors cluster by year.

	Dependent variable:				
	cds				
	(1)	(2)	(3)	(4)	(5)
Trade (Percent of GDP, log)	-165.925^{**}	-368.460^{**}	-319.348^{***}	-339.927^{***}	-177.503^{***}
	(73.004)	(155.068)	(55.685)	(66.325)	(43.760)
Debt (percent of GDP, log)		50.347			26.450^{**}
		(54.684)			(11.151)
GDP (log)	-65.726^{***}	-234.815^{**}	-89.851^{***}	-95.230^{***}	-66.562^{***}
	(10.613)	(81.545)	(10.341)	(13.670)	(9.807)
Current Account (Percent of GDP)				1.601	0.610
				(1.678)	(1.516)
Instrument for Trade	No	No	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	No	No	No
Year and Oil Fixed Effects	Yes	Yes	No	Yes	Yes
Safe Countries Only	No	No	No	No	Yes
Observations	704	703	541	537	418
R^2	0.216	0.680	0.161	0.150	0.233
Note:					*p<0.1; **p<0.05; ***p<0.01

5.2 Debt and Trade

In this Section, we want to show that, consistently with assertion 3, debt increases in trade openness. First, we run the instrumental variable regression induced by Frankel-Romer, as in the previous Section. The reduced form and first stage of the regression are:

$$\begin{aligned} CDS_{i,t} &= \gamma\, Trade_{i,t} + \delta \log Debt_{i,t} + \beta\, GDP_{i,t} + \alpha_t + \varepsilon_{i,t} \\ Trade_{i,t} &= c\,\widehat{Trade}_i^{FR} + d \log Debt_{i,t} + b\, GDP_{i,t} + a_t + e_{i,t} \end{aligned}$$

with the Frankel-Romer instrument defined thanks to bilateral trade data from 2007. The results of the regression confirm the cases we studied in the previous Section: more openness as defined by geographic factors is associated with larger debt stocks. However, the period is short and does not allow us to control for long-run changes in the trade capacity. Ideally, we would apply the Feyrer instrument to the regressions from the previous Section: but the time span for which CDS data are available is too short for the instrument to be a good predictor of trade.

Unlike CDS, debt data are available over the long run: a lot of countries have debt data from 1950, and even further for some western countries. Moreover, debt is typically slow-moving, so that long-run relations make more sense. We test for the long-run relationship between trade costs and debt in the long run.

Using the Feyrer instrument defined in Section 4.2.2, we can run a new instrumental regression. The reduced form and the first stage regressions are given by:

$$\begin{aligned} Debt_{i,t} &= \gamma\, Trade_{i,t} + \alpha_{GDP} GDP_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t} \\ Trade_{i,t} &= c\,\widehat{Trade}_{i,t}^{Feyrer} + a_{GDP} GDP_{i,t} + a_i + a_t + e_{i,t} \end{aligned}$$

By construction, the first stage is very robust (see appendix). The exclusion restriction hypothesis associated with this IV regression is that difference between air distance and sea distance did matter only through the impact on trade. Note that panel could also be replaced with a difference-in-difference method, instead of including a country fixed effect. Changing the method did not affect the results.

In table 3, we show the results of the reduced-form of this regression. In order to control for the rise of average imbalances, as in Reyes-Heroles (2016), we propose a fourth variable in column (3), which the average of absolute value of trade balance in each country over different decades[20]. Our results suggest that countries that trade more thanks to air and sea variation also happen to borrow more sovereign debt. The result is not driven by the size of global imbalances and seems robust. A 10% increase in trade predicts a 3% increase in debt-to-GDP ratio, in line with our computational results from Section 4.

6 Conclusion

In this paper, we argued that more open countries should be able to commit more easily to repay debt. After showing that defaulting countries seem to trade less as a consequence of default, we argued that the trade interruption was a realistic representation of

[20]We define Average trade balance as $aca_{i,t} = \sum_{\tau:c(\tau)=c(t)} |TB_{i,t}|$ where $TB_{i,t}$ is trade balance of country i at time t.

Table 3: Trade openness and Debt-to-GDP in the long run: Reduced Form IV using Feyrer's instrument

	Debt-to-GDP ratio		
Fixed Effects	Year+Country	Year+Oil+Country	Year+Oil+Country
Trade-to-GDP, log (Instrumented)	0.319***	0.326***	0.315***
	(0.059)	(0.054)	(0.057)
Real GDP (log)		−1.129***	
		(0.107)	
GDP (log)		0.401***	−0.190***
		(0.054)	(0.025)
Average Imbalances			−0.107
			(0.104)
Observations	2,918	2,847	2,847
R^2	0.258	0.355	0.283
Note:			*p<0.1; **p<0.05; ***p<0.01

what default cost could be. We investigated two consequences: more open countries are considered safer by markets, and more open countries seem to borrow more in the long run, and we have shown empirically that they were plausible. Our results suggest that a 10% increase in the total volume of trade to GDP should lead up to a 40 b.p. (basis points) decrease in CDS premia, for a given level of debt. Moreover, it should lead to a 3% increase in debt-to-GDP ratio. With those estimates, we can argue that if Argentina had been trading as much as Italy relative to its GDP in early 2014, its CDS premium would have been up to 400 b.p. lower, which is quite large: to give an example, increase in trade volume between China and Argentina might have played an important role in the build-up or Argentinian debt before 2000: according to our theory, it might have created favorable terms of credit for Argentina and led the country to borrow more.

Roos (2019) noticed that, as of 2019, the share of world defaulters was surprisingly low (defaulting countries were 0.2% of world GDP only), and that even very fragile countries preferred to repay large debt burdens rather than to default. He argued that it was because the power of lenders and financial systems from rich countries had dramatically increased. Our theory can be considered a complementary explanation: the fear of an interruption of trade may have become much stronger today, after the deep international integration of goods' markets. This paper gives hints at trade as an important commitment device for sovereign international finance. Countries with anti-tariff policies do not only send a signal to markets about their economic management: they tie their hands with their gains from trade. Larger dependence on trade means that sovereign debt crises might be less likely but also more dramatic. This phenomenon could also explain the covariation of CDS sovereign premia observed by Longstaff et al. (2011) and Pan and Singleton (2008): the cycle of world trade could partly determine comovement of spreads.

We think two topics might be worth investigating for future research.The first is how trade channels might impact financial systems. A country's international liabilities can be paid back because of the country's dependence on international trade: how would a crisis in neighbor countries affect trade of other countries? The second is the extent to which trade depends on finance: did it change over time, is there a way to increase it? For example, if default interrupts trade only through an interruption of trade finance, dependence on trade finance is double-edged: it increases the ability to borrow ex ante, but hurts defaulting countries ex post. What has been the evolution of trade finance? Is it the reason why some countries chose not to default in recent years?

The study of sovereign debt could more generally give us a better understanding of the gains from trade: some countries accept to pay very large debt burdens inherited from previous years. If we assume these governments are rational, the size of these burdens should give us an insight of what the real gains from trade and financial integration are.

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Appendix

Default Cost - Computations and General Case

Proposition 1: Proof

Equation details for the CES case, we compute the level of debt $B^D(Y_2, \tau)$ at which a government is indifferent between defaulting and repaying debt in the final period:

$$\begin{aligned}\frac{B^D(Y_2,\tau)}{Y_2} &= \frac{(\alpha + (1-\alpha)(p(\tau,Y_2))^{1-\sigma})^{\frac{1}{\sigma-1}} - \alpha^{\frac{1}{\sigma-1}}}{(\alpha + (1-\alpha)(p(\tau,Y_2))^{1-\sigma})^{\frac{1}{\sigma-1}}} \\ &= 1 - (1 + \underbrace{\frac{1-\alpha}{\alpha}\frac{1}{p^{1-\sigma}}}_{=\frac{IM^\star}{1-IM^\star}})^{\frac{1}{1-\sigma}} \\ &= 1 - (1 - IM^\star(Y_2,\tau))^{\frac{1}{\sigma-1}} \qquad (6.1)\end{aligned}$$

The general case stems from the application of the central result used in Arkolakis, Costinot, and Rodriguez-Clare (2012). In their framework, if elasticity of substitution stays constant, gains from trade always write as a function of imports as above, and one gets:

$$\begin{aligned}\frac{B^D(Y_2,\tau)}{Y_2} &= \frac{1+g(Y_2,\tau)}{g(Y_2,\tau)}\\ &= 1-(1-IM^\star(Y_2,\tau))^{\frac{1}{\sigma-1}}\end{aligned}$$

where $1+g=(1-IM^\star)^{\frac{1}{\varepsilon}}$ and $IM^\star$ is the import share after taking trade surplus into account (that occurs because of debt). Both functions depend on endowment (because of terms of trade and substitution effects) and τ. Therefore, as long as trade decreases in bilateral trade costs, our proposition should hold:

$$\frac{\partial \frac{B^D(Y_2,\tau)}{Y_2}}{\partial IM^\star} > 0$$

and the proposition follows as long as we have: $\frac{\partial IM^\star}{\partial \tau} < 0$, which should be true for bilateral trade costs in a trade model. Larger trade costs imply less imports which implies less default costs. Once we apply this to the pricing of financial markets, that corresponds to the default probability, we get the result: for any level of future GDP, sustainable debt is larger next period when a country gets more open. Incidentally, we also proved that, for the same level of debt and endowment, a country that is more open has higher utility (this will turn out to be useful for the generalization of the proof in the next paragraph).

The proposition easily generalizes to a standard Eaton-Gersovitz model with trade (assuming again that terms of trade are not affected by debt) and infinite periods. To prove it, we are going to assume that, at the equilibrium, sustainable debt increases in trade openness, and proceed by induction.

Let Y be any value for the endowment. The value associated with repayment of debt in a model with $N+1$ periods is:

$$V^{R,\tau}_{N+1}(B,Y) = \max_{B'} u((Y-B+q^\tau_N(B',Y)B')v(1,p(\tau,Y)))+\beta\mathbb{E}\big(\max\{V^{R,\tau}_N(B',Y_1),V^D_N(Y_1)|Y_0=Y\big)$$

and the value associated with default does not depend on τ and is given by:

$$V^D_{N+1}(L) = \mathbb{E}\big(\sum_{t=0}^{N+1}\beta^t u(L_t)|L_0=L\big)$$

As we proved it for $N=0$, we assume for the induction that:

$$\forall(B',L'),\ \frac{\partial V^{R,\tau}_N(B',L')}{\partial \tau} < 0$$

and the amount of sustainable debt decreases in trade costs:

$$\frac{\partial \frac{B^D_N(Y,\tau)}{Y}}{\partial \tau} < 0$$

where B_N^D is defined as the solution to:

$$V_N^D(Y) = V_N^{R,\tau}(B_N^D, Y)$$

Now we want to prove that:

$$\frac{\partial B_{N+1}^D(Y,\tau)}{\partial \tau} < 0$$

and

$$\frac{\partial V_N^{R,\tau}(B', Y)}{\partial \tau} < 0$$

where sustainable level of debt is defined as the unique solution to:

$$V_{N+1}^D(Y) = V_{N+1}^{R,\tau}(B^D, Y)$$

To prove our point, it is enough to prove that $V_{N+1}^{R,\tau}(B, Y)$ increases in τ for any B, because V_{N+1}^D does not depend on τ. Let $\tau' > \tau$. By induction assumption, we know that, for any B' and Y', we have:

$$V_N^{R,\tau'}(B', Y') < V_N^{R,\tau}(B', Y')$$

Because financial markets are competitive and the price of bonds decreases in the probability of default, it implies that

$$\forall B', q_N^{\tau'}(B', Y) \leq q_N^{\tau}(B', Y)$$

By the property of trade models, we also have:

$$v(1, p(\tau', Y)) \leq v(1, p(\tau', Y))$$

Now, because consumption has to be positive, we deduce that, for every B' that makes consumption of government with cost τ positive:

$$(Y - B + q_N(B', \tau')B')v(1, p(\tau', Y)) < (Y - B + q_N(B', \tau)B')v(1, p(\tau', Y))$$

Combining the inequalities, we can conclude that:

$$\forall B \text{ s.t. } Y - B + q_N(B', \tau)B' \geq 0,$$

$$\begin{aligned} u((Y - B + q_N(B', \tau)B')v(1, p(\tau, Y))) &\geq u((Y - B + q_N(B', \tau')B')v(1, p(\tau, Y))) \\ &+ \beta\mathbb{E}\big(\max\{V_N^{R,\tau}(B', Y_1), V_N^D(Y_1)|Y_0 = Y\big) \\ &- \beta\mathbb{E}\big(\max\{V_N^{R,\tau}(B', Y_1), V_N^D(Y_1)|Y_0 = Y\big) \end{aligned}$$

Moreover, because $Y - B + q_N(B', \tau)B' \leq 0 \implies Y - B + q_N(B', \tau)B' \leq 0$, and negative consumption would not be part of the choice of a rational government, we can apply the previous inequality at the maximum and conclude:

$$\forall (Y, B), V_{N+1}^{R,\tau}(B, Y) \geq V_{N+1}^{R,\tau'}(B, Y)$$

which is enough to conclude the induction.

To finish our proof, we need to go to the limit as N goes to infinity. In the limit-case, we converge to an Eaton-Gersovitz equilibrium and our properties cannot revert to the limit by continuity, if the functions are well-behaved. However, there can be multiple equilibria, so that the equilibrium defined by the iteration is not the only one. This won't be true any more if one assumes that GDP is a Markov process with a finite number of states. Finiteness of Markov states ensures that the equilibrium is unique, as was proved in Auclert and Rognlie (2016).[21]

None of the arguments applied above would prevent us from including GDP of other countries, which should affect the domestic country to the extent they affect terms of trade. More generally, the result is robust to additional state variables. The only limitation would be to assume that the number of states is finite in the case of infinite periods (and it is only a sufficient condition to ensure the equilibrium is unique).

Note that the result might be ambiguous about a general increase of trade costs in the world economy. We only studied the effect of one country's bilateral trade costs. In the case of a general increase in trade costs, it is conceivable that one country could not benefit from more openness: for example, an increase in openness can benefit to a direct competitor of our sovereign country and reduce its gains from trade under certain circumstances.

Proposition 3: Proof

In this paragraph, we derive the formula from proposition 3 and also show the more general formula and detail the discussion about forces in motion to know whether the face value of debt increases as trade openness increases in the model.

More generally, if one assumes that preferences only consist in an aggregator with constant returns, then define

$$\nu(x, y) = \max_{c^D \in [0,1]} A(c^D, \frac{1 - xc^D}{y})$$
$$1 + g = \frac{\nu(\tau, p/\tau)}{A(1,0)}$$

With that notation, government defaults if and only if:

$$L \leq (1 + g)(L - B)$$
$$L \leq \frac{B}{g}(1 + g)$$
$$\iff (1 - \delta)L \geq L - B$$
$$\iff L \leq \frac{B}{\delta}$$

[21] Their framework allows to have a utility that is state-dependent, which means that our assumption that terms of trade depend on GDP does not prevent uniquesness of equilibrium.

where $\delta := \frac{g}{1+g}$ is the cost of default in standard models. δ depends on τ. We use this simpler notation. One obviously finds that δ increases in τ. Is the optimal borrowing quantity larger in this case? To answer that question, one only needs to compute what happens when δ increases.

At the first period, government maximizes (after normalizing the GDP of the first period to 1 and the interest rate to 0):

$$\begin{aligned}V(B,\delta) &= u(1+q_\delta(B)B) + \beta\mathbb{E}u\big(\max((1-\delta)L; L-B)\big)\\ &= u(1+\mathbb{P}(L>\frac{B}{\delta})\times B) + \beta\int_0^{\frac{B}{\delta}} u((1-\delta)L)f(L)dL + \beta\int_{\frac{B}{\delta}}^{+\infty} u(L-B)f(L)dL\end{aligned}$$

To prove this, we are going to use Topkis' theorem. Since we assume the distributional function is smooth enough, we can compute cross-derivatives, using the equilibrium condition to compute the function q. We compute

$$\begin{aligned}\frac{\partial}{\partial B}V(B,\delta) &= \frac{\partial(q(B,\delta)B)}{\partial B}u'(1+q(B,\delta)B) - \beta\int_{\frac{B}{\delta}}^{+\infty} u'(L-B)f(L)dL\\ \theta(B,\delta) := \frac{\partial^2}{\partial B\partial\delta}V(B,\delta) &= \frac{\partial^2(q(B,\delta)B)}{\partial B\partial\delta}u'(1+q(B,\delta)B) + \frac{\partial(q(B,\delta)B)}{\partial B}\frac{\partial(q(B,\delta)B)}{\partial\delta}u''(1+q(B,\delta)B)\\ &\quad - \beta\frac{\partial(q(B,\delta)B)}{\partial\delta}u'((1-\delta)\frac{B}{\delta})\end{aligned}$$

One can notice that this quantity is equal to 0 whenever debt is negative or when B/δ is strictly less than the lower bound of the support of the distribution of GDP. In such a case, a change in the cost of default (equivalently, a change in trade costs) should not affect the will to borrow. Indeed, if the optimal level of borrowing is negative or strictly below the threshold for a positive probability of default, it means that the government is not constrained by default risk: it could happen for example if β is large enough, or, equivalenty, if the government expects low GDP GDP growth at the next period. The cost of default is irrelevant in this case: in an economy with pure commitment, government would borrow the same quantities.

Back to the general case, let A be absolute risk-aversion for a given level of consumption:

$$\begin{aligned}\theta(B,\delta) &= \frac{B}{\delta^2}u'(1+q(B,\delta)B)\times\Big((\frac{B}{\delta}f'(\frac{B}{\delta}) + 2f(\frac{B}{\delta}) - \beta\frac{u'(\frac{B}{\delta})}{u'(1+q(B,\delta)B)}f(\frac{B}{\delta}))\\ &\quad - (q(B) - \frac{B}{\delta}f(\frac{B}{\delta}))f(\frac{B}{\delta})A(1+q(B,\delta)B)\Big)\end{aligned}$$

If u is linear, $u'$is constant and positive and $A = u'' = 0$, so that θ is positive if and only if:

$$(2-\beta)f(x) + xf'(x) > 0$$

with $B > 0$ (which is assumed to be true, because probability of default is positive). This is equation of the proposition, modulo the normalization of interest rate.

One can notice that:

$$\frac{\partial^2}{\partial B \partial \delta} q(B)B = 2\frac{B}{\delta^2} f(\frac{B}{\delta}) + \frac{B^2}{\delta^3} f'(B)$$
$$= \frac{B}{\delta^2}(f(\frac{B}{\delta}) + \frac{B}{\delta} f'(\frac{B}{\delta}))$$

A more general local condition guaranteeing that a larger default cost (which is equivalent to lower trade costs) implies more debt is the equation:

$$\theta(B, \delta) > 0$$

One can note that, in an infinite-time model, as β goes to 0, the solution converges to the one of the two-period model. Therefore, when β is low enough, this result should extend to infinite time period.

In the expression:

$$\frac{\partial(q(B,\delta)B)}{\partial B} u'(1 + q(B,\delta)B) - \beta \int_{\frac{B}{\delta}}^{+\infty} u'(L - B) f(L) dL = 0$$

default cost appears in 3 different ways:

- As a factor impacting price of debt today in $\frac{\partial(q(B,\delta)B)}{\partial B}$. As long as $\frac{\partial^2(q(B,\delta)B)}{\partial B \partial \delta}$ is positive, this effect should increase debt. All the standard distributions we have tested are such that this assumption is true for the range of relevant welfare-maximizing debt levels. This is the meaning of the term $\frac{B}{\delta} f'(\frac{B}{\delta}) + 2f(\frac{B}{\delta})$ in the formula for $\theta(B,\delta)$. This is the substitution effect.

- It appears in the final period's consumption: larger default costs mean that there are more cases where debt should be repaid. This is the meaning for the term $\beta \frac{u'(\frac{B}{\delta})}{u'(1+q(B,\delta)B)} f(\frac{B}{\delta})$ in the formula for $\theta(B,\delta)$.

- Inside the marginal utility $u'(1+q(B,\delta)B)$ with an unambiguous negative effect on debt: better borrowing conditions today increase consumption today, and therefore lead to a decrease in marginal utility today and shift the consumption smoothing towards more consumption tomorrow. This is the meaning of the term $-(q(B) - \frac{B}{\delta} f(\frac{B}{\delta})) f(\frac{B}{\delta}) A(1 + q(B,\delta)B)$

-The second and third effects are clearly negative: if the cost of default of default increases, it means debt should have to be repaid in more states of the world in the next period. Then, borrower with a larger default cost should pay more attention to debt regarding its future consumption. The size of that effect should naturally get multiplied by β. This is the meaning of the term $\beta \frac{u'(\frac{B}{\delta})}{u'(1+q(B,\delta)B)} f(\frac{B}{\delta})$ in the formula for $\theta(B,\delta)$.

Example: Pareto Distribution Consider the case with a Pareto distribution with parameter γ and $L_{\min}$. With such a distribution for second period's GDP, there is a threshold $B_{\min}$ such that:

$$\forall B \leq B_{\min} q(B)B = \frac{B}{1+r}$$

Moreover, $q(B)B$ decreases in B whenever $B \geq B_{\min}$. The maximal amount a utility-maximizer government would like to borrow is B_{min}, because it is the revenue-maximizing level of debt. Moreover, when total borrowing is lower than $B_{\min}$, it means that government does not feel constrained by commitment problem. As $B_{\min}$increases in $g(\tau)$, the actual amount borrowed should be non-increasing in trading costs. Therefore, in this case, debt increases or stays constant as the country becomes more open.

This reasoning for this special case is more general than it looks: it can be applied to all governments that borrow little quantities of debt and maintain a fixed probability of default. One can imagine that the world is perceived by government as giving binary outcomes, bad or wrong, so that a discrete distribution perfectly summarizes the forecasts of agents and government. For those governments, an increase in openness is going to imply an expansion of the ability to borrow at the safe interest rate: this can in no case decrease the total level of debt.

Proposition 4: Proof

In this Section, we prove that the probability of default should increase in trade costs (equivalently, decrease in trade openness or default costs). We use the same notation as in the appendix Section above, and prove that when δ increases, the probability of default decrease. We assume that the cumulative distribution function of the GDP in the final period is increasing.

To prove it, we define an equivalent dual maximization problem where government maximizes its utility as a function of the probability of default and apply theorem 1 in Topkis (1978). Let P be the probability of default.

To keep exposition as simple as possible, we suppose $r = 0$ so that:

$$q(B, \delta) = 1 - P = \mathbb{P}(Y \geq \frac{B}{\delta}) = 1 - F(\frac{B}{\delta})$$

Then we can write B as:

$$B = \delta F^{-1}(P)$$

As long as F^{-1} is uniquely defined. If it is not uniquely defined, it means a local increase in debt B should lead to a no impact on the probability of default, so that the proposition would still hold. For now, we assume F^{-1} is uniquely defined and differentiable.

We write the new maximization problem of the government which maximizes its utility as a function of the probability of default at the next period, depending on the default cost:

$$V(P,\delta) := u\big(1+\delta F^{-1}(P)(1-P)\big)+\beta\int_0^{+\infty} f(Y)\max\{u(Y-\delta F^{-1}(P)),u((1-\delta)Y)\}dY$$

First order condition implies:

$$\frac{\partial V(P,\delta)}{\partial P}=0$$

which can also br written:

$$\delta\Big(F^{(-1)\prime}(P)(1-P)-F^{-1}(P)\Big)u'\big(1+\delta F^{-1}(P)(1-P)\big)-\beta\delta\int_{F^{-1}(P)}^{+\infty} F^{(-1)\prime}(P)f(Y)u'(Y-\delta F^{-1}(P))dy=0$$

where $F^{(-1)\prime}$ is the derivative of F^{-1}. Finally, one can compute:

$$\begin{aligned}\frac{\partial^2 V(P,\delta)}{\partial P\partial\delta} &= ((F^{(-1)\prime}(P)(1-P)-F^{-1}(P))u'\big(1+\delta F^{-1}(P)(1-P)\big)\\ &-\beta\int_{F^{-1}(P)}^{+\infty} F^{(-1)\prime}(P)f(Y)u'(Y-\delta F^{-1}(P))dy\\ &+\delta F^{-1}(P)(1-P)\Big(F^{(-1)\prime}(P)(1-P)-F^{-1}(P)\Big)u''\big(1+\delta F^{-1}(P)(1-P)\big)\\ &+\beta F^{-1}(P)\int_{F^{-1}(P)}^{+\infty} F^{(-1)\prime}(P)f(Y)u''(Y-\delta F^{-1}(P))dy\end{aligned}$$

From the first order condition, one can observe that, at the optimum, the two first terms should cancel out:

$$\begin{aligned}\frac{\partial^2 V(P,\delta)}{\partial P\partial\delta} &= \delta F^{-1}(P)(1-P)\Big(F^{(-1)\prime}(P)(1-P)-F^{-1}(P)\Big)u''\big(1+\delta F^{-1}(P)(1-P)\big)\\ &+\beta F^{-1}(P)\int_{F^{-1}(P)}^{+\infty} F^{(-1)\prime}(P)f(Y)u''(Y-\delta F^{-1}(P))dy\end{aligned}$$

We know that the term $F^{(-1)\prime}(P)(1-P)-F^{-1}(P)$ cannot be negative: otherwise, a decrease in the default probability (equivalent to a decrease in borrowing) would imply more revenues today: this option would be improving consumption today and tomorrow. The integral on the right-hand side is negative because u is concave. As a consequence the term $\frac{\partial^2 V(P,\delta)}{\partial P\partial\delta}$ is negative at the optimum if the utility function is concave. Hence, as consequence of Topkis' theorem, if the utility function is concave, the probability of default should be decreasing in default cost.

Default Risk and Trade: a Log Formula

In this paragraph, we present hypothesis under which the equation tested in Section 5.2 becomes a structural regression.

As seen earlier, the gains from trade are a good summary of each government's willingness to repay its debt in the model, and they can also be computed indirectly thanks to a sufficient statistics approach. We use a simplifying assumption (local Pareto) to derive an approximation that we can directly test in the data.

Let $L_{j,t}$ be the GDP of country j at time t. The probability of default of a government that borrower $B_{j,t}$ at the next period should then be:

$$P^D = \mathbb{P}(\frac{B_{j,t}}{L_{j,t+1}} > 1 - (1 - IM^\star)^\varepsilon)$$

If you assume that $\varepsilon = 1$ [22], then the probability of default is simply given by:

$$P^D = \mathbb{P}(\tilde{L}_{j,t+1} < \frac{b_{j,t}}{IM^\star})$$

where $b_{j,t} = B_{j,t}/L_{j,t}$. Combining this with previous assumption, the CDS premium for risky countries should be given by:

$$CDS = -\log(1 - \mathbb{P}(\tilde{L}_{j,t+1} < \frac{b_{j,t}}{IM^\star}))$$

Assume now that $\tilde{L}_{j,t+1}$ is distributed according to a Pareto distribution (at least locally) with parameters $C_j C_t$ and γ, then:

$$CDS = \gamma \log b_{j,t} - \gamma \log IM^\star + \log C_j + \log C_t$$

The fact the coefficients for $b_{j,t}$ and $IM^\star_{j,t}$ are the same stem from our assumptions. With different functional forms and different elasticity of substitution for, one can find different results.

[22] This assumption is equivalent to assuming that the elasticity of substitution between international goods is $\sigma = 2$, a lower bound of the estimates, generally between 4 and 10.

Table 5: Frankel-Romer's definition Regression

	Dependent variable:
	Trade between Reporter and Partner (over reporter's GDP)
Distance (log)	-0.700^{***}
	(0.016)
Common Border	3.920^{***}
	(1.229)
Distance if Common Borser	0.519^{***}
	(0.143)
Common official language	0.381^{***}
	(0.056)
Common language	0.453^{***}
	(0.056)
Population (log) of partner	0.474^{***}
	(0.006)
Population (log) of reporter	-0.386^{***}
	(0.006)
Area (reporter)	-39.936^{***}
	(5.756)
Area (partner)	73.696^{***}
	(5.843)
Population if common border (partner)	-0.198^{***}
	(0.060)
Population if common border (reporter)	-0.216^{***}
	(0.060)
	(0.202)
Observations	25,129
R^2	0.426
Note:	*p<0.1; **p<0.05; ***p<0.01

First Stage Regression

Table 5: First Stage Regression for Section 5.3 - Difference (Reference year is 1970).

	Dependent variable:
	Trade (Difference)
Feyrer's Instrument	3.938***
	(0.256)
Diffgdp	0.071***
	(0.015)
Observations	4,234
R^2	0.594
Adjusted R^2	0.589
Residual Std. Error	0.552 (df = 4182)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 6: First Stage Regression for Section 5.3 - Panel Regression (Country Fixed Effects)

	Dependent variable:
	Trade (log)
Feyrer Instrument (log)	1.010***
	(0.019)
GDP (log)	0.100***
	(0.014)
Observations	4,606
R^2	0.962
Adjusted R^2	0.961
Residual Std. Error	0.400 (df = 4435)
Note:	*p<0.1; **p<0.05; ***p<0.01

OLS: CDS and Trade Openness

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Table 7: CDS and Trade Openness: OLS.

	Dependent variable:			
	CDS Spread			
	(1)	(2)	(3)	(4)
Trade to GDP (log)	-164.813^{**}	-368.460^{**}	-367.577^{**}	-374.310^{**}
	(74.829)	(155.068)	(151.559)	(159.186)
Debt-to-GDP (log)	39.539	50.347	64.624	57.932
	(22.684)	(54.684)	(61.923)	(60.944)
GDP (log)	-67.775^{***}	-234.815^{**}	-222.626^{**}	-216.599^{**}
	(10.707)	(81.545)	(90.237)	(88.021)
Trade Balance				-0.514
(Percentage of GDP)				(2.593)
Year Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	No	Yes	Yes	Yes
Year and Oil Fixed Effects	No	No	Yes	Yes
Observations	703	703	703	699
R^2	0.225	0.680	0.681	0.682

Note:
*p<0.1; **p<0.05; ***p<0.01