Review of Economic Studies (2011) **78**, 49–82 doi: 10.1093/restud/rdq015

Globalization and Risk Sharing

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First version received August 2008*; final version accepted November* 2009 (*Eds.*)

We study the effects of globalization on risk sharing and welfare. Like the previous literature, we assume that governments cannot commit to enforce the repayment of debts owed by their citizens. Unlike the previous literature, we assume that governments cannot discriminate between domestic and foreign creditors when enforcing debt payments. This creates novel interactions between domestic and international trade in assets. (i) Increases in domestic trade raise the benefits of enforcement and facilitate international trade. In fact, in our set-up, countries can obtain international risk sharing even in the absence of default penalties. (ii) Increases in foreign trade raise the costs of enforcement and hamper domestic trade. As a result, globalization may worsen domestic risk sharing and lower welfare. We show how these effects depend on various characteristics of tradable goods and explore the roles of borrowing limits, debt renegotiations, and trade policy.

Keywords: Globalization, Risk sharing, Goods and asset trade, Enforcement risk, Domestic and international financial markets

JEL Codes: F15, F34, F36, G15

1. INTRODUCTION

What is the effect of globalization on risk sharing and welfare? This is an old question in international economics that has gained relevance as the world economy becomes more integrated. Textbook predictions notwithstanding, there is a widespread and growing perception that globalization is making the world riskier and that this reduces welfare. Newbery and Stiglitz (1984) provided an early and influential example of how this might happen. They modelled globalization as a reduction in trade costs in a small open economy. Before globalization, shocks to production lead to offsetting movements in goods prices that stabilize individual incomes. After globalization, shocks to production no longer affect goods prices and individual incomes become volatile. Newbery and Stiglitz showed that the costs of this worsening in risk sharing might exceed the gains from goods trade leading to a welfare loss.[1]

Newbery and Stiglitz did not explain why, in their example, individuals cannot insure themselves against income risk. And knowing this turns out to be crucial for their argument, as Dixit (1987, 1989*a*, 1989*b*) has forcefully argued in a series of seminal papers. Assuming that individuals have private information about their actions (moral hazard), the state of nature (imperfectly observed outcomes), or their type (adverse selection), Dixit showed that globalization is welfare improving unless we add exogenous restrictions on the nature of private contracts that are available or the sort of government policies that are feasible. The intuition for this result is simple: if globalization raises the demand for insurance, private arrangements and government policies

1. Eaton and Grossman (1985) made a similar point.

that allow individuals to insure will be adopted. Once we allow markets and governments to optimally react, globalization is welfare improving.[2]

In this paper, we adopt the alternative but complementary view that markets are incomplete because of enforcement problems.[3] In particular, we assume that governments have a preference for their own citizens and cannot commit to force them to repay their debts.[4] It is well known that, under these assumptions, insurance against aggregate risk is imperfect. Moreover, we shall show that insurance against individual risk is also imperfect even if all information is public. Unlike Dixit, we find that availability of insurance might decline even if globalization increases its demand and markets and governments react optimally to changes in the environment. The reason is that globalization also increases the severity of the underlying friction. This did not happen in Dixit's models since the informational frictions he considers are not affected by globalization.

A crude example helps build intuition for our results. Consider a world with two regions: Home and Foreign; each containing two individuals: Hans and Fritz. All individuals have the same concave utility function, $u(\cdot)$, and receive a stochastic endowment. There are four equiprobable states of nature:

Endowments

	State 1	State 2	State 3	State 4
HH	$1+\varepsilon+\iota$	$1+\varepsilon-\iota$	$1-\varepsilon$	$1-\varepsilon$
HF	$1+\varepsilon-\iota$	$1+\varepsilon+\iota$	$1-\varepsilon$	$1-\varepsilon$
FH	$1-\varepsilon$	$1-\varepsilon$	$1+\varepsilon+\iota$	$1+\varepsilon-\iota$
FF	$1-\varepsilon$	$1-\varepsilon$	$1+\varepsilon-\iota$	$1+\varepsilon+\iota$

where HH stands for Home Hans, and so on. It is straightforward to interpret the endowment of each individual as the sum of three components: (i) the average, *i.e.* 1; (ii) a regional shock, *i.e.* $\{-\varepsilon,+\varepsilon\}$; and (iii) an individual shock, *i.e.* $\{-\iota,0,+\iota\}$. There exists a full set of Arrow–Debreu securities that can be used to obtain insurance against these shocks. For these securities to be valuable, however, governments must enforce payments. For instance, if HH sells an Arrow–Debreu security that pays in State 1, the Home government must force HH to pay once State 1 is realized. Otherwise, HH cannot sell this security in the first place and markets are incomplete.

Before globalization, trade leads to domestic risk sharing if payments are enforced:

Consumptions with domestic risk sharing

	State 1	State 2	State 3	State 4
HH	$1+\varepsilon$	$1+\varepsilon$	$1-\varepsilon$	$1-\varepsilon$
HF	$1+\varepsilon$	$1+\varepsilon$	$1-\varepsilon$	$1-\varepsilon$
FH	$1-\varepsilon$	$1-\varepsilon$	$1+\varepsilon$	$1+\varepsilon$
FF	$1-\varepsilon$	$1-\varepsilon$	$1+\varepsilon$	$1+\varepsilon$

2. This view has also played an important role in the recent debate on the effects of globalization on the size of governments. Rodrik (1998) argues that globalization increases individual risk and, in the absence of appropriate insurance markets, governments must grow to deal with the increased need for social insurance mechanisms. See Epifani and Gancia (2009) for an alternative view.

3. Private information is a major source of market incompleteness, but it cannot account for the lack of insurance against aggregate risk that is observable. See Lewis (1999) for a useful survey of the evidence.

4. The enforcement problems that this combination of assumptions generates are widely known in the international finance literature as "sovereign risk." In other fields, however, this term often refers to the risk that private individuals, either domestic or foreign, run when lending to the sovereign (*e.g.* the king or the national government), which is above the law.

But do governments have incentives to enforce payments? Assume that (i) governments cannot commit and must choose enforcement after the state of nature is realized and (ii) governments cannot discriminate and must enforce all payments or none. Then, domestic risk sharing is an equilibrium if governments prefer *ex post* the allocation that results from enforcing payments to the allocation that would result from not doing so. For instance, if governments maximize average utility, they would enforce payments in all states only if

$$u(1+\varepsilon) \geq \frac{u(1+\varepsilon+\iota)+u(1+\varepsilon-\iota)}{2}.$$

The concavity of $u(\cdot)$ ensures this, and domestic risk sharing is thus an equilibrium. But this equilibrium is not unique. Not trading is best response for individuals if there is no enforcement. And not enforcing is best response for governments if there is no trade. Therefore, in the absence of commitment, there is always a "market collapse" equilibrium in which there is neither enforcement nor trade.

After globalization, trade also leads to international risk sharing if payments are enforced:

Consumptions with domestic and international risk sharing

	State 1	State 2	State 3	State 4
HH	1	1	1	1
HF	1	1	1	1
FH	1	1	1	1
FF	1	1	1	1

But now the condition for governments to enforce in all states of nature is more stringent:

$$u(1) \geq \frac{u(1+\varepsilon+\iota)+u(1+\varepsilon-\iota)}{2}.$$

In particular, concavity of the utility function is no longer enough to guarantee enforcement. When this condition fails, the "market collapse" equilibrium is unique and globalization lowers welfare.

This crude example illustrates the key enforcement trade-off that underlies our theory. Before globalization, governments find enforcement desirable because payments among domestic residents contribute to domestic risk sharing and raise welfare. After globalization, this positive effect of enforcement is still there. But there is now also a negative effect since payments from domestic to foreign residents lower domestic consumption and welfare. This is why the enforcement condition becomes more stringent. Enforcement is only possible if the gains from domestic trade are large relative to the gains from international trade, *i.e.* if ι is large relative to ε. In Section 3, we provide a full characterization of this enforcement trade-off in a set-up with many goods, many individuals, and many states of nature. Unlike this example, our set-up allows for gradual changes in the extent of both globalization and market incompleteness.

We then exploit this enforcement trade-off to study the effects of globalization in Section 4. In our set-up, globalization brings the usual gains from goods trade. It also affects the incentives to enforce and therefore the degree of market incompleteness. On average, globalization increases payments from domestic to foreign residents, worsening enforcement. But globalization also affects the terms of trade and therefore the properties of regional and individual shocks, *i.e.* $\{-\varepsilon, +\varepsilon\}$ and $\{-\iota, 0, +\iota\}$. Through this channel, globalization sometimes increases payments

among domestic residents or even reduces payments from domestic to foreign residents. When this happens, enforcement improves.[5,6]

There are two externalities that play a key role in our arguments. The first one is that individuals do not consider how their trades affect enforcement, leading them to borrow so much from abroad that governments prefer not to enforce. One might think that imposing borrowing limits would solve this problem. The second externality is that governments do not consider how their enforcement decisions affect foreigners, leading them not to enforce even if the foreign costs outweigh the domestic benefits. It might seem therefore that the problem could be avoided if governments could pay each other *ex post* to enforce. We show in Section 5, however, that the negative effects of globalization on market incompleteness remain even if governments adopt optimal borrowing limits and are free to negotiate enforcement among themselves. We also show that attempts to fight back globalization with trade policy are futile if governments lack commitment.

There is an extensive related literature on sovereign risk that developed in response to the debt crises of the early 1980's. Like us, this literature assumes that governments cannot commit to enforce. Unlike us, this literature implicitly assumes that enforcement is discriminatory and all domestic payments are enforced.[7,8] In our set-up, discriminatory enforcement would lead to vastly different results. In the example above, for instance, governments would always enforce domestic payments but never foreign ones. Globalization would have no effects at all!

The results in this paper move the theory of sovereign risk towards greater empirical relevance both in terms of its assumptions and its results. Regarding assumptions, today's institutional set-up for international borrowing favours our assumption of non-discriminatory enforcement.[9] Governments borrow from abroad mostly by selling bonds that are traded in deep secondary markets, while liberalized capital accounts permit the private sector to access international financial markets directly or through an increasing variety of financial intermediaries. In such an environment, governments' ability to discriminate between domestic and foreign creditors is seriously limited. In the case of bonds and stocks, discriminating against foreigners is difficult because they can sell these assets to domestic residents in secondary markets.[10] When asset trade is intermediated, discrimination might not be possible since governments typically do not know the nationality of the clients of banks, mutual funds, and other financial intermediaries that hold domestic debt. Even if this information were available, governments might

5. The existing literature on international risk sharing has often emphasized the role of the terms of trade and its response to shocks. In addition to Newbery and Stiglitz (1984) and Eaton and Grossman (1985), see Cole and Obstfeld (1991), Kraay and Ventura (2002), Perri and Heathcote (2002), and Corsetti, Dedola and Leduc (2008).

6. Mclaren and Newman (2002), Dixit (2003), and Levchenko (2005) deal with some of these issues but model globalization differently from us.

7. This is a consequence of adopting the representative-agent framework. See Eaton and Gersovitz (1981), Grossman and Van Huyck (1988), Bulow and Rogoff (1989*a*, 1989*b*), Fernández and Rosenthal (1990), Atkeson (1991), Cole, Dow and English (1995), Cole and Kehoe (1997), Kletzer and Wright (2000), Kehoe and Perri (2002), Wright (2002), and Amador (2008). See Eaton and Fernández (1995) for an excellent survey.

8. Kremer and Mehta (2000), Brutti (2009), Guembel and Sussman (2009), Broner and Ventura (2010), Gennaioli, Martin and Rossi (2010), and Rappoport (2010) also adopt the non-discrimination assumption and study the implications of this trade-off for the determination of government debt, tax policy, and the macroeconomic effects of financial liberalization.

9. The assumption of discriminatory enforcement used by the earlier literature was justified in the 1970's and 1980's. Then, governments borrowed abroad almost exclusively from foreign banks using syndicated loans, while the private sector was largely shut out from international financial markets. This institutional set-up facilitates *ex post* discrimination, as governments can choose not to pay foreign banks without interfering with domestic asset trade.

10. For a thorough analysis of the role of secondary markets in the presence of sovereign risk, see Broner, Martin and Ventura (2008, 2010).

still not be able to control how these intermediaries distribute their losses among domestic and foreign clients. Finally, courts often abide by equal treatment rules that limit the possibility of discrimination based on nationality.[11]

Regarding results, this paper moves the theory of sovereign risk towards greater empirical relevance by allowing it to account for two types of interactions between domestic and international trade in assets. The first one is that increases in domestic trade raise the benefits of enforcement and facilitate international trade. This is consistent with the contrasting experience of emerging markets and industrial countries that have undergone financial liberalization. Contrary to the former, industrial countries have been able to take greater advantage of international markets without suffering destabilizing effects.[12] The second interaction is that increases in foreign trade raise the costs of enforcement and hamper domestic trade. There is by now substantial empirical evidence that this is the case for emerging markets and a growing theoretical literature that tries to explain why this is so.[13]

2. A BENCHMARK MODEL OF INTERNATIONAL RISK SHARING

In this section, we introduce the economic environment we use throughout the paper. This is a world in which all individuals are *ex ante* identical, although they might receive *ex post* different endowments of goods. This creates a role for markets in helping individuals to pool or share risks. We first examine a situation in which these markets work well. This case will serve as a useful benchmark when we introduce enforcement problems in Section 3.

2.1. *Preferences and technology*

The world economy contains two regions: Home and Foreign, indexed by $j \in \{H, F\}$. Both regions have identical population size, normalized to 1. Let I^W be the set of inhabitants of this world, indexed by i, and let I^H and I^F be the sets of Home and Foreign residents, respectively. Naturally, $I^H \cup I^F = I^W$ and $I^H \cap I^F = \emptyset$. Let $j(i)$ denote the region where individual i resides, and $-j(i)$ the other region. The world and its inhabitants last two periods, which we refer to as youth and old age. There is no uncertainty about youth but there is uncertainty regarding old age. Let S be the set of all possible states of nature during old age. This set includes all the relevant aspects of the world economy that are not known during youth. We assume that, once realized,

11. Not surprisingly, there are many instances in which governments do not discriminate. With few exceptions, episodes of default on government debts have affected all bondholders. See Sturzenegger and Zettelmeyer (2007). The same holds true in the case of generalized defaults on debts issued by firms and/or banks. A recent and very visible example is the case of the "pesificación" of bank deposits and loans in Argentina in 2001, which induced a generalized default that affected all depositors.

12. This differential impact of financial integration has been analysed by a number of papers. For instance, Broner and Rigobon (2006) show that capital flows to emerging markets are much more volatile than those to industrial countries, that this difference cannot be accounted for by macroeconomic fundamentals, and that it is associated with underdeveloped domestic financial markets. This interaction is explored theoretically by Caballero and Krishnamurthy (2001), Tirole (2003), Broner, Martin and Ventura (2008, 2010), Arellano and Kocherlakota (2008), and Broner and Ventura (2010).

13. With respect to the empirical evidence, it has been found that banking crises and reductions in credit to the private sector are associated with globalization (*e.g.* Diaz-Alejandro, 1985; Kaminsky and Reinhart, 1999), sovereign default (*e.g.* International Monetary Fund, 2002; Arteta and Hale, 2008), and currency crises (*e.g.* Glick and Hutchison, 2001). With respect to the theory, see Boyd and Smith (1997), Chang and Velasco (1999), Aghion, Bacchetta and Banerjee (2004), Matsuyama (2004, 2007), Daniel and Jones (2007), Mendoza and Yue (2008), and Aoki, Benigno and Kiyotaki (2009).

all individuals observe the state of nature. We denote by π_s the probability at youth of state $s \in S$ occurring during old age.[14]

There is a continuum of goods, indexed by $z \in [0,1]$. A fraction τ of these goods can be transported between regions at negligible cost. We refer to these goods as "tradable." The rest of the goods cannot be transported across regions and we refer them as "non-tradable." The goods are indexed so that tradable goods correspond to low indices, *i.e.* $z \in [0,\tau]$ and non-tradable goods correspond to high indices, *i.e.* $z \in (\tau,1]$. When considering two alternative specifications, we shall say that the world is more globalized the higher τ is.

Utility is derived only from old age consumption and individuals are expected-utility maximizers. Let $c_{is}(z)$ be the quantity of good z consumed by individual i in state s. The objective function of individual i during old age is assumed to take the popular logarithmic form, *i.e.*

$$u_{is} = \int_0^1 \ln c_{is}(z) \cdot dz \quad \text{for } s \in S,\ i \in I^W, \tag{2.1}$$

while his/her objective function during youth is given by

$$U_i = \int_{s \in S} \pi_s \cdot u_{is} \quad \text{for } i \in I^W. \tag{2.2}$$

A standard feature of dynamic decision problems is that the objective function of agents (individuals or governments) varies over time. This gives rise to a standard time-inconsistency problem that plays a central role in this paper.

During old age, individuals receive a bundle of goods. We refer to this bundle as the endowment of individual i. Let $y_{is}(z)$ be the endowment of good z received by individual i in state s. To simplify notation, let $y_s^j(z) \equiv \int_{i \in I^j} y_{is}(z)$ for $j \in \{H,F\}$ be the regional average endowment of good z in state s, while $y_s^W(z) \equiv 0.5 \cdot (y_s^H(z) + y_s^F(z))$ be the corresponding world average.

There is full symmetry between and within regions. First, if there exists a state s with $\pi_s = \pi$ and given sets of endowments in Home $\{y_{is}(\cdot)\}_{i \in I^H} = \bar{Y}$ and in Foreign $\{y_{is}(\cdot)\}_{i \in I^F} = \underline{Y}$, then there exists a corresponding state s' with $\pi_{s'} = \pi$ and sets of endowments in Home $\{y_{is'}(\cdot)\}_{i \in I^H} = \underline{Y}$ and in Foreign $\{y_{is'}(\cdot)\}_{i \in I^F} = \bar{Y}$. Second, for every pair of individuals i and i' residing in the same region, if there exists a state s with $\pi_s = \pi$ and given sets of endowments in Home and Foreign in which $y_{is}(\cdot) = \bar{y}(\cdot)$, then there also exists a corresponding state s' with $\pi_{s'} = \pi$ and the same sets of endowments in Home and Foreign in which $y_{i's'}(\cdot) = \bar{y}(\cdot)$. These assumptions imply that *ex ante* endowments are the same in both regions and for all individuals within a region. Of course, this need not be the case *ex post* and this is why there are gains from trade.

In this world, markets allow individuals to transfer consumption across goods and across states of nature. Some trades might involve the exchange of goods during old age, while some others might involve the exchange of promises during youth to deliver goods during old age. We refer to the former as "goods" trade and the latter as "asset" trade. We start by considering the benchmark case of complete markets. As usual, by "complete,"it is meant that the existing set of markets allows all pairs of individuals to carry out all mutually desired trades. There are many possible ways of organizing markets that ensure this. For convenience, we consider a sequential formulation of markets: during youth there are asset (or forward) markets where individuals can trade promises to deliver one unit of the numeraire good in state s in any of the two regions; and during old age there are goods (or spot) markets where individuals can exchange the different

14. With some abuse of language, we shall refer to π_s as the probability of state s even though for continuous state spaces we are really referring to the probability density function.

goods. Intuitively, asset markets are used to distribute income across states of nature, while goods markets are used to distribute consumption across goods.[15]

As usual, it is useful to construct the competitive equilibrium recursively, going backwards in time. During old age, individuals take their income as given and choose how to distribute their consumption across goods so as to maximize utility. During youth, individuals choose how to distribute their income across states of nature so as to maximize their expected utility. We study each of these choices in turn.

2.2. *Goods markets*

During old age, the state of nature is known and only goods markets are open. Let $p_s^j(z)$ be the price of one unit of good z in state s in region j. Let y_{is} be the value of the endowment of individual i in state s, *i.e.* $y_{is} \equiv \int_0^1 p_s^{j(i)}(z) \cdot y_{is}(z) \cdot dz$; and let x_{is} be the value of the assets held by individual i in state s. Let $y_s^j \equiv \int_{i \in I^j} y_{is}$ for $j \in \{H, F\}$ be the regional average values of the endowment in state s, while $y_s^W \equiv 0.5 \cdot (y_s^H + y_s^F)$ is the corresponding world average. Also, let $x_s^j \equiv \int_{i \in I^j} x_{is}$ for $j \in \{H, F\}$ be the regional average values of assets in state s. The world average value of assets is zero. With this notation, we can write the budget constraint of old individuals as follows:

$$\int_0^1 p_s^{j(i)}(z) \cdot c_{is}(z) \cdot dz \leq y_{is} + x_{is} \quad \text{for } s \in S, i \in I^W. \tag{2.3}$$

The budget constraint states that the value of consumption cannot exceed income, which in turn consists of the value of the endowment plus the value of assets held.

For goods markets to clear, we must impose these conditions:

$$\frac{1}{2} \cdot \int_{i \in I^W} c_{is}(z) = y_s^W(z) \quad \text{and} \quad p_s^H(z) = p_s^F(z) \equiv p_s^W(z) \quad \text{for } z \in [0, \tau], s \in S, \tag{2.4}$$

$$\int_{i \in I^j} c_{is}(z) = y_s^j(z) \quad \text{for } z \in (\tau, 1], s \in S, j \in \{H, F\}. \tag{2.5}$$

Equations (2.4) and (2.5) state that supplies of the different goods must equal their demands. For those goods that are tradable, international arbitrage ensures that the prices of a given good delivered at Home and Foreign are equalized. This international arbitrage does not operate for non-tradable goods.

A competitive equilibrium during old age consists of a set of goods prices and quantities such that individuals maximize their utility—equation (2.1)—subject to their budget constraint—equation (2.3)—and goods markets clear—equations (2.4) and (2.5). Note that the state variables of the old age problem are individual endowments $\{y_{is}(\cdot)\}_{i \in I^W}$ and asset holdings $\{x_{is}\}_{i \in I^W}$.

We show that the equilibrium exists and is unique by construction. It follows from individual maximization that consumption demands are given by $c_{is}(z) = (y_{is} + x_{is})/p_s^{j(i)}(z)$ for $i \in I^W$, $z \in [0, 1]$. Substituting these demands into the market-clearing conditions in equations

15. This sequential formulation of markets is sometimes referred to as a Radner equilibrium. The classic Arrow–Debreu equilibrium assumes instead that there is a set of forward markets during youth where individuals can trade promises to deliver one unit of *any* good in state s in any of the two regions. The Arrow–Debreu equilibrium minimizes the use of spot markets, while the sequential or Radner equilibrium minimizes the use of forward markets. If all markets work well, both equilibria deliver the same allocations. This equivalence breaks down however once we introduce enforcement risk in the next section. This type of risk negatively affects the functioning of forward markets, without affecting the functioning of spot markets. This provides incentives to minimize the use of forward markets and justifies our choice of equilibrium.

(2.4) and (2.5), we find that prices are given by $p_s^W(z) = y_s^W / y_s^W(z)$ for $z \in [0, \tau]$ and $p_s^j(z) = (y_s^j + x_s^j)/y_s^j(z)$ for $z \in (\tau, 1], j \in \{H, F\}$. Therefore, equilibrium consumption allocations are given by

$$c_{is}(z) = \begin{cases} \dfrac{y_{is} + x_{is}}{y_s^W} \cdot y_s^W(z) & \text{if } z \in [0, \tau] \\ \dfrac{y_{is} + x_{is}}{y_s^{j(i)} + x_s^{j(i)}} \cdot y_s^{j(i)}(z) & \text{if } z \in (\tau, 1] \end{cases} \quad \text{for } s \in S, i \in I^W. \tag{2.6}$$

Equation (2.6) shows how Home and Foreign residents distribute their consumption across the different goods. In particular, individuals share goods in proportions that are directly related to their incomes. For tradable goods, world endowments are shared according to world relative incomes. For non-tradable goods, regional endowments are shared according to regional relative incomes. We can find individual incomes as a share of world income as follows:[16]

$$\frac{y_{is} + x_{is}}{y_s^W} = \int_0^\tau \frac{y_{is}(z)}{y_s^W(z)} \cdot dz + \frac{y_s^{j(i)} + x_s^{j(i)}}{y_s^W} \cdot \int_\tau^1 \frac{y_{is}(z)}{y_s^{j(i)}(z)} \cdot dz + \frac{x_{is}}{y_s^W} \quad \text{for } s \in S, i \in I^W, \tag{2.7}$$

and, integrating equation (2.7) over residents of each region, we also find regional incomes as a share of world income:

$$\frac{y_s^j + x_s^j}{y_s^W} = \frac{1}{\tau} \cdot \left(\int_0^\tau \frac{y_s^j(z)}{y_s^W(z)} \cdot dz + \frac{x_s^j}{y_s^W} \right) \quad \text{for } s \in S, \ j \in \{H, F\}. \tag{2.8}$$

A region's income increases with its relative endowment of tradables and with its assets.[17]

Equations (2.6), (2.7), and (2.8) provide a full description of the consumption allocation as a function of the state variables of this problem, *i.e.* individual endowments $\{y_{is}(\cdot)\}_{i \in I^W}$ and asset holdings $\{x_{is}\}_{i \in I^W}$. Individual endowments are determined by nature, but asset holdings are determined by trade during youth and we turn to this now.

2.3. *Asset markets*

During youth, only asset markets are open. Let q_s be the price of an asset that promises to deliver one unit of the numeraire in state s, and let x_{is} be the number of such assets held by individual i. Therefore, the budget sets of the young are characterized by

$$\int_{s \in S} q_s \cdot x_{is} \leq 0 \quad \text{for } i \in I^W, \tag{2.9}$$

$$x_{is} \geq -y_{is} \quad \text{for } s \in S, i \in I^W. \tag{2.10}$$

Equation (2.9) is the budget constraint and says that purchases of assets must be financed by corresponding sales of other assets, while equation (2.10) simply says that consumption must be non-negative. Naturally, during youth, asset markets must clear:

$$\int_{i \in I^W} x_{is} = 0 \quad \text{for } s \in S. \tag{2.11}$$

Equation (2.11) states that there is a zero net supply of all assets or promises.

16. To see this, substitute prices into the definition of y_{is}.

17. Note that assets increase income more than one-to-one if $\tau < 1$. The reason is that assets shift purchasing power from foreign to domestic residents. This raises the demand for domestic non-tradable goods relative to foreign ones. And this increases the value of the domestic endowment relative to the foreign one. This additional effect of asset holdings on incomes is well known in the literature on the "transfer problem."

A competitive equilibrium during youth consists of a set of asset prices and quantities such that individuals maximize expected utility—equation (2.2)—subject to their constraints—equations (2.9) and (2.10)—and asset markets clear—equation (2.11). When maximizing their utility, individuals take as given how their individual consumption during old age depends on their individual asset holdings.

We show again that this equilibrium exists and is unique by construction. Note that log preferences imply that a young individual i will choose asset holdings $\{x_{is}\}_{s\in S}$ such that $y_{is} + x_{is} = \lambda_i^{-1} \cdot (\pi_s/q_s)$, where λ_i is the Lagrange multiplier associated with individual i's budget constraint. Since all individuals are *ex ante* identical (preferences and endowments) and have access to the same set of markets, they all have the same multiplier $\lambda_i \equiv \lambda$ for $i \in I^W$. Integrating this expression over $i \in I^W$ and using the market-clearing conditions in equation (2.11), we find $\lambda^{-1} = (q_s/\pi_s) \cdot y_s^W$. As a result, we have

$$x_{is} = y_s^W - y_{is} \quad \text{for } s \in S,\ i \in I^W. \tag{2.12}$$

Equation (2.12) provides the equilibrium asset holdings, *i.e.* $\{x_{is}\}_{i\in I^W}$. During old age, income is always equally distributed within and between regions.

We have now a full description of the complete-markets equilibrium. For a given set of individual endowments $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{is}\}_{i\in I^W}$, equations (2.6–2.8) describe the equilibrium consumption allocation. For a given set of individual endowments $\{y_{is}(\cdot)\}_{i\in I^W}$, equation (2.12) describes the equilibrium asset holdings. We describe the welfare properties of this equilibrium next.

2.4. *Domestic and international risk sharing with complete markets*

Markets allow individuals to share endowment risks both within and between regions. We can provide a sharper description of how this happens by decomposing endowments, $y_{is}(z)$, as follows:

$$y_{is}(z) = \phi_{is}(z) \cdot \phi_s^{j(i)}(z) \cdot y_s^W(z) \quad \text{for } z \in [0,1],\ s \in S,\ i \in I^W, \tag{2.13}$$

where $\phi_{is}(z) \equiv y_{is}(z)/y_s^{j(i)}(z)$ and $\phi_s^{j(i)}(z) \equiv y_s^{j(i)}(z)/y_s^W(z)$ for $z \in [0,1]$, $s \in S$, $i \in I^W$ are the individual and regional components of the endowments, respectively. By construction, these components have a constant mean, *i.e.* $\int_{i\in I^j} \phi_{is}(z) = 1$ and $0.5 \cdot (\phi_s^H(z) + \phi_s^F(z)) = 1$ for $z \in [0,1]$, $s \in S$. We will refer to a (mean-preserving) spread in $\phi_{is}(z)$ and $\phi_s^{j(i)}(z)$ as an increase in individual and regional risk for good z, respectively.

With these definitions at hand, we can use equations (2.6) and (2.12) to find equilibrium consumption allocations:

$$c_{is}(z) = \begin{cases} y_s^W(z) & \text{if } z \in [0,\tau] \\ \phi_s^{j(i)}(z) \cdot y_s^W(z) & \text{if } z \in (\tau,1] \end{cases} \quad \text{for } s \in S,\ i \in I^W, \tag{2.14}$$

and substituting for these consumption allocations in equation (2.2), we obtain *ex ante* utility:[18]

$$U = \int_0^1 \left(\int_{s\in S} \pi_s \cdot \ln y_s^W(z) \right) \cdot dz + \int_\tau^1 \left(\int_{s\in S} \pi_s \cdot \ln \phi_s^{j(i)}(z) \right) \cdot dz \quad \text{for } i \in I^W. \tag{2.15}$$

Equations (2.14) and (2.15) provide a full description of consumption and welfare. There is perfect domestic sharing of all goods but perfect international sharing only of tradable ones.

18. All individuals enjoy the same *ex ante* utility because of our symmetry assumptions.

Naturally, this is because it is not technologically feasible to share non-tradable goods across regions. Markets work well but they cannot overcome technological constraints. In fact, it is straightforward to show that the complete-markets consumption allocations are *ex ante* Pareto efficient and strictly Pareto dominate all other symmetric consumption allocations.[19]

Not surprisingly, welfare increases with world endowments of all goods $y_s^W(z)$. Moreover, Jensen's inequality shows that a mean-preserving spread in world endowments lowers welfare. Higher volatility in world endowments cannot be diversified away and must lead one-to-one to higher volatility in individual consumption. Since individuals are risk averse, they suffer from this.

A feature of the complete-markets equilibrium is that welfare is not affected by an increase in individual risk.[20] Since there is perfect domestic sharing of all goods, the "*ex post*" distribution of endowments among individuals of the same region has no effects on individual consumption or welfare.

Welfare is not affected by an increase in regional risk on tradable goods either, but welfare is affected by an increase in regional risk on nontradable goods.[21] Since there is perfect international sharing of tradable goods, the *ex post* distribution of tradable endowments between regions has no effects on consumption or welfare. Since transport costs preclude international sharing of non-tradable goods, higher volatility of the regional component of their endowments must lead one-to-one to higher volatility in the consumption of these goods and this lowers *ex ante* utility.

This discussion provides a short but comprehensive description of the complete-markets equilibrium. Goods and asset markets combine to allow individuals to share endowment risks. Given technological constraints to trade, this is an ideal world. But this is too rosy a picture of asset markets. There is a fundamental difference in the nature of goods and asset markets that the complete-markets model ignores. In goods markets, individuals trade commodities for commodities, while in asset markets, individuals trade promises for promises. Unlike commodities, promises are only valuable if individuals can commit to fulfil them later. We have assumed this implicitly in the previous analysis. In the Section 3, we relax this assumption.

3. INTERNATIONAL RISK SHARING WITH ENFORCEMENT RISK

The feasibility of the complete-markets consumption allocation rests on society's ability to solve a standard time-inconsistency problem. Even though individuals would like to commit *ex ante* to pay their debts, *ex post*, they have incentives not to do so and enjoy a higher level of consumption. Either old individuals are not maximizing their utility or their true utility cannot be fully represented by equation (2.1). The standard way to think about the complete-markets model is as describing a world in which there is also a government that imposes an unbearable utility cost to those individuals that fail to pay their debts. In this situation, equation (2.1) can be understood as representing utility only conditional on paying debts. The (very low) level of utility that results from not paying debts can be disregarded since it is never chosen in equilibrium.

Although recognizing the role that governments play in sustaining asset markets is a small step towards greater realism, it begs the question of why governments would always want to

19. Since we shall focus exclusively on symmetric consumption allocations throughout the paper, we refer to those in equation (2.14) as "the" Pareto efficient consumption allocations, even though we recognize that there exist asymmetric allocations that are also Pareto efficient.

20. To see this, simply note that the individual component of endowments is absent in equations (2.14) and (2.15).

21. To see the former, simply note that the regional component of tradable endowments is absent in equations (2.14) and (2.15). To see the latter, use Jensen's inequality to show that a mean-preserving spread in the non-tradable component of regional endowments lowers *ex ante* utility.

enforce payments. To the extent that governments care more about domestic residents than about foreign ones, they are subject to the same type of time-inconsistency problem that individuals are. Even though governments would like to commit *ex ante* to enforce payments by domestic residents, *ex post* they may have incentives to deviate and allow domestic residents to enjoy a higher level of consumption. The goal of this section is to analyse how this time-inconsistency problem affects risk sharing and welfare.

3.1. *The model with enforcement risk*

We consider again the world economy described in Section 2.1, but now we explicitly model governments and their role as enforcers of private contracts. There are two governments, a Home government, which can enforce payments by residents of Home, and a Foreign government, which can enforce payments by residents of Foreign. *Ex post*, an individual only pays if his/her government forces him/her to pay. Governments only care about the utility of the residents of their region. In particular, they maximize the average utility of domestic residents during old age, denoted $v_s^j \equiv \int_{i \in I^j} u_{is}$ for $s \in S$, and the expected average utility of domestic residents during youth, denoted $V^j \equiv \int_{i \in I^j} \pi_s \cdot U_i$ for $j \in \{H, F\}$.[22]

If governments could commit to enforce all payments during youth, they would always choose to do so and all asset markets would be open. This is the extreme or polar case of perfect commitment.[23] We introduce enforcement risk by moving to the other extreme and assuming that governments cannot commit at all to enforce:

Assumption 1 *LACK OF COMMITMENT: Governments simultaneously choose enforcement during old age after the state of nature has been revealed and before markets open.*

The effects of this lack of commitment depend crucially on the degree to which governments can discriminate among creditors when enforcing payments. Assume, for instance, that governments choose *ex post* which individual payments to enforce so that they can fully discriminate between creditors. This is the polar case of perfect discrimination without commitment. In the context of our model, this would imply that governments would never enforce any payment from a domestic resident to a foreign one. Asset markets would be geographically segmented and there would be no trade in assets between residents of different regions.[24]

If discrimination is less than perfect, lack of enforcement affects both domestic and international transactions and this creates new and interesting interactions between domestic and international asset trade. We take a first step towards analysing these interactions by going to the other polar case and assuming that governments cannot discriminate at all. In particular, we assume:

22. The fact that governments maximize average utility implies that, given our assumptions of symmetry, they have incentives to enforce domestic payments to improve the distribution of consumption. In addition to distributional considerations, in reality governments probably have other reasons to enforce domestic payments. Brutti (2009), Basu (2010), and Gennaioli, Martin and Rossi (2010) propose models in which domestic defaults reduce investment and output by destroying liquidity held by the private sector.

23. With perfect commitment, the equilibrium would be identical to the complete-markets model and would therefore be fully described by equations (2.6–2.8) and (2.12).

24. With perfect discrimination without commitment, there would still be international trade in goods since such trade is arms' length and, thus, not affected by enforcement risk. In addition, domestic asset trade would still take place since, in equilibrium, this trade would result in payments from residents with low marginal utility to residents with high marginal utility. Enforcing these payments would raise the average utility of the region. Therefore, the equilibrium with perfect discrimination and without commitment is fully described by equations (2.6–2.8) with asset holdings $x_{is} = y_s^{j(i)} - y_{is}$ for $s \in S$, $i \in I^W$.

Assumption 2 *NON-DISCRIMINATORY ENFORCEMENT: Governments choose whether to enforce all payments or none.*

There are two aspects to this assumption. The first and crucial one is that governments cannot discriminate by asset holder when deciding enforcement. All of our results depend on this. The second aspect is that governments cannot discriminate by asset issuer when deciding enforcement. This is necessary to keep the competitive nature of the equilibrium and we conjecture that it is not crucial for the results that follow.[25] Once again, we construct next the competitive equilibrium recursively going backwards in time.

3.2. *Goods markets and enforcement*

During old age, the state of nature is revealed, then governments enforce payments, and then goods markets open. Define $x_{j,is}$ as the assets held by individual i that pay in state s issued by residents of region j. Since governments now decide whether to enforce payments independently, it is not sufficient to know the overall asset holdings of an individual but also the residence of the issuer.

Unlike Section 2.2, the budget constraints of old individuals must now reflect the fact that assets are worthless if there is no enforcement. That is, we must replace equation (2.3) with the following one:

$$\int_0^1 p_s^{j(i)}(z) \cdot c_{is}(z) \cdot dz \leq y_{is} + e_s^H \cdot x_{H,is} + e_s^F \cdot x_{F,is} \quad \text{for } s \in S,\ i \in I^W, \tag{3.16}$$

where e_s^j is an indicator variable that takes the value one if government j enforces and zero otherwise.

Governments simultaneously choose whether to enforce payments or not so as to maximize the average utility of domestic residents. When considering their enforcement choice, each government takes the actions of the other government as given. That is, enforcement decisions are the Nash equilibrium of a game between governments. Their best responses therefore satisfy:

$$e_s^j = \begin{cases} 1 \text{ if } v_s^j(\text{enforce}) > v_s^j(\text{not enforce}) \\ 0 \text{ if } v_s^j(\text{enforce}) < v_s^j(\text{not enforce}) \end{cases} \quad \text{for } s \in S,\ j \in \{H, F\}. \tag{3.17}$$

Note that when $v_s^j(\text{enforce}) = v_s^j(\text{not enforce})$, the government is indifferent between enforcing or not and both $e_s^j = 1$ and $e_s^j = 0$ are best responses. We define $E^j \subseteq S$ as the set of states in which government j decides to enforce payments for $j \in \{H, F\}$.[26]

A competitive equilibrium during old age consists of a set of goods prices and quantities such that individuals maximize their utility—equation (2.1)—subject to their budget constraint—equation (3.16)—governments enforce so as to maximize average utility of their region—equation (3.17)—and goods markets clear—equations (2.4) and (2.5). Once again, the state variables of this problem are individual endowments $\{y_{is}(\cdot)\}_{i \in I^W}$ and asset holdings $\{x_{j,is}\}_{j \in \{H,F\}, i \in I^W}$.

25. We could allow for discrimination by groups of issuers as long as all groups have many individuals. Then, individuals would still take enforcement as given and behave competitively. If discrimination is instead at the individual level, then individuals would choose their privately optimal level of borrowing. The reason why this would not significantly affect the results is that as long as individuals cannot control who holds the assets they issue, they cannot reduce their borrowing from foreigners without reducing their borrowing from other domestic residents. We conjecture that the equilibrium allocation would be identical to the one with optimal borrowing limits we analyse in Section 5.1.

26. We are focusing on non-cooperative equilibria. Section 5.2 explores the effects of cooperation.

To compute this equilibrium, replace

$$x_{is} = e_s^H \cdot x_{H,is} + e_s^F \cdot x_{F,is} \quad \text{for } s \in S,\ i \in I^W, \tag{3.18}$$

in equations (2.6–2.8) to find the equilibrium consumption allocations as functions of enforcement decisions. Then substitute these consumption allocations into the best responses of governments to find the equilibrium enforcement decisions as a function of the state variables of this problem, *i.e.* individual endowments $\{y_{is}(\cdot)\}_{i \in I^W}$ and asset holdings $\{x_{j,is}\}_{j \in \{H,F\}, i \in I^W}$. Once again, asset holdings are determined during youth as we show next.

3.3. *Asset markets*

During youth, individuals trade in asset markets. The individual maximization problems are as in Section 2.3, except that now agents can only sell securities that pay in states in which their government enforces payments. Then, the budget sets in equations (2.9) and (2.10) are replaced by

$$\int_{s \in S} (q_s^H \cdot x_{H,is} + q_s^F \cdot x_{F,is}) \leq 0 \quad \text{for } i \in I^W, \tag{3.19}$$

$$x_{j(i),is} \geq -\hat{y}_{is} \quad \text{and} \quad x_{-j(i),is} \geq 0 \quad \text{for } s \in S,\ i \in I^W, \tag{3.20}$$

where $\hat{y}_{is}$ is now pledgeable income, defined as

$$\hat{y}_{is} = \begin{cases} y_{is} & \text{if } s \in E^{j(i)}, \\ 0 & \text{if } s \notin E^{j(i)}, \end{cases} \quad \text{for } i \in I^W. \tag{3.21}$$

Equation (3.19) is the budget constraint. Equations (3.20) and (3.21) define the borrowing constraint. They say that individuals cannot pledge income in states in which their government does not enforce payments and that consumption must be non-negative.[27] They also say that individuals cannot issue assets that are enforced by the government of the other region. Note that individuals do not take into consideration how their choice of asset holdings affects the enforcement decision of their government and, consequently, the borrowing constraints of other residents. This externality leads individuals to borrow too much from abroad during youth.[28,29]

The market-clearing conditions for asset markets are now given by

$$\int_{i \in I^W} x_{j,is} = 0 \quad \text{for } s \in S,\ j \in \{H, F\}. \tag{3.22}$$

Equation (3.22) simply states that there is a zero net supply of each country's assets.

27. For example, a Home resident might want to sell assets that pay in a state, say s, in which his/her endowment is high in order to purchase assets that pay in states in which his/her endowment is low. However, if in state s, the Home government does not enforce payments, $s \notin E^H$, this resident will not pay his/her debts when state s materializes. Knowing this *ex ante*, other agents would not be willing to purchase any assets that pay in state s from this Home resident. Therefore, the Home endowment in state s is not pledgable. Similarly, no agent would be willing to purchase assets from Foreign residents that pay in states in which the Foreign government does not enforce payments.

28. We shall come back to this point in Section 5.1 to show that our results go through even if governments introduce optimal borrowing limits.

29. This overborrowing externality has played a central role in the literature on sovereign risk. For recent discussions of the problem, see Fernández-Arias and Lombardo (2000), Caballero and Krishnamurthy (2001), Tirole (2003), Kehoe and Perri (2004), Jeske (2006), Uribe (2006), Wright (2006), and Kim and Zhang (2010). This externality is not present in a related literature that assumes that governments never enforce payments and asks instead whether the desire to keep an individual-specific reputation provides sufficient incentives for individuals to repay their debts. See Kehoe and Levine (1993), Kocherlakota (1996), and Alvarez and Jermann (2000).

A competitive equilibrium during youth consists of a set of asset prices and quantities such that individuals maximize expected utility—equation (2.2)—subject to their budget and borrowing constraints—equations (3.19–3.21)—and asset markets clear—equation (3.22). Naturally, when maximizing their utility, individuals take into account how their individual consumption during old age depends on their individual asset holdings.

We restrict the analysis to symmetric equilibria.[30] Define a coarse partition of states of nature based on sets of endowments in Home and Foreign as opposed to individual endowments. Abusing notation, we refer to the set of states $\{s \in S : \{y_{is}(\cdot)\}_{i \in I^H} = \bar{Y} \text{ and } \{y_{is}(\cdot)\}_{i \in I^F} = \underline{Y}\}$ as a single "state" characterized by regional sets of endowments $(\bar{Y}, \underline{Y})$. Given our assumption of symmetry within regions, each such "state" is composed of a large number of equiprobable states, one for each way in which these regional sets of endowments can be distributed among residents within each region. Given our assumption of symmetry between regions, each state s characterized by sets of endowments $(\bar{Y}, \underline{Y})$ has a corresponding symmetric state s' with the same probability and characterized by sets of endowments $(\underline{Y}, \bar{Y})$. We say that an equilibrium is symmetric if enforcement sets can be defined over this coarser partition of states and $(\bar{Y}, \underline{Y}) \subset E^H$ if and only if $(\underline{Y}, \bar{Y}) \subset E^F$. This restriction is not without loss of generality since the model also has asymmetric equilibria. But it delivers a high pay-off in terms of tractability since it implies that residents in both regions have the same budget constraint multipliers λ during youth and we can therefore analyse pairs of symmetric states independently.

Typically, there are many symmetric equilibria. To see this, consider a pair of symmetric states. If individuals expect enforcement in both regions, it is possible (but not necessary) that asset trade be such that both regions enforce and validate individuals' expectations. If individuals expect non-enforcement in both regions, then there is no asset trade and these individuals' expectations are a consistent belief. Thus, expectations play an important role in this world. But we do not emphasize this feature in what follows. Instead, we focus exclusively on the best symmetric equilibrium and we refer to it as "the" enforcement-risk equilibrium. This equilibrium arises when individuals have the most optimistic expectations about enforcement and the maximum number of asset markets are open.

Appendix A provides a detailed description of how we construct this equilibrium. We find that the best symmetric equilibrium sometimes contains states in which there is enforcement in one region but not in the other, *i.e.* $E^H \neq E^F$. To streamline the exposition, in the main text we focus only on the case in which, in all states, there is enforcement either in both regions or in neither and $E^H = E^F \equiv E$.[31] This case generates the following simple and intuitive closed-form solutions for equilibrium asset holdings:

$$x_{is} = \begin{cases} y_s^W - y_{is} & \text{if } s \in E, \\ 0 & \text{if } s \notin E, \end{cases} \quad \text{for } i \in I^W. \tag{3.23}$$

That is, income is equally divided among all individuals in those states in which asset markets are open. Naturally, there is no asset trade in those states in which asset markets are closed.

30. Without loss of generality (see Appendix A), we also impose the restriction that there be no two-way international trade in the same asset. That is, either $\int_{i \in I^H} x_{F,is}$ or $\int_{i \in I^F} x_{H,is}$ is zero for $s \in S$.

31. This does not affect the results in the paper. To see this, note first that if there is an equilibrium with enforcement only in the rich region, then there must also be an equilibrium with enforcement in both regions. Since the latter delivers higher welfare, we need not consider the former. Next, if there is no equilibrium with enforcement in both regions but there is an equilibrium with enforcement in the poor region, focusing instead on the collapse equilibrium does not qualitatively affect the results. The reason is that, as in the collapse equilibrium, when there is enforcement only in the poor region, international risk sharing does not take place, domestic risk sharing is lost (in the rich region), and welfare is lower than in autarky.

We have now a complete description of the enforcement-risk equilibrium. For a given set of individual endowments $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{j,is}\}_{j\in\{H,F\},i\in I^W}$, equations (2.6–2.8), (3.17), and (3.18) describe the consumption allocation that comes out of goods markets during old age and equation (3.17) determines the enforcement set. For a given set of individual endowments $\{y_{is}(\cdot)\}_{i\in I^W}$, equation (3.23) describes the asset holdings that come out from asset markets during youth. We describe the welfare properties of this equilibrium next.

3.4. *Domestic and international risk sharing with enforcement risk*

Enforcement risk destroys some asset markets and this reduces domestic and international risk sharing. The equilibrium consumption allocations are now given by

$$c_{is}(z)=\begin{cases} y_s^W(z) & \text{if } z\in[0,\tau], \\ \phi_s^{j(i)}(z)\cdot y_s^W(z) & \text{if } z\in(\tau,1], \end{cases} \quad \text{for } s\in E,\ i\in I^W, \tag{3.24}$$

$$c_{is}(z)=\begin{cases} \phi_{is}\cdot\phi_s^{j(i)}\cdot y_s^W(z) & \text{if } z\in[0,\tau], \\ \phi_{is}\cdot\phi_s^{j(i)}(z)\cdot y_s^W(z) & \text{if } z\in(\tau,1], \end{cases} \quad \text{for } s\notin E,\ i\in I^W, \tag{3.25}$$

where $\phi_{is}\equiv\int_0^\tau(\phi_s^{j(i)}(z)/\phi_s^{j(i)})\cdot\phi_{is}(z)\cdot dz+\int_\tau^1\phi_{is}(z)\cdot dz$ and $\phi_s^j\equiv\tau^{-1}\cdot\int_0^\tau\phi_s^j(z)\cdot dz$. To interpret these expressions, note that equations (2.7) and (2.8) imply that

$$\frac{y_{is}+x_{is}}{y_s^W}=\begin{cases} 1 & \text{if } s\in E \\ \phi_{is}\cdot\phi_s^{j(i)} & \text{if } s\notin E \end{cases} \quad \text{for } i\in I^W. \tag{3.26}$$

That is, ϕ_{is} and ϕ_s^j measure the individual and regional components of incomes when there is no enforcement. By construction, these components have a constant mean, *i.e.* $\int_{i\in I^j}\phi_{is}=1$ and $0{\cdot}5\cdot(\phi_s^H+\phi_s^F)=1$ for $s\notin E$. In those states in which asset markets are open, there are no individual and regional components to incomes because asset trade ensures perfect sharing of income risk. But this is not possible in those states in which asset markets are closed.[32] Plugging the consumption allocations in equations (3.24) and (3.25) into equation (2.2), we obtain *ex ante* utility:

$$\begin{aligned} U=&\int_0^1\left(\int_{s\in S}\pi_s\cdot\ln y_s^W(z)\right)\cdot dz+\int_\tau^1\left(\int_{s\in S}\pi_s\cdot\ln\phi_s^{j(i)}(z)\right)\cdot dz \\ &+\int_{s\notin E}\pi_s\cdot\tau\cdot\ln\phi_s^{j(i)}+\int_{s\notin E}\pi_s\cdot\ln\phi_{is}\quad\text{for } i\in I^W. \end{aligned} \tag{3.27}$$

Finally, it follows from equation (3.17) that the enforcement set is given by

$$E=\left\{s\in S:-\int_{i\in I^R}\ln\phi_{is}\geq\tau\cdot\ln\phi_s^R\right\}, \tag{3.28}$$

where R is the rich region in the corresponding state, *i.e.* $\phi_s^R=\max\{\phi_s^H,\phi_s^F\}$. The right- and left-hand sides of the enforcement condition are the cost and benefit of enforcement, respectively. The cost of enforcement equals the number of goods that are shared between regions, τ, times

32. Note that, in states without enforcement, individuals are constrained to consuming a bundle of goods whose value is equal to the value of their endowment. They are not constrained to consuming their own endowments because they can still trade in goods markets.

the average (across goods) reduction in *ex post* welfare that the rich region suffers when it shares them with the poor region, $\ln \phi_s^R$. The benefit of enforcement consists of avoiding domestic inequality, $-\int_{i \in I^R} \ln \phi_{is}$.

Equations (3.24), (3.25), (3.27), and (3.28) provide a full description of consumption and welfare. If there is no enforcement in some states, *i.e.* $E \neq S$, there is imperfect domestic sharing of all goods and imperfect international sharing of tradable goods. This is because individuals are forced to choose consumption baskets worth no more than their endowments in those states in which the corresponding asset market is closed. The enforcement-risk consumption allocations are therefore *ex ante* Pareto inefficient. This is shown in equation (3.27) which differs from equation (2.15) by the third and the fourth integrals. Jensen's inequality implies that these two integrals are negative. The third integral reflects the welfare loss from not being able to perfectly share tradable goods between regions, while the fourth integral reflects the welfare loss from not being able to perfectly share all goods within regions.

The complete-markets equilibrium can now be reinterpreted as the special case of the enforcement-risk equilibrium in which the enforcement set contains all states of nature, *i.e.* $E = S$, and markets are complete. In general, however, the enforcement set is smaller than the set of all states, *i.e.* $E \subset S$, and markets are incomplete. The number of asset markets that are closed and therefore the inefficiency created by enforcement risk depends on individual and regional income risk. A mean preserving spread in ϕ_{is} in the rich region increases the loss in average utility that results from a breakdown in domestic payments, increasing government incentives to enforce and therefore the size of the enforcement set. A mean preserving spread in ϕ_s^j raises the gains in average utility that result from not paying debts to foreigners, reducing incentives to enforce and therefore the size of the enforcement set.[33]

The enforcement-risk equilibrium shares some features with the complete-markets equilibrium. For instance, in both equilibria welfare increases with the world endowment of any good but decreases with a mean-preserving spread in the world endowment of any good. Also, in both equilibria welfare decreases with an increase in regional risk on non-tradable goods. Moreover, the intuitions behind these results are exactly the same in both equilibria since neither the world endowment nor the regional component of the endowment of non-tradables affect the size of the enforcement set.

But the enforcement-risk equilibrium differs from the complete-markets equilibrium in that welfare depends on both individual risk and regional risk on tradable goods. This dependence can be quite complex but can always be analysed as the sum of two different effects. For a given enforcement set, higher volatility in individual and regional tradable endowments cannot be diversified away in those states in which asset markets are closed and must lead one-to-one to higher volatility in individual consumption in those states. This first effect of increases in individual and regional risk always lowers welfare. But higher volatility in individual and tradable endowments also affect the size of the enforcement set. An increase in individual risk tends to increase the enforcement set and this increases welfare. Therefore, the first and second effects tend to work against each other in the case of individual risk. An increase in regional risk for tradables tends to reduce the enforcement set and this lowers welfare. Therefore, the first and second effects tend to reinforce each other in the case of regional risk on tradable goods.

The enforcement-risk equilibrium provides a rich description of international trade in assets. Lack of commitment or trust destroys asset markets and constitutes an impediment to trade.

33. One must be careful when studying the effects of individual and regional risk for a given good. It is possible that a mean-preserving spread in $\phi_{is}(z)$ benefits disproportionately poor individuals and reduces the enforcement set. Similarly, it is also possible that a mean-preserving spread in $\phi_s^j(z)$ benefits disproportionately the poor region and increases the enforcement set.

Individuals cannot sell enough assets to finance the purchase of other assets that would protect them from the risks they face. Therefore, this is less than an ideal world given technological constraints to trade. There exist two important interactions between domestic and international risk sharing. On the one hand, the more domestic risk sharing is needed, the more asset markets are open and the more international risk sharing is possible. After all, it is the fear to destroy domestic risk sharing that induces governments to enforce international payments and thus sustains asset markets. On the other hand, the more international risk sharing is needed, the more asset markets are closed and the less domestic risk sharing is possible. After all, it is the temptation to default on foreigners that induces governments not to enforce domestic payments and thus destroys asset markets. These interactions play a crucial role in determining the effects of globalization, as we describe in Section 4.[34]

4. THE EFFECTS OF GLOBALIZATION

Globalization is a dynamic process. Thus, in this section, we reinterpret the model as describing the life of a typical generation in a world with overlapping generations. The number of generations, which may be infinite, equals T. Generation t members are born at time t and receive their endowments at $t+1$. They maximize expected utility from consumption at $t+1$. At time t, they trade in assets to diversify their endowment risk. Generation t members cannot trade assets with members of different generations: at time $t+1$, they are old and the best they can do is to consume all of their income; at time t, the only other living generation is generation $t-1$, but since this generation is old they cannot trade. As a result, individuals diversify their endowment risk by trading assets with other members of the same generation.[35]

The process of globalization consists of an increase in τ over time. In particular, we assume $\tau_0 = 0$, $\tau_{t+1} \geq \tau_t$, and $\lim_{t\to T} \tau_t = 1$. We define the gains from globalization as $G(\tau) \equiv U(\tau) - U(0)$, where we have made explicit that the utility of any given generation depends on the fraction of goods that are tradable. A generation born in autarky would be indifferent between experiencing growth in world endowments and consumption (of all goods in all states) by a factor $\exp\{G(\tau)\}$ and experiencing an increase in the fraction of traded goods from 0 to τ. It follows from equation (3.27) that

$$G(\tau) = -\int_0^\tau \left(\int_{s\in E(\tau)} \pi_s \cdot \ln \phi_s^{j(i)}(z)\right)\cdot dz - \int_0^\tau \left(\int_{s\notin E(\tau)} \pi_s \cdot \ln\left(\frac{\phi_s^{j(i)}(z)}{\phi_s^{j(i)}}\right)\right)\cdot dz + \\ + \int_{s\notin E(\tau)} \pi_s \cdot \ln \phi_{is} \quad \text{for } i \in I^W. \tag{4.29}$$

Equation (4.29), together with equation (3.28), provides a full description of the gains from globalization. In autarky, enforcement risk is not a problem and all asset markets are open. There is perfect domestic sharing of all goods, but technological constraints to trade prevent

34. These interactions were not present in the case without enforcement risk described in Section 2. They would not be present either if enforcement were fully discriminatory.

35. In this section, we focus on equilibria of this many-period model in which the present actions of governments and/or individuals are independent of past actions. This rules out bubbly and reputational equilibria. In this case, the consumption and welfare of each generation is identical to that of the two-period model of Section 3 and is fully described by equations (3.24), (3.25), (3.27), and (3.28). Our focus on one-stage Nash equilibria can be justified by assuming that governments only represent the living generation or by assuming that governments simply fail to play reputational equilibria even if they are long lived. In Appendix B, we analyse reputational equilibria and show that our results are robust along this dimension.

international sharing. As a result, i's consumption of good z fluctuates across states following the regional endowment. Globalization removes technological constraints to trade but also creates enforcement risk that leads to the closing of asset markets. In those states in which asset markets are open, *i.e.* $s \in E$, globalization allows perfect international sharing of tradable goods without affecting domestic sharing. This gain is captured by the first term in equation (4.29). In those states in which asset markets are closed, *i.e.* $s \notin E$, globalization allows imperfect international sharing of tradable goods, but it reduces domestic sharing of all goods. The second and third terms in equation (4.29) capture this gain and loss from globalization. In this section, we study how all of these forces combine to determine the effects of globalization on risk sharing and welfare.[36]

4.1. *Globalization, enforcement, and welfare without terms-of-trade effects*

We start our analysis with the case in which both regions have the same relative supplies of goods so that there are no terms-of-trade effects. This case provides a natural benchmark since, as in most of modern macroeconomics, the world economy behaves as if there were a single aggregate or composite good. The results that come out of this case are the main insights or predictions of the theory.

Since endowments are exogenous to the analysis, globalization can only affect their relative values, ϕ_{is} and ϕ_s^j, through changes in goods prices. When this is the case, we say that globalization has terms-of-trade effects. We ensure next that globalization has no terms-of-trade effects by assuming that regional endowments have the same proportions of all goods:

$$\phi_s^j(z) = \phi_s^j(0) \quad \text{for } z \in [0,1],\ s \in S,\ j \in \{H, F\}. \tag{4.30}$$

This condition implies that $\partial \phi_{is}/\partial \tau = 0$ and $\partial \phi_s^j/\partial \tau = 0$. That is, globalization affects neither the within- nor the between-region inequality that would occur in the absence of enforcement.[37] In this case, the gains from globalization are

$$G(\tau) = -\tau \cdot \int_{s \in E(\tau)} \pi_s \cdot \ln \phi_s^{j(i)} + \int_{s \notin E(\tau)} \pi_s \cdot \ln \phi_{is} \quad \text{for } i \in I^W. \tag{4.31}$$

For a given enforcement set, welfare is non-decreasing in τ. In those states in which asset markets are open, *i.e.* $s \in E$, globalization permits international sharing of a growing fraction of goods. In those states in which asset markets are closed, *i.e.* $s \notin E$, globalization does not affect domestic or international sharing of goods. This is all standard and well known.

But the enforcement set is itself a non-increasing function of τ. To see this, consider a pair of symmetric states $\{s, s'\}$. The top panel of Figure 1 shows the benefit and cost of enforcement in these states (see equation (3.28)). While the benefit of enforcement does not depend on τ, the

36. In the polar case of perfect commitment, all asset markets would be open and all the gains from globalization would come from being able to perfectly share a larger fraction of goods, *i.e.* $G(\tau) = -\int_0^\tau \left(\int_{s \in S} \pi_s \cdot \ln \phi_s^{j(i)}(z)\right) \cdot dz \geq 0$ for $i \in I^W$. In the polar case of perfect discrimination without commitment, asset markets would be geographically segmented and the gains from globalization would come from being able to imperfectly share a larger fraction of goods, *i.e.* $G(\tau) = -\int_0^\tau \left(\int_{s \in S} \pi_s \cdot \ln(\phi_s^{j(i)}(z)/\phi_s^{j(i)})\right) \cdot dz \geq 0$ for $i \in I^W$. Both of these polar cases therefore yield a smooth and conventional picture of globalization gradually increasing welfare because globalization does not affect the degree of market incompleteness.

37. In this world of symmetric regions and individuals, asset trade ensures that all incomes are equalized when there is enforcement.

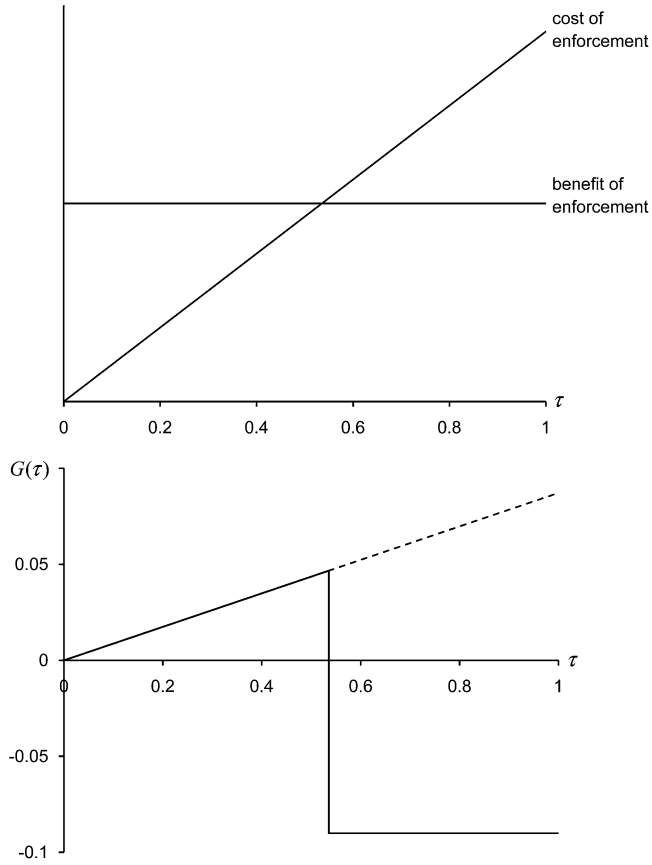

FIGURE 1

This figure illustrates the effects of globalization on enforcement incentives and welfare for one pair of symmetric states. The dashed line corresponds to the effects on welfare under complete markets. The regional component of production is such that $\phi^R(z) = 1.4$ and $\phi^P(z) = 0.6$ for all $z \in [0,1]$. The individual component of production satisfies $\phi^R_{is}(z) = 1.55$ for half of the residents in R and $\phi^R_{is}(z) = 0.45$ for the other half. There is no individual risk in the poor region

cost of enforcement is proportional to τ. If individual risk is not too high, *i.e.* $-\int_{i \in I^R} \ln \phi_{is} < \ln \phi^R_s$, there exists a threshold $\tau^*_s (= \tau^*_{s'})$ such that, if $\tau \leq \tau^*_s$ both asset markets exist, but if $\tau > \tau^*_s$ both asset markets are missing. This threshold is obtained by equating the cost and benefit of enforcement:

$$\tau^*_s = \frac{-\int_{i \in I^R} \ln \phi_{is}}{\ln \phi^R_s}. \tag{4.32}$$

This threshold is increasing in individual risk but decreasing in regional risk. This is a direct implication of the already familiar trade-off behind enforcement decisions. If $\tau^*_s > 1$, globalization never closes the market for assets that pay in state s. If $\tau^*_s < 1$, globalization closes this market on the first date t in which $\tau_{t+1} > \tau^*_s$ and it never reopens again. This effect of globalization on enforcement is new and uncovering it is one of the main contributions of this paper.

Our symmetry assumptions allow us to study the contribution to overall welfare of each pair of symmetric states independently. The bottom panel of Figure 1 shows how the contribution of

the pair of states s and s' changes as globalization proceeds. Assume $\tau_s^* < 1$ and let t_s^* be the generation such that $\tau_{t_s^*} \leq \tau_s^* < \tau_{t_s^*+1}$. All generations born at date $t < t_s^*$ open the asset markets for this pair of states. Therefore, globalization allows international sharing on a growing number of goods and increases the contribution of this pair of states to welfare. But this also requires growing payments between regions in these states. When generation t_s^* arrives, these payments would have grown too large and the temptation to default would have been irresistible. Since individuals anticipate this, the asset markets for this pair of states close. This eliminates all international sharing of tradable goods and worsens domestic sharing of goods. As a result, the contribution to welfare of this pair of states drops discretely to a level that is below that of autarky. All the generations born at dates $t \geq t_s^*$ share this low level of welfare in this pair of states.

It is now straightforward to use the theory to provide an account of the effects of globalization. Let the set of all pairs of symmetric states be denoted as $S = \{(s_1, s_1'), (s_2, s_2'), \ldots, (s_P, s_P')\}$. Let τ_p^* be defined as above for the pair of states (s_p, s_p'). In a given date t, asset markets exist for the pair of states (s_p, s_p') if and only if $\tau_t < \tau_p^*$. Without loss of generality, we order pairs of symmetric states according to τ_p^*, *i.e.* $\tau_1^* \leq \tau_2^* \leq \cdots \leq \tau_P^*$.

The effects of globalization on welfare are illustrated in the three panels of Figure 2. Assume that there exists some (s_p, s_p') such that $\tau_p^* < 1$ and, for these pairs, let t_p^* be the period such that $\tau_{t_p^*} \leq \tau_p^* < \tau_{t_p^*+1}$. All generations born in date $t < t_1^*$ benefit from globalization because all asset markets are open and globalization enlarges the set of goods that are shared internationally. At $t = t_1^*$, the asset markets corresponding to the pair of symmetric states (s_1, s_1') close leading to a reduction in both domestic and international sharing in these states. This leads to a discrete loss of welfare that persists forever since these asset markets never reopen. All generations born in dates $t_1^* < t < t_2^*$ benefit from further globalization as, once again, it enlarges the set of goods that can be shared internationally. Note, however, that this effect is smaller than in earlier generations because the newly tradable goods cannot be shared in the pair of states (s_1, s_1'). At $t = t_2^*$, the asset markets corresponding to the pair of symmetric states (s_2, s_2') close and this leads to another discrete and persistent loss of welfare. After this, subsequent generations benefit from further globalization until the following pair of asset markets close. This process continues until the world is fully globalized.

The theory therefore predicts that globalization worsens enforcement. It also highlights the interplay of two opposing forces that shape the net effect of globalization on welfare. On the one hand, globalization removes technological constraints to trade and improves international sharing of goods. On the other hand, globalization creates enforcement risk and worsens domestic and international sharing of goods. The top panel of Figure 2 shows the case in which the balance of these effects is always positive and welfare increases monotonically with globalization. The middle panel shows the opposite case in which the balance of these effects is negative and welfare falls monotonically with globalization. Finally, the lower panel shows a case in which the balance of these effects changes sign many times and the effects of globalization on welfare are not monotonic.

The benchmark case in which globalization does not generate terms-of-trade effects provides a sharp picture of the effects globalization.[38] When we go beyond this benchmark case and generalize the theory, we find that the basic picture remains robust, although it requires some interesting qualifications. We show this next.

38. Note that we have assumed much less than in standard macroeconomics models since we allow for individual differences in relative endowments. We have only assumed that there are no differences in regional relative endowments so that there is no scope for international trade in goods.

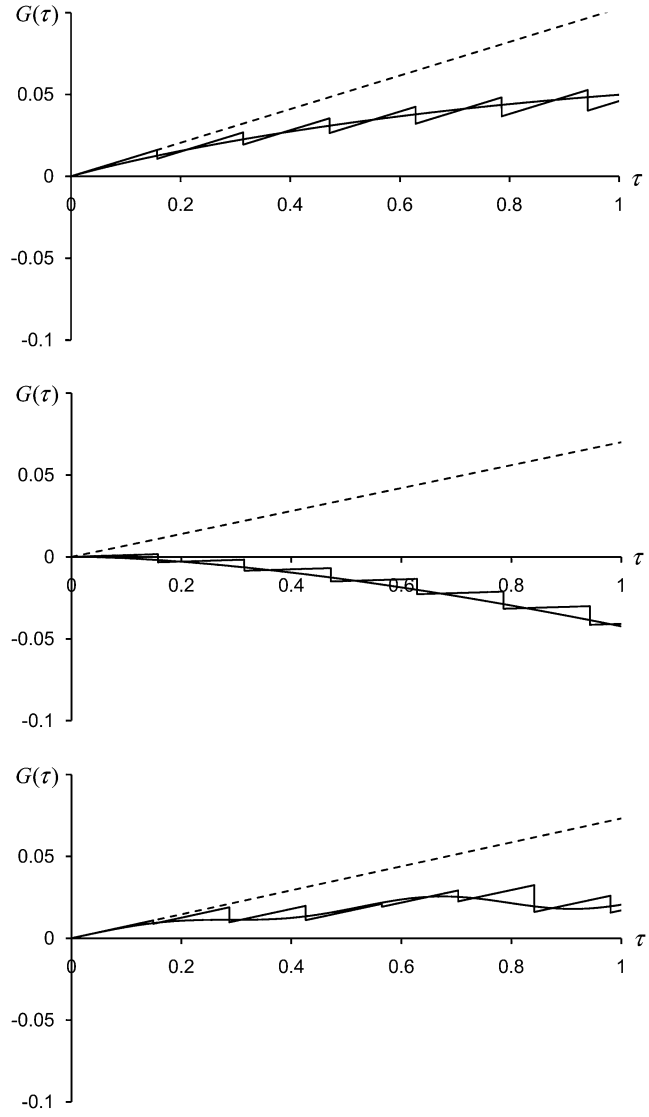

FIGURE 2

This figure illustrates the effects of globalization on welfare with many pairs of symmetric states. The dashed lines correspond to the effects on welfare under complete markets. The top and middle panels use uniformly distributed states (a few for the jagged lines and thousands for the smooth lines). In the top panel, a large fraction of states satisfy $\tau_p^* > 1$. In the middle panel, a large fraction of states satisfy $\tau_p^* < 1$. In the bottom panel, states are distributed according to a sinusoidal density function

4.2. *Globalization, enforcement, and welfare with terms-of-trade effects*

If condition (4.30) does not hold, globalization creates changes in the terms of trade that affect the relative values of individual and regional endowments, ϕ_{is} and ϕ_s^j. That is, globalization can affect within- and between-region inequality in the absence of enforcement, *i.e.* $\partial\phi_{is}/\partial\tau \neq 0$ and $\partial\phi_s^j/\partial\tau \neq 0$.

It is useful to consider first the case in which globalization does not affect within-region inequality in the absence of enforcement. This happens when the endowments of all individuals within a region have the same proportions of all goods:

$$\phi_{is}(z) = \phi_{is}(0) \quad \text{for } z \in [0,1],\ s \in S,\ i \in I^W. \tag{4.33}$$

When this condition holds, we have that $\partial \phi_{is}/\partial \tau = 0$.

For a given enforcement set, welfare is non-decreasing in τ like in the previous section. In those states in which asset markets are open, *i.e.* $s \in E$, globalization allows perfect international sharing of a larger fraction of goods. In those states in which asset markets are closed, *i.e.* $s \notin E$, globalization does not affect domestic sharing but allows imperfect international sharing of a larger fraction of goods.

But the effects of globalization on enforcement are richer than in the previous section. Since condition (4.33) ensures that $\partial \phi_{is}/\partial \tau = 0$, we still have that the benefit of enforcement is independent of τ. But now the cost of enforcement need not be proportional to τ. If globalization increases (decreases) regional risk, *i.e.* $\partial \phi_s^R/\partial \tau > 0$ ($\partial \phi_s^R/\partial \tau < 0$), the cost of enforcement will increase more (less) than proportionally with τ. And whether globalization increases or reduces regional risk depends on whether the marginal tradable good is more or less procyclical than the average tradable one, *i.e.* on whether $\phi_s^R(\tau) > \phi_s^R$ or $\phi_s^R(\tau) < \phi_s^R$.[39] If the marginal goods are more (less) procyclical than the average one, the cost of enforcement grows faster (slower) than in the benchmark case. It is even possible that the marginal tradable goods be so countercyclical that the cost of enforcement falls with globalization in some range. In this case, it is also possible that globalization improves enforcement.[40]

Finally, if we relax Condition (4.33), globalization creates terms-of-trade effects that affect both between- and within-region inequality in the absence of enforcement. The effects of globalization on the cost of enforcement are as described above. But in this case, globalization also affects the benefit of enforcement.

Should we expect globalization to increase or decrease within-region inequality in the absence of enforcement? The answer, once again, depends on whether the marginal tradable goods are more or less procyclical than the average one.[41] But, it also depends now on the importance of the marginal tradable goods in the endowments of rich and poor individuals. To see this, consider first how globalization affects the price of these goods in the absence of enforcement. If they are less procyclical than the average one (*i.e.* they are relatively scarce in the rich region), their price declines relative to other goods. In turn, if these goods are abundant in the endowments of poor (rich) individuals, within-region inequality increases (falls). A similar reasoning applies to the case in which the marginal tradable goods are more procyclical than the average one. Therefore, for globalization to increase the benefits of enforcement, two conditions are necessary. The first one is that globalization change goods prices. This requires that the cyclical properties of the marginal tradable goods be different from those of the average one. The second condition is that this change in goods prices negatively affect poor individuals.

39. To see this note that $\partial \phi_s^R/\partial \tau = \tau^{-1} \cdot (\phi_s^R(\tau) - \phi_s^R)$.

40. In Broner and Ventura (2006), we analyse an example in which this happens. In particular, we assumed that

$$\phi_s^R(z) = \begin{cases} \phi^R(L) & \text{for } z \in [0.5], \\ 2 - \phi^R(L) & \text{for } z \in (0.5, 1], \end{cases}$$

with $\phi^R(L) > 1$.

41. Note that when $\phi_s^R(\tau) = \phi_s^R$, then $\partial \phi_{is}/\partial \tau = 0$ for $i \in I^W$.

This requires that their endowments be relatively abundant in those goods whose price falls with globalization.[42]

5. THE ROLE OF POLICY

The cornerstone of the theory developed above is the trade-off that governments face when deciding their enforcement policy. On the one hand, enforcement increases payments from domestic to foreign residents that lower domestic consumption and welfare. On the other hand, enforcement increases payments between domestic residents that improve domestic sharing of goods and therefore raise welfare. This trade-off determines the states of nature in which governments choose to enforce payments and, therefore, the set of assets that can be traded.

In our set-up, the closure of markets constitutes a failure and this is the direct result of two externalities. The first one is that individuals do not take into consideration how their choice of asset holdings affects the enforcement decision of their government. This externality leads individuals to borrow so much from abroad that governments prefer not to enforce. One might think that imposing borrowing limits would solve this problem and avoid the closure of markets. Section 5.1 shows that this is only partially true and that, in any case, allowing the government to set optimal borrowing limits has surprisingly little effect on the picture of globalization developed in the last two sections.

The second externality is that governments do not take into consideration how their enforcement decisions affect foreigners. This externality leads governments not to enforce payments even though the domestic benefits from not enforcing are always below the foreign costs. It might seem therefore that the closure of markets could be avoided if governments could pay each other *ex post* to enforce. Section 5.2 shows that this is not the case however.

If governments cannot fully offset these externalities, it might still be possible to improve welfare by using trade policy to fight globalization back. After all, countries are not forced to accept globalization "as it comes." Unfortunately, we show in Section 5.3 that when governments lack commitment fighting globalization back is not as easy as it might seem.

5.1. *Borrowing limits*

In our model, individuals sometimes borrow so much from abroad during youth that governments prefer not to enforce in old age. In principle, the solution to this externality consists of imposing limits to foreign borrowing. But this might be difficult. If governments cannot discriminate between asset holders when enforcing payments, it is reasonable to assume also that they

42. In Broner and Ventura (2006), we analyse an example in which the gains from globalization fall disproportionately on the rich. As a result, inequality and the benefits of enforcement increase. In fact, this effect is so strong that globalization improves enforcement. In particular, we assumed that

$$\phi_i(z) = \begin{cases} 2 \text{ for } z \in [0, 0.5] \text{ and } 0 \text{ for } z \in (0.5, 1] & \text{with prob. } 0.5, \\ 0 \text{ for } z \in [0, 0.5] \text{ and } 2 \text{ for } z \in (0.5, 1] & \text{with prob. } 0.5, \end{cases} \quad \text{for } i \in I^j,\ j \in \{H, F\}.$$

$$\phi_s^R(z) = \begin{cases} \phi^R(L) & \text{for } z \in [0, 0.5], \\ 2 - \phi^R(L) & \text{for } z \in (0.5, 1], \end{cases}$$

with $\phi^R(L) > 1$.

cannot discriminate when imposing borrowing limits. We therefore assume that governments can only impose limits on overall borrowing.[43]

Assume governments limit private borrowing using asset-specific issuance rights. Governments choose the number of issuance rights for each asset, denoted $\bar{x}_s^j$ for $s \in S$, $j \in \{H, F\}$, which they distribute equally among their domestic residents. During youth, agents trade in both issuance rights and assets, under the constraint that the assets they issue are limited by the rights they hold. Therefore, the budget sets during youth in equations (3.19) and (3.20) are replaced by

$$\int_{s\in S} (q_s^H \cdot x_{H,is} + q_s^F \cdot x_{F,is} + \iota_s^{j(i)} \cdot (\bar{x}_{is} - \bar{x}_s^{j(i)})) \leq 0 \quad \text{for } i \in I^W, \tag{5.34}$$

$$x_{j(i),is} \geq -\min\{\hat{y}_{is}, \bar{x}_{is}\} \text{ and } x_{-j(i),is} \geq 0 \quad \text{for } s \in S, i \in I^W, \tag{5.35}$$

where $\bar{x}_{is}$ denotes the state-s issuance rights held by individual i after the market for issuance rights closes, ι_s^j denotes the price of state-s issuance rights in country j, and we used the fact that before the market for issuance rights opens individual i holds $\bar{x}_s^{j(i)}$ state-s issuance rights. In addition to the market-clearing conditions for assets in equation (3.22), we now also have market-clearing conditions for issuance rights, which are given by

$$\int_{i\in I^j} \bar{x}_{is} = \bar{x}_s^j \quad \text{for } s \in S, \ j \in \{H, F\}. \tag{5.36}$$

A competitive equilibrium with borrowing limits during youth consists of a set of asset prices and quantities such that individuals maximize expected utility—equation (2.2)—subject to their budget and borrowing constraints—equations (5.34), (5.35), and (3.21)—and asset markets clear—equations (3.22) and (5.36). Naturally, when maximizing their utility, individuals take into account how their individual consumption during old age depends on their individual asset holdings.

In Appendix C we, analyse the equilibrium with optimal borrowing limits and show that it contains three types of states. In those states in which there is enforcement even in the absence of borrowing limits, it is optimal not to impose binding limits and the price of issuance rights is zero in both regions. In the remaining states, it is possible (but not necessary) that borrowing limits in the rich region allow enforcement and trade. In those states in which this happens, we have that the price of issuance rights is positive in the rich region and asset markets are open. Paying issuance rights introduces a wedge between the *ex post* incomes of borrowers and lenders and, even though asset markets are open, both domestic and international sharing of goods is imperfect. In those states in which there is no borrowing limit that would lead to enforcement and trade, the price of issuance rights is zero in both regions and asset markets remain closed.

43. With discriminatory borrowing limits, governments could achieve a constrained efficient equilibrium in which there is perfect domestic risk sharing and constrained international risk sharing. In particular, for each state the rich region would impose no limits on domestic borrowing and the loosest limit $\bar{x}_s^R$ on foreign borrowing such that the corresponding enforcement condition

$$-\int_{i\in I^R} \ln \phi_{is} \geq \tau \cdot \ln \phi_s^R - \tau \cdot \ln \max\left\{1, \frac{y_s^R + \bar{x}_s^R}{y_s^W}\right\}$$

holds. In this constrained optimum, globalization would never have negative effects on domestic risk sharing, although it may (locally) tighten the borrowing constraint and worsen international risk sharing. It would still be true that the higher the importance of domestic risk sharing the more international risk sharing there can be.

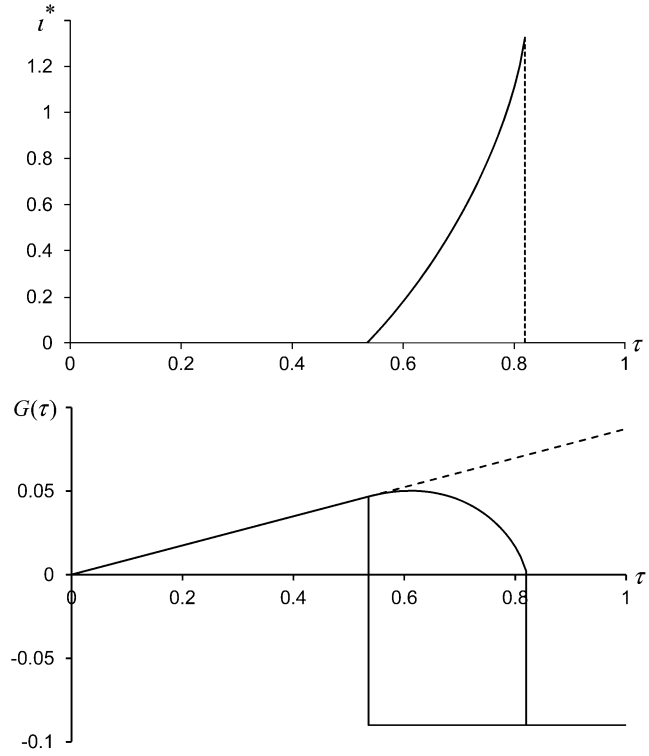

FIGURE 3

This figure illustrates the effects of globalization on optimal borrowing limits and welfare in the example of Figure 1. The dashed line corresponds to the effects on welfare under complete markets

The effects of globalization with optimal borrowing limits are illustrated in Figure 3, which shows the effects of introducing issuance rights in the example of Figure 1. The top panel shows the optimal issuance rights price in the rich region as a function of τ (this price is always zero in the poor region), which we denote $\iota_s^*(\tau)$. For $\tau < \tau_s^*$, borrowing limits are not needed for enforcement to take place so $\iota_s^*(\tau) = 0$. In addition, for τ sufficiently higher than τ_s^* borrowing limits are not useful either since the issuance rights price would need to be so high for enforcement to take place that no resident of the rich region would sell assets anyway. The optimal issuance rights prices are positive only for values of τ that are slightly above τ_s^*.

The effects of globalization on welfare for this pair of symmetric states is shown in the bottom panel. These effects are quite similar to those in the absence of borrowing limits. The difference is that when generation t_s^* arrives, instead of asset trade disappearing the rich region imposes borrowing limits that lead to a positive issuance rights price $\iota_s^*(\tau_{t_s^*+1})$. Although asset markets remain open, there is imperfect domestic and international sharing of goods. Each new generation requires higher issuance rights prices to keep enforcement. Conditional on issuance rights prices and enforcement, globalization improves international sharing of newly tradable goods. However, domestic sharing of goods and international sharing of inframarginal tradable goods worsen as a result of higher issuance rights prices. The net effects of globalization on welfare are ambiguous. At some point, enforcement is impossible even with borrowing limits, so the price of issuance rights fall to zero and globalization eliminates all domestic and international sharing of goods. Borrowing limits delay the date in which enforcement breaks down.

This discussion shows that borrowing limits, though welfare improving, have little effect on the picture of globalization we presented in Section 4.[44]

5.2. *Renegotiation*

We have assumed so far that governments decide enforcement policies non-cooperatively and do not take into account how their decisions affect foreigners. This policy externality leads markets to close whenever the costs of making foreign payments are greater than the benefit of keeping domestic payments. At first sight, this might seem an easy problem to solve. After all, the gains that the rich region obtains from not enforcing are always smaller than the losses that the poor region suffers. Allowing regions to renegotiate their debts *ex post* should therefore ensure that there is always enforcement. Unfortunately, this argument is wrong and we explain next why.

Consider a pair of symmetric states for which we concluded that there is no enforcement in the best symmetric equilibrium. We reached this conclusion by contradiction. Assume individuals expect enforcement, then asset trade would be as in the complete-markets model and the government of the rich region would have incentives not to enforce. Therefore, individuals cannot expect enforcement.

This argument does not formally consider the possibility that regions cooperate during old age. Assume instead that the poor region can make a transfer to the rich region in exchange for enforcement. To raise revenue for this transfer, the poor region levies lump-sum taxes on its residents. *Ex post*, the poor region would be willing to offer a transfer to the rich region that is as large as the payments that its residents are due. Since not enforcing destroys valuable domestic payments, the value of not enforcing for the rich region is smaller than the foreign payments it saves by not enforcing. This observation seems to suggest that enforcement should be the only outcome of any efficient (and also some inefficient) *ex post* bargaining between regions.

But this conclusion would be unwarranted since it assumes that unrestricted asset trade during youth can lead to imperfect sharing *ex post*. To see this, assume that individuals expect enforcement in old age and that this requires a transfer. Anticipating the transfer, domestic residents would now feel richer and sell more assets to foreign residents which now feel poorer. Thus, asset trade would not be as in the complete-markets model. In particular, asset trade would be such that it fully offsets the transfer and achieves perfect domestic sharing of all goods and perfect international sharing of tradable goods *after* the transfer has been paid. But we know already that in this case the rich region has incentives not to enforce and therefore individuals cannot expect that the transfer be enough to induce the rich region to enforce.

This argument shows that the expectation of a debt renegotiation cannot sustain the opening of asset markets, and leads us to conclude that allowing *ex post* cooperation between regions does not affect the equilibrium of the model.

5.3. *Trade policy*

Throughout the paper, we have analysed the effects of globalization, understood as an increase in the fraction of goods that can be traded across regions. Given the potentially negative effects of globalization, it seems natural to explore the role of trade policy. In this section, we do this by considering the effects of a very simple form of trade policy. We assume that gov-

44. In Broner and Ventura (2006), we allow governments to shut down private asset markets and directly control the amount of borrowing by issuing public debt. We show that such public intervention would also have little effect on the picture of globalization presented here. The reason is that governments can control how much they borrow but cannot control who they borrow from. In fact, the outcome with optimal public borrowing is inferior to the one with optimal borrowing limits.

ernments have the option of keeping all potentially tradable goods (*i.e.* $z \in [0, \tau]$) tradable or making all goods non-tradable. We also assume that governments have as much commitment in setting trade policy as they do in setting enforcement policy. Perhaps surprisingly, we show next that trade policy has no effects whatsoever on the workings of asset markets and welfare.[45]

The equilibria of the model with trade policy are characterized by asset trade during youth, and enforcement, trade policy, and goods trade during old age. As in the model without trade policy, we only consider symmetric equilibria and can thus analyse pairs of symmetric states independently. Let E be the set of states in which there is enforcement in the model without trade policy. If trade policy is to have positive effects, these must come from an improvement in enforcement in states $s \notin E$. We consider these states first. In addition, trade policy might have negative effects by affecting enforcement or goods trade in states $s \in E$. We consider these states second.

If state $s \notin E$, in the model without trade policy there is no enforcement and goods trade is allowed. It is clear that in the model with trade policy, this policy outcome is also an equilibrium. The reason is that in the absence of enforcement, there is no reason to interfere in goods trade. Can enforcement be gained by prohibiting goods trade? Conjecture that during youth individuals expect that the government of the rich region will prohibit goods trade in state s. As a result, international payments cannot be made in this state and there would be no trade in state-s securities between residents of different regions during youth. But then, during old age, the government of the rich region would find it optimal to allow goods trade. The reason is that it is not necessary to impose trade restrictions to avoid foreign payments and, by allowing goods trade, domestic residents would gain from *ex post* trade in goods. As a result, enforcement cannot be gained by prohibiting goods trade. This shows that trade policy has no effects in states in which there is no enforcement in the absence of trade policy.

If state $s \in E$, in the model without trade policy there is enforcement and goods trade is allowed. Is this policy outcome still an equilibrium when there is trade policy? At first, it might seem that this need not be the case since the government of the rich region might have incentives to prohibit goods trade to avoid payments to foreigners. However, there is always a distribution of asset holdings such that these incentives are not strong enough to warrant the losses associated with trade disruption. In particular, consider the case in which all payments to foreigners are owed by a small subset of domestic residents, which we can think of as "intermediaries."[46] In this case, even if prohibiting goods trade leads to non-payment to foreigners, the benefit of this can be made arbitrarily small by reducing the subset of intermediaries.[47] As a result, both enforcement and goods trade are maintained. This shows that trade policy has no effects in states in which there is enforcement in the absence of trade policy.

This discussion shows that when governments have no commitment they cannot use trade policy to fight back the potentially negative effects of globalization, and our results still hold.

45. Of course, this would not be the case if governments had commitment over trade policy. Then, globalization would never lower welfare. However, we do not consider realistic to assume that governments have commitment over some policies but not others.

46. If there exists an equilibrium with enforcement in some state s, there also exists an equilibrium with enforcement in state s in which all foreign payments are made by an arbitrarily small subset of domestic residents I_1. To see this, start from the first equilibrium and replace any foreign payment by residents $i \notin I_1$ with a payment from i to some $i' \in I_1$ and a foreign payment by i'.

47. This is because, as $\lim_{c \to \infty} u'(c) = 0$, the increase in average utility resulting from not making foreign payments goes to zero as the size of the subset of intermediaries goes to zero.

6. FINAL REMARKS

This paper has developed a novel theory of endogenous asset market incompleteness based on enforcement risk. The key innovation is our assumption that governments cannot discriminate between domestic and foreign creditors when choosing enforcement. This has important implications for the theory of sovereign risk:

- If governments can discriminate between domestic and foreign creditors, enforcement risk keeps all asset markets open but geographically segmented. Domestic asset trade is not affected and can only be limited by other financial market imperfections. International asset trade is not feasible unless the country can offer some collateral.[48] Increases in collateral improve international risk sharing, without affecting domestic risk sharing. Reductions in trade costs improve the functioning of goods markets without affecting the functioning of asset markets and always raise welfare.[49]
- If governments cannot discriminate between domestic and foreign creditors, enforcement risk closes some asset markets but keeps those that are open global. Even in the absence of other financial market imperfections, domestic asset trade is limited. Even in the absence of collateral, some international asset trade is possible. Increases in collateral improve both international and domestic risk sharing. Reductions in trade costs improve the functioning of goods markets but might either improve or worsen the functioning of asset markets, and the effects on welfare can go either way.

Therefore, our assumption of no discrimination: (i) provides a new explanation for why countries can borrow from abroad even in the absence of default penalties;[50] (ii) shows that there are crucial interactions between domestic and international asset trade; and (iii) accounts for much richer effects of globalization on risk sharing. In addition, the assumption of no discrimination seems to us more realistic than the previous one of perfect discrimination, as argued in the introduction.

What is the effect of globalization on risk sharing and welfare? Globalization increases goods trade and the scope for international risk sharing, leading to standard gains from trade. However, globalization might also reduce enforcement and increase market incompleteness. This worsens risk sharing and creates costs that might—or might not—outweigh the standard gains from trade. These costs arise even if we allow markets and governments to react optimally to the changes brought about by globalization. The reason is that globalization increases the severity of the underlying friction, namely, enforcement risk.

APPENDIX A. CONSTRUCTION OF ENFORCEMENT-RISK EQUILIBRIA

In this appendix, we construct the enforcement-risk equilibrium analysed in the text. With complete markets, there are equilibria that share the same prices and quantities but differ in the distribution of assets among individuals. This multiplicity is clearly irrelevant since it does not matter whose assets an individual holds. With enforcement risk, the

48. We use here a broad concept of collateral. This concept includes the narrow view of collateral, *i.e.* the value of the real assets that foreign creditors can directly seize in the event of default. It also includes the effects of default penalties, *i.e.* the value of the payments that foreign creditors can elicit through the threat of applying penalties of various sorts.

49. The trade theorist will immediately recognize that this statement needs a few words of qualification. In the model of this paper, globalization with perfect discrimination would raise the *ex ante* welfare of all regions because they are *ex ante* identical and a reduction in trade costs has no *ex ante* terms-of-trade effects. With asymmetric regions, it is possible to construct examples in which there are *ex ante* terms-of-trade effects that lead some regions to gain and some to lose as a result of globalization. See Ventura (2005) for a comprehensive analysis of the effects of globalization (as modelled here) on trade, growth, and welfare.

50. In Appendix B, we analyse the effects of default penalties in our set-up.

distribution of assets may be relevant since it can affect the governments' incentives to enforce payments *ex post*. To simplify the exposition, we impose the condition that there may be no state in which Home residents receive payments from Foreign and Foreign residents receive payments from Home. That is, either $\int_{i\in I^H} x_{F,is}$ or $\int_{i\in I^F} x_{H,is}$ is zero for $s \in S$. This restriction is without loss of generality since it can be easily shown that if a given allocation can be supported as an equilibrium in which this condition is not satisfied, then this allocation can also be supported as an equilibrium in which this condition is satisfied.

It follows from the symmetry assumption that we can analyse pairs of symmetric states independently. For each pair of symmetric states s and s', there are three possible symmetric enforcement levels: (i) both regions enforce: $s \in E^H \cap E^F$ and $s' \in E^H \cap E^F$; (ii) one region enforces: either $s \in E^F - E^H$ and $s' \in E^H - E^F$ or $s \in E^H - E^F$ and $s' \in E^F - E^H$; and (iii) no region enforces: $s \notin E^H \cup E^F$ and $s' \notin E^H \cup E^F$. We construct the best symmetric equilibrium and this is the one in which enforcement levels are as high as possible. To find this equilibrium, we take each pair of symmetric states s and s' and follow three steps:[51]

Step 1. *We check whether in equilibrium both regions can enforce payments simultaneously. Assume this is the case. Then, asset holdings are as in the complete-markets model and consumptions are given by equations* (2.14). *Using these consumption allocations and the fact that utility is logarithmic, we find that the enforcement condition is given by*

$$-\int_{i\in I^j} \ln\left(\frac{y_{is}^{N^j}+x_{-j,is}}{y_s^{j,N^j}+x_{-j,s}^{j}}\right) \geq \tau\cdot\ln\left(\frac{y_s^{j,N^j}+x_{-j,s}^{j}}{y_s^{W,N^j}}\right) \quad \text{for } j\in\{H,F\},$$

where y^{N^j} *stands for the value of income in case of unexpected non-enforcement by the government of region* j. *The left-hand side measures the loss in average utility that results from a breakdown in domestic risk sharing in region* j, *while the right-hand side measures the gains in average utility that result from not paying debts to foreigners. The left-hand side is non-negative for both regions, while the right-hand side is zero for the poor (or creditor) region and positive for the rich (or debtor) region. Therefore, the poor region has no incentives to deviate. Has the rich region incentives to deviate? Let* R *be the rich region. Since nobody in this region holds assets issued by residents of the poor region, i.e.* $x_{P,is}=0$ *for* $i\in I^R$, *individual and regional incomes of the rich region if it deviates are obtained by setting* $x_{is}=0$ *in equations* (2.7) *and* (2.8). *If, given these values of productions, the equation above holds, we conclude that the government of the rich region enforces payments. In this case,* $s\in E^H\cap E^F$ *and* $x_{is}=y_s^W-y_{is}$ *for* $i\in I^W$. *Otherwise, we move to the next step.*

Step 2. *We check whether the poor region enforces payments, even though the rich region does not. Assume this is the case. Since the rich region does not enforce payments, there are some residents of this region that would like to sell assets but cannot do so. Typically, there are also some "poor" residents of the rich region that purchase assets from "rich" residents of the poor region. Therefore, the rich region becomes the creditor, while the poor region becomes the debtor. Let* P *be the poor region. Then, we have that asset holdings are given by*

$$x_{is}=\begin{cases}\max\{y_s^P+x_s^P-y_{is},0\} & \text{for } i\in I^R,\\ y_s^P+x_s^P-y_{is} & \text{for } i\in I^P\end{cases}$$

and the market-clearing condition in equation (2.11). *These asset holdings imply that there is full risk sharing among those individuals for which the borrowing constraint is not binding. This includes all residents of the poor region and the "poor" residents of the rich region. The "rich" residents of the rich region are forced to consume all of their production. Substituting these asset holdings into equations* (2.6–2.8), *we obtain incomes and consumption allocations. Moreover, this allows us to write the enforcement condition for the poor region as*

$$-\int_{i\in I^P}\ln\left(\frac{y_{is}^{N^P}}{y_s^{P,N^P}}\right)\geq\tau\cdot\left[\ln\left(\frac{y_s^{P,N^P}}{y_s^{W,N^P}}\right)-\ln\left(\frac{y_s^P+x_{P,s}^P}{y_s^W}\right)\right].$$

Once again, the left-hand side measures the loss in average utility that results from a breakdown in domestic risk sharing in the poor region, while the right-hand side measures the gains in average utility that result from not paying debts to

51. Since states s and s' are symmetric, we just perform these steps for state s.

residents of the rich region. Both the left- and right-hand sides are non-negative. Since residents of the rich region cannot sell assets, individual and regional incomes of the poor region if it deviates are obtained by setting $x_{is} = 0$ in equations (2.7) and (2.8). If, given these values of productions, the condition above holds, we conclude that $s \in E^P - E^R$ and asset holdings are determined as described above. Otherwise, we move to the next step.

Step 3. *If we arrive to this step, it means that none of the regions enforce payments and we conclude that $s \notin E^H \cup E^F$ and $x_{is} = 0$ for $i \in I^W$, $j \in \{H, F\}$. We then obtain incomes and consumption allocations by substituting these asset holdings into equations (2.6–2.8).*

This procedure delivers the best equilibrium. This follows from two observations. First, the enforcement level in a given pair of states does not affect enforcement or welfare in any other pair of states. This is because we focus on symmetric equilibria and in all of them the relative wealth of individuals is the same. Second, the welfare in any pair of states increases with the enforcement level. This is because there are gains from trade and the larger the number of markets the more of these gains individuals reap.

APPENDIX B. PENALTIES AND REPUTATION

In this appendix, we extend our model by introducing default penalties, which can take the form of the seizure of valuable collateral, the application of trade embargoes, or the loss of reputation. We show that such penalties can improve enforcement and lower market incompleteness to some extent, but none of the qualitative results described in the previous sections are affected.

Assume that the government of region $j \in \{H, F\}$ suffers a penalty κ_s^j if it defaults on payments to foreigners in state $s \in S$. Also assume that κ_s^j satisfies the same between-region symmetry conditions that productions satisfy. Furthermore, to preserve the competitive nature of the equilibrium, assume that penalties are conditional on default taking place on a positive measure of payments.

Equilibrium consumption allocations are still given by equations (3.24) and (3.25) and welfare is still given by equation (3.27). The only difference is that the enforcement set now depends on penalties, *i.e.* $E(\{\kappa_s^H, \kappa_s^F\}_{s \in S})$. For short, we shall write $E(\kappa)$ and $E(0)$ to denote the enforcement sets with and without default penalties, respectively. Therefore, we replace equation (3.28) with

$$E(\kappa) = \left\{ s \in S : -\int_{i \in I^R} \ln \phi_{is} + \kappa_s^R \geq \tau \cdot \ln \phi_s^R \right\}. \tag{6.37}$$

The penalty κ_s^j can be a direct penalty that each government can impose on the other government if it defaults. It can also be a cost associated with disruptions in trade in goods if governments have the ability to restrict trade in response to defaults. In this case, the penalty is given by

$$\kappa_s^R = \int_0^\tau \ln\left(\frac{\phi_s^R(z)}{\phi_s^R}\right) \cdot dz + \left(\int_{i \in I^R} \ln \phi_{is} - \int_{i \in I^R} \ln \phi_{is}'\right), \tag{6.38}$$

where $\phi_{is}' \equiv \int_0^1 \phi_{is}(z) \cdot dz$. The first term, which is positive, represents the losses due to having to consume tradable goods in proportion to their domestic endowment as opposed to the world endowment. The second term, which might be positive or negative, represents the changes in domestic inequality as a result of the changes in goods prices that result from closing down trade in goods. In general, we would expect the first term to dominate and trade sanctions to have its usual positive effects on enforcement. We can calculate κ_s^R for each state using equation (6.38) and then replace it in equation (6.37) to find the enforcement set $E(\kappa)$.

The two interpretations of exogenous penalties and trade sanctions have the problem that governments must either be "forced" to impose the penalties if and only if default takes place or else have access to a technology that would let them commit *ex ante* to impose the penalties if and only if default takes place.

A more common way of endogenizing κ_s^j is to assume that governments play a repeated game and then focus on reputational equilibria. For instance, assume that governments agree to enforce if $s \in E(\kappa)$ and that, if one deviates, they revert to the one-stage Nash equilibrium analysed in the rest of the paper in which governments only enforce if $s \in E(0) \subseteq E(\kappa)$. The discount factor is $\beta < 1$. For a given enforcement set E, the loss from default is given by

$$\kappa(E) = \frac{\beta}{1-\beta} \cdot \left[-\tau \cdot \int_{s \in E - E(0)} \pi_s \cdot \ln \phi_s^H - \int_{s \in E - E(0)} \pi_s \cdot \ln \phi_{is} \right]. \tag{6.39}$$

The two terms inside the bracket, which are positive, represent the future losses in international and domestic risk sharing in the states in which enforcement is lost, respectively.[52] To find the reputational equilibria, we must find fixed points (κ, E) of the mapping given by equations (6.37) and (6.39). The best reputational equilibrium can be found with the following procedure. Set $E_1 = S$. Find κ_1 and eliminate from E_1 those states for which the enforcement condition is not satisfied, obtaining a new $E_2 \subseteq E_1$. Find $\kappa_2 \in [0, \kappa_1]$ and eliminate from E_2 those states for which the enforcement condition is not satisfied, obtaining a new $E_3 \subseteq E_2$. And so on. Since this is a contraction mapping, the procedure must converge. That it converges to the best possible reputational equilibrium follows from the fact that if the enforcement condition fails for a state at any iteration it will fail for all later iterations since the condition gets tougher to satisfy as states are eliminated and, thus, the cost of default becomes lower.

The introduction of default penalties does not affect significantly the effects of globalization on risk sharing and welfare. In the case of exogenous penalties, they increase the benefit of enforcement by an amount independent of τ, delaying the disappearance of markets and hastening their reappearance. When penalties take the form of disruptions in goods trade, the size of the penalties depend on the types and fraction of goods that are tradable. For example, in the case of no terms-of-trade effects, trade sanctions have no effect whatsoever because there are no incentives to trade in goods. When there are terms-of-trade effects, trade penalties also delay the disappearance of markets and hasten their reappearance. When penalties take the form of losses of reputation, the analysis is more involved. In particular, equation (6.39) is correct only when τ increases very slowly. In general, it needs to be replaced by one that correctly accounts for the net present value of reputation.

Interestingly, although the introduction of penalties does not affect qualitatively our results, our model suggests a new potential benefit from a strengthening of penalties. In our model, default penalties not only improve international risk sharing but also domestic risk sharing. This is in contrast with previous literature that assumed that governments can discriminate between domestic and foreign creditors. In this literature, asset markets are geographically segmented and there is perfect domestic risk sharing. Increases in penalties increase international risk sharing but have no effect on domestic risk sharing.

APPENDIX C. EQUILIBRIUM WITH OPTIMAL BORROWING LIMITS

In this appendix, we analyse the equilibrium with optimal borrowing limits. Instead of finding the optimal issuance rights directly, we first find the optimal issuance rights prices $\{\iota_s\}_{s\in S}$. Given these prices and resulting asset issuance, the optimal issuance rights are given by

$$\bar{x}_s^j = \int_{i\in I^j} \max\{0, -x_{is}\} \text{ for } s \in S, j \in \{H, F\}.$$

As before, we can analyse pairs of symmetric states independently. To simplify the analysis of the effects of globalization and make it comparable to those in Section 4, we assume that either there is enforcement in both regions or there is not enforcement in either region. We only consider cases in which the issuance rights prices in the poor region are $\iota_s^P = 0$. This condition will be satisfied at the optimum because it is the government of the rich region that might have *ex post* incentives not to enforce payments. So let us denote the issuance rights prices in the rich region by ι_s. Equilibrium in asset markets in state s is characterized by

$$x_{is} = \begin{cases} (1+\iota_s)\cdot(y_s^P + x_s^P) - y_{is} & \text{if } 1+\iota_s < \dfrac{y_{is}}{y_s^P + x_s^P}, \\ 0 & \text{if } 1 \le \dfrac{y_{is}}{y_s^P + x_s^P} \le 1+\iota_s \text{ for } s \in E, i \in I^R, \\ y_s^P + x_s^P - y_{is} & \text{if } \dfrac{y_{is}}{y_s^P + x_s^P} < 1, \end{cases} \tag{6.40}$$

$$x_{is} = y_s^P + x_s^P - y_{is} \text{ for } s \in E, i \in I^P, \tag{6.41}$$

and $x_{is} = 0$ for $s \notin E$, $i \in I^W$; and the asset market-clearing condition $x_s^R + x_s^P = 0$. These conditions imply that, when there is enforcement, the richest residents of the rich region make payments to the poorest residents of the rich region and to the residents of the poor region. Borrowing limits introduce a wedge between the *ex post* incomes of individuals in these two groups.

Whether or not there is enforcement in state s depends on asset holdings, which in turn depend on borrowing limits. Let $x_{is}(\iota_s)$ be the amount of assets individual i purchases when issuance rights prices are ι_s, if all individuals expect

52. There are two points worth noting. First, we have assumed that the reputational loss of default is not a function of the state s. Second, we have also assumed that τ is constant over time. Both assumptions are common in the literature and it is straightforward to see that none of the qualitative results would be affected if we relaxed either one of them.

enforcement. Then $x_s^P(\iota_S) \equiv \int_{i \in I^P} x_{is}(\iota_S)$ is a decreasing function of ι_S. This is because, as ι_S increases, both the set of richest residents in the rich region who want to sell assets and the amount of assets that each such resident wants to sell decreases. It also follows that $x_s^P(\iota_S)$ is continuous in ι_S and that there exists a high enough ι_S such that $x_s^P(\iota_S) = 0$. Let us define $\bar{\iota}_S \equiv \min\left\{\iota_S : x_s^P(\iota_S) = 0\right\}$, which we call the prohibitive issuance rights price for state s. Let ι_s^E be the set of issuance rights prices such that enforcement takes place, namely

$$\iota_s^E \equiv \left\{\iota_S : v_s^R(\text{enforce}) \geq v_s^R(\text{not enforce}) \text{ when } x_{is} = x_{is}(\iota_S) \text{ for } i \in I^W\right\} \text{ for } s \in S.$$

Let the optimal issuance rights price be denoted ι_s^*. Then $[\bar{\iota}_S, \infty) \subseteq \iota_s^E$ and since the optimal issuance rights prices are those that maximize asset trade, $\iota_s^* \leq \bar{\iota}_S$. The optimal issuance rights price will be such that there is enforcement in all states except in those in which the issuance rights prices need to be so large for enforcement that no issuance takes place (*i.e.*. $\iota_s^E = [\bar{\iota}_S, \infty)$ and $x_{is}(\bar{\iota}_S) \geq 0$ for $i \in I^R$). The optimal issuance rights prices are then given by

$$\iota_s^* \equiv \begin{cases} \min\left\{\iota_s^E\right\} & \text{if } \min\left\{x_{is}(\min\left\{\iota_s^E\right\}) : i \in I^R\right\} < 0 \\ 0 & \text{if } \min\left\{x_{is}(\min\left\{\iota_s^E\right\}) : i \in I^R\right\} \geq 0 \end{cases} \quad \text{for } s \in S.$$

Clearly, $\iota_s^* = 0$ for those states in which there was enforcement in the equilibrium without borrowing limits, and $\iota_s^* \in [0, \bar{\iota}_S]$ for the other states. If $\min_{i \in I^R}\{x_{is}(0)\} < x_s^P(0)$, then when $\iota_S = \bar{\iota}_S$ there are no payments to residents of the poor region while there are payments from the richest residents of the rich region to the poorest residents of the rich region. As a result, the government of the rich region strictly prefers to enforce payments. By continuity, $\iota_s^* < \bar{\iota}_S$. As a result, if $\min_{i \in I^R}\{x_{is}(0)\} < x_s^P(0)$ *ex ante* utility is strictly higher with optimal borrowing limits than without them. In addition, there is some international sharing of goods since $x_s^P(\iota_s^*) > 0$. If $\min_{i \in I^R}\{x_{is}(0)\} \geq x_s^P(0)$, then when $\iota_S = \bar{\iota}_S$ there are neither payments to residents of the poor region nor payments to the poorest resident of the rich region. Whether or not there exists an issuance rights price $\iota_S < \bar{\iota}_S$ such that there is enforcement depends on the distribution of individual shocks in the rich region and the fraction of goods that are tradable τ. In all cases, even with optimal borrowing limits enforcement risk still leads to imperfect domestic and international sharing of goods.

Acknowledgement. We thank Sergi Lanau for excellent research assistance. We received valuable comments from Alberto Martin, Ricardo Caballero, Giovanni Cespa, Martín Uribe, Mark Wright, Andrei Levchenko, Fabrizio Perri, and Felipe Meza. We are grateful for generous financial support from Foundation Banque de France as part of the grant "Managing Financial Integration." We also acknowledge financial support from the Spanish Ministry of Science and Innovation, the Generalitat de Catalunya, and the Barcelona GSE.

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