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Globalization and Risk Sharing*

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Abstract

This paper presents a theoretical study of the effects of globalization on risk sharing and welfare. Throughout, we adopt a "technological" view of the globalization process. That is, we model this process as consisting of a gradual (and exogenous) increase in the fraction of goods that are tradable. One might therefore expect globalization to increase trade opportunities and raise welfare. We find however that, in the presence of sovereign risk, this expectation is not always fulfilled. While globalization always increases trade opportunities in goods or spot markets, we also find that it can either increase or decrease trade opportunities in asset or forward markets. The net effect on risk sharing and welfare of this process of creation and destruction of trade opportunities might be either positive or negative depending on a variety of factors that the theory highlights.

Keywords: globalization, risk sharing, sovereign risk, domestic markets, international markets.

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This paper presents a theoretical study of the effects of globalization on risk sharing and welfare. Throughout, we adopt a "technological" view of the globalization process. That is, we model this process as consisting of a gradual (and exogenous) increase in the fraction of goods that are tradable. One might therefore expect globalization to increase trade opportunities and raise welfare. We find however that, in the presence of sovereign risk, this expectation is not always fulfilled. While globalization always increases trade opportunities in goods or spot markets, we also find that it can either increase or decrease trade opportunities in asset or forward markets. The net effect on risk sharing and welfare of this process of creation and destruction of trade opportunities might be either positive or negative depending on a variety of factors that the theory highlights.[1]

We study a world with two regions. The basic setup also has two periods, youth and old age, although sometimes we re-interpret it as a many-period model with an overlapping-generations structure. During youth, all individuals have identical preferences and use the same technology. But this technology is random and leads to differences in production bundles during old age. This provides a role for markets to help individuals pool or share production risks. Goods markets open during old age and allow individuals to trade commodities or goods, while asset markets open during youth and allow individuals to trade promises or assets. Naturally, asset markets can only open if governments enforce during old age the trades agreed upon during youth. We assume that governments choose enforcement policy so as to maximize the utility of the average or representative individual of their region. As usual, this leads governments to prefer different enforcement policies over time. During youth, governments would like to commit to enforce all payments during old age and allow domestic residents to reap all the gains from trade. But during old age, governments would like to enforce only payments between domestic residents because payments from domestic to foreign residents lower domestic consumption and welfare.[2] This standard time-inconsistency problem is also known as sovereign risk in international economics.

There are two polar cases that deliver well-known results in this setup. The first one is the perfect commitment model. If governments can credibly commit during youth to enforce all payments during old age, they will always choose to do so. In this case, asset markets are always open and there is perfect domestic sharing of all goods but only perfect international sharing of

[1] Whether globalization improves or worsens risk sharing is an old question in international economics. Newbery and Stiglitz (1984) provided a famous example in which asset markets are missing and globalization can reduce risk sharing and welfare. However, Dixit (1987, 1989a, and 1989b) showed that this cannot happen if the absence of asset markets, instead of simply assumed, is endogenously derived by introducing private information. Here we endogenize the absence of asset markets by introducing sovereign risk. We find that the result of Newbery and Stiglitz that globalization can reduce risk sharing and welfare still holds. Moreover, our result is even stronger since we also show that globalization can also destroy asset markets.

[2] Why would governments want to enforce payments between domestic residents? In equilibrium, payments are made by individuals that have a low marginal utility of consumption to individuals that have a high marginal utility of consumption and therefore raise the average utility of the region.

tradable goods. Globalization is welfare-improving because it increases the fraction of goods that can be shared internationally. The other polar case is the perfect discrimination model without commitment. If governments choose during old age which payments to enforce, they will choose a discriminatory policy that enforces payments between domestic residents but does not enforce payments from domestic residents to foreign ones. In this case, asset markets are also open but geographically segmented. As a result, there is perfect domestic sharing of all goods but only imperfect international sharing of tradable goods. Globalization is welfare-improving again because it increases the fraction of goods that are shared internationally albeit imperfectly.[3]

We think however that these polar cases leave behind the most interesting effects of globalization, namely, those on the workings of asset markets. To show this, we study here a third polar case in which governments have neither commitment nor the ability to discriminate between domestic and foreign creditors when enforcing payments. In this situation, asset markets are never geographically segmented if open, but some asset markets might be closed. This is the result of governments facing a trade-off when deciding whether to enforce payments that is absent in the other two polar cases. 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 contribute to domestic sharing of goods and therefore raise welfare. This trade-off determines the states of nature in which governments choose to enforce payments during old age and, therefore, the set of assets that can be traded during youth. In those states of nature in which asset markets are open, there is perfect domestic sharing of all goods and perfect international sharing of tradable goods. In those states of nature in which asset markets are closed, there is not only imperfect international sharing of tradable goods but also imperfect domestic sharing of all goods.

This enforcement trade-off provides a theory of asset market incompleteness based on sovereign risk that we exploit to study the effects of globalization. For a given degree of asset market incompleteness, globalization improves international sharing of goods but has ambiguous effects on domestic sharing of goods. In those states of nature in which asset markets are open, globalization leads to perfect international sharing of newly traded goods without affecting domestic sharing of goods. In those states of nature in which asset markets are closed, globalization still improves international sharing of tradable goods but, unlike in the other polar cases, globalization might now also improve or worsen domestic sharing of goods. More importantly, globalization also affects the degree of asset market incompleteness. If the newly tradable goods are similar to the old ones,

[3] International sharing of tradable goods is imperfect because it can only take place through goods markets. During old age, regions trade tradable goods that are abundant in their bundle for other tradable goods that are scarce.

globalization increases international payments without affecting domestic payments. This leads to the closing of some asset markets. If the newly tradable goods are sufficiently different from the old tradable goods, globalization might lead to the opening of some asset markets if it results in smaller international payments and/or larger domestic payments.

This paper is directly related to an extensive literature on sovereign risk that developed in response to the debt crises of the early 1980's in emerging markets. Without exception, this literature adopted the polar case of perfect discrimination.[4] This choice was justified because this assumption provide a reasonably realistic description of the institutional setup of emerging markets in the late 1970's and 1980's. This was a period in which governments borrowed almost exclusively from foreign banks using syndicated loans, while the private sector was largely shut out from international financial markets. This institutional setup clearly facilitates ex-post discrimination, as governments can choose not to pay foreign banks without interfering with domestic asset trade.

But the institutional setup of emerging-market borrowing has changed dramatically in the 1990's and 2000's. Governments now borrow from abroad by selling bonds which are traded in increasingly deep secondary markets, while capital account liberalization now permits private sector agents to access international financial markets directly or through an increasing variety of financial intermediaries. These changes have made it much more difficult for governments to discriminate ex-post.[5] As a result, while the existing literature on sovereign risk is most relevant to understand emerging-market borrowing during the 1970's and 1980's, we believe that the results presented in this paper are most relevant to understand emerging-market borrowing in the 1990's and 2000's.

The rest of the paper is organized as follows. Section one presents the basic setup and describes the equilibrium wih complete markets. Section two introduces sovereign risk. Section three studies the effects of globalization. Section four extends the theory by allowing governments to intervene in asset markets and cooperate among them. Finally, section five concludes.

[4]See Eaton and Gersovitz (1981), Grossman and van Huyck (1988), Bulow and Rogoff (1989a and 1989b), Fernandez and Rosenthal (1990), Atkeson (1991), Cole, Dow and English (1995), Cole and Kehoe (1997), Kletzer and Wright (2000), Kehoe and Perri (2002a), Wright (2002), and Amador (2003). See Eaton and Fernandez (1995) for an excellent survey. All these papers assume there is perfect domestic risk sharing (i.e. each region contains a representative consumer) and ask when would governments enforce international payments. As mentioned above, the answer is 'never' in the two-period setup. This is why these papers focus on reputational equilibria of the many-period version of the model. In section 4.2, we examine the many-period version of our model and show how our results relate to those of this previous literature.

[5]In an environment characterized by financial intermediaries and deep secondary markets, governments' ability to discriminate between domestic and foreign residents is seriously limited. Governments typically do not know the nationality of the clients of banks, mutual funds and other financial intermediaries. And even if they knew, they might still not be able to control how these intermediaries distribute the losses from not enforcing payments among its domestic and foreign clients. And even in those cases in which asset trade is not intermediated, foreign creditors could still get repaid indirectly by selling their assets to domestic residents in secondary markets.

1 A benchmark model of risk sharing

We consider a world in which all individuals are ex-ante identical since they all have the same preferences over different goods and they all have access to the same technology to produce them. This technology is random and generates ex-post differences in the quantity and types of goods produced by the different individuals. This creates a role for markets that can help individuals pool or share risks. In this section, we examine a situation in which these markets work well.

1.1 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 $I^H \cap I^F = \varnothing$. Let $j(i)$ denote the region where individual i resides. 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, 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.[6] 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 to them as "nontradable." The goods are indexed so that tradable goods correspond to low indices, i.e. $z \in [0, \tau]$, and nontradable 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 agents 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.

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

while his/her objective function during youth is given by

$$U_i = \int_{s \in S} \pi_s \cdot u_{is} \quad \text{for all } i \in I^W. \tag{2}$$

[6] 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.

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

During youth, individuals build a project located in their own region. Projects deliver a bundle of goods during old age. We refer to this bundle as the production of the project of individual i or, for short, as the production of individual i. Let $y_{is}(z)$ be the production of good z 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 productions of good z in state s, while $y_s^W(z) \equiv \frac{1}{2} \cdot \left(y_s^H(z) + y_s^F(z)\right)$ 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 productions in Home $\{y_{is}(\cdot)\}_{i \in I^H} = \overline{Y}$ 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 productions in Home $\{y_{is'}(\cdot)\}_{i \in I^H} = \underline{Y}$ and in Foreign $\{y_{is'}(\cdot)\}_{i \in I^F} = \overline{Y}$. 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 productions in Home and Foreign in which $y_{is}(\cdot) = \overline{y}(\cdot)$, then there also exists a corresponding state s' with $\pi_{s'} = \pi$ and the same sets of productions in Home and Foreign in which $y_{i's'}(\cdot) = \overline{y}(\cdot)$. These assumptions imply that ex-ante productions 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 that all valuable trades are carried out. 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 goods. Intuitively, asset markets are used to distribute income across states of nature, while goods markets are used to distribute consumption across goods.[7]

[7] 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 sovereign risk in the next section. This type of risk negatively affects the functioning of forward markets,

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.

1.2 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 production 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. To simplify notation, let $y_s^j \equiv \int_{i \in I^j} y_{is}$ for $j \in \{H, F\}$ be the regional average values of production in state s, while $y_s^W \equiv \frac{1}{2} \cdot \left(y_s^H + y_s^F\right)$ 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. We need not define the world average value of assets since assets are nothing but promises and the aggregate or average value of these promises must be zero, i.e. $x_s^H + x_s^F = 0$. With this notation, we can write the budget constraint of old individuals as follows:

$$\int_0^1 p_s^{j(i)}(z) \cdot c_{is}(z) \cdot dz \leq y_{is} + x_{is} \text{ for all } s \in S \text{ and } i \in I^W. \tag{3}$$

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

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

$$\frac{1}{2} \cdot \int_{i \in I^W} c_{is}(z) = y_s^W(z) \text{ and } p_s^H(z) = p_s^F(z) \equiv p_s^W(z) \text{ for all } z \in [0, \tau] \text{ and } s \in S, \tag{4}$$

$$\int_{i \in I^j} c_{is}(z) = y_s^j(z) \text{ for all } z \in (\tau, 1],\ s \in S, \text{ and } j \in \{H, F\}. \tag{5}$$

Equations (4) and (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 nontradable goods.

A competitive equilibrium during old age consists of a set of goods prices and quantities such that individuals maximize their utility –Equation (1)– subject to their budget constraint –Equation

without affecting the functioning of spot markets. This provides incentives to minimize the use of forward markets and justifies our choice of equilibrium.

(3)– and goods markets clear –Equations (4) and (5). Note that the state variables of this problem are individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$ 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 $c_{is}(z) = \frac{y_{is}+x_{is}}{p_s^{j(i)}(z)}$ for all $i \in I^W$ and $z \in [0,1]$. Substituting these demands into the market clearing conditions in Equations (4) and (5) we find that prices are given by $p_s^W(z) = \frac{y_s^W}{y_s^W(z)}$ for $z \in [0,\tau]$ and $p_s^j(z) = \frac{y_s^j + x_s^j}{y_s^j(z)}$ for $j \in \{H,F\}$ and $z \in (\tau,1]$. Therefore, equilibrium consumption allocations are given by:

$$c_{is}(z) = \begin{cases} \dfrac{y_{is}+x_{is}}{y_s^W}\cdot y_s^W(z) & \text{if } z \in [0,\tau] \\ \dfrac{y_{is}+x_{is}}{y_s^{j(i)}+x_s^{j(i)}}\cdot y_s^{j(i)}(z) & \text{if } z \in (\tau,1] \end{cases} \quad \text{for all } s \in S, \text{ and } i \in I^W. \tag{6}$$

Equation (6) shows how Home and Foreign residents distribute their consumption across the different goods. All individuals share all goods in proportions that are directly related to their incomes. The later are given as follows:[8]

$$\frac{y_{is}+x_{is}}{y_s^W} = \int_0^\tau \frac{y_{is}(z)}{y_s^W(z)}\cdot dz + \frac{y_s^{j(i)}+x_s^{j(i)}}{y_s^W}\cdot\int_\tau^1 \frac{y_{is}(z)}{y_s^{j(i)}(z)}\cdot dz + \frac{x_{is}}{y_s^W} \quad \text{for all } s \in S \text{ and } i \in I^W, \tag{7}$$

and integrating (7) over residents of each region, we get

$$\frac{y_s^j+x_s^j}{y_s^W} = \frac{1}{\tau}\cdot\left(\int_0^\tau \frac{y_s^j(z)}{y_s^W(z)}\cdot dz + \frac{x_s^j}{y_s^W}\right) \quad \text{for all } s \in S \text{ and } j \in \{H,F\}. \tag{8}$$

A region's income increases with its relative production of tradables and with its assets.[9]

Equations (6), (7) and (8) provide a full description of the consumption allocation as a function of the state variables of this problem, i.e. individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{is}\}_{i\in I^W}$. Individual productions are determined by nature, but asset holdings are determined by trade during youth and we turn to this now.

1.3 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.

[8] To see this, substitute prices into the definition of y_{is}.

[9] 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 nontradable goods relative to foreign ones. And this increases the value of domestic production relative to foreign. This additional effect of asset holdings on incomes is known as the "transfer problem."

Therefore, the budget sets of the young are characterized by:

$$\int_{s\in S} q_s \cdot x_{is} \leq 0 \quad \text{for all } i \in I^W, \tag{9}$$

$$x_{is} \geq -y_{is} \quad \text{for all } s \in S \text{ and } i \in I^W. \tag{10}$$

Equation (9) is the budget constraint and says that purchases of assets must be financed by corresponding sales of other assets, while Equation (10) is a solvency constraint that says that individuals can only issue promises that are backed by their own production. Naturally, during youth asset markets must clear:

$$x_s^H + x_s^F = 0 \quad \text{for all } s \in S. \tag{11}$$

Equation (11) states that there is a zero net supply of all assets or promises.

A competitive equilibrium during youth consists of a set of asset prices and quantities such that individuals maximize expected utility –Equation (2)– subject to their budget and solvency constraints –Equations (9) and (10)– and asset markets clear –Equation (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 $y_{is}+x_{is} = \lambda_i^{-1}\dfrac{\pi_s}{q_s}$ where λ_i is the Lagrange multiplier in the individual i's maximization problem. Since all individuals are ex-ante identical (preferences and technology) and have access to the same set of markets, they all have the same multiplier $\lambda_i \equiv \lambda$ for all $i \in I^W$. Integrating this expression over $i \in I^W$ and using the market clearing conditions in Equation (11) we find $\lambda^{-1} = \dfrac{q_s}{\pi_s} y_s^W$. As a result, we have the following equilibrium asset holdings:

$$x_{is} = y_s^W - y_{is} \quad \text{for all } s \in S \text{ and } i \in I^W. \tag{12}$$

Equation (12) provides the equilibrium set of 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 complete description of the complete-markets equilibrium. For a given set of individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{is}\}_{i\in I^W}$, Equations (6), (7) and (8) describe the consumption allocation that come out of goods markets during old age. For a given set of individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$, Equation (12) describes the asset holdings that come out from asset markets during youth. We describe the welfare properties of this equilibrium next.

1.4 Domestic and international risk sharing with complete markets

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

$$y_{is}(z) = \phi_{is}(z) \cdot \phi_s^{j(i)}(z) \cdot y_s^W(z) \text{ for all } z \in [0,1], s \in S, \text{ and } i \in I^W, \tag{13}$$

where $\phi_{is}(z) \equiv \dfrac{y_{is}(z)}{y_s^{j(i)}(z)}$ and $\phi_s^{j(i)}(z) \equiv \dfrac{y_s^{j(i)}(z)}{y_s^W(z)}$ for $z \in [0,1]$, $s \in S$, and $i \in I^W$ are the individual and regional components of production respectively. By construction, these components have a constant mean, i.e. $\int_{i \in I^j} \phi_{is}(z) = 1$ and $\dfrac{1}{2} \cdot \left(\phi_s^H(z) + \phi_s^F(z)\right) = 1$ for all $z \in [0,1]$ and $s \in S$. 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 (6) and (12) to find equilibrium consumption allocations:

$$c_{is}(z) = \begin{cases} y_s^W(z) & \text{if } z \in [0,\tau] \\ \phi_s^{j(i)}(z) \cdot y_s^W(z) & \text{if } z \in (\tau, 1] \end{cases} \quad \text{for all } s \in S, \text{ and } i \in I^W. \tag{14}$$

an plugging these consumption allocations in Equation (2), we obtain 'ex-ante' utilities:

$$U_i = \int_0^1 \left(\int_{s \in S} \pi_s \cdot \ln y_s^W(z) \right) \cdot dz + \int_\tau^1 \left(\int_{s \in S} \pi_s \cdot \ln \phi_s^{j(i)}(z) \right) \cdot dz \tag{15}$$

Equations (14) and (15) provide a full description of consumption and welfare. There is perfect domestic sharing of all goods, but only perfect international sharing of tradable ones. Naturally, this is because it is not technologically possible to share nontradable goods across regions. Markets work well, but they cannot overcome geographical 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.[10]

Not surprisingly, welfare increases with world production of all goods $y_s^W(z)$. Moreover, Jensen's inequality shows that a mean-preserving spread in world production lowers welfare. Higher volatility in world production 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

[10] By symmetric consumption allocations, we refer to those in which all individuals obtain the same 'ex-ante' utility. Since we shall focus exclusively on symmetric consumption allocations throughout the paper, we refer to those in Equations (14) as "the" Pareto efficient consumption allocations, even though we recognize that there exist asymmetric allocations that are also Pareto efficient.

individual risk. To see this, simply note that the individual component of production is absent in Equations (14) and (15). Since there is perfect domestic sharing of all goods, the 'ex-post' distribution of production among individuals of the same region has no effects on individual consumption or welfare.

Welfare is not affected either by an increase in regional risk on tradable goods, but welfare is affected by an increase in regional risk on nontradable goods. To see the former, simply note that the regional component of tradable production is absent in Equations (14) and (15). To see the latter, use Jensen's inequality to show that a mean-preserving spread in the nontradable component of production lowers ex-ante utility. Since there is perfect international sharing of tradable goods, the 'ex-post' distribution of tradable production between regions has no effects on consumption or welfare. Since transport costs preclude international sharing of nontradable goods, higher volatility of the regional component of their production must lead one-to-one to higher volatility in the consumption of these goods and this lowers ex-ante utility.

This discussion provides a simple but comprehensive description of the complete-markets equilibrium. Goods and asset markets combine to allow individuals to share production 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 fulfill them later. We have assumed this implicitly in the previous analysis. In the next section we relax this assumption.

2 Sovereign 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 to deviate 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 (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 that fail to pay their debts. In this situation, Equation (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 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 to allow domestic residents to enjoy a higher level of consumption. This time-inconsistency problem of governments is usually referred to as sovereign risk, and the goal of this section is to analyze how it affects risk sharing and welfare.

2.1 The model with sovereign risk

We consider again the world economy described in section 1.1, 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, i.e. $v_s^j = \int_{i \in I^j} u_{is}$ during old age and $V^j = \int_{s \in S} \pi_s \cdot v_s^j$ during youth for $j \in \{H, F\}$.

If governments were could credibly commit to enforce all payments before the state of nature is revealed, they would always choose to do so and all asset markets would be open. This is the extreme or polar case of perfect commitment.[11] If governments have some choice over enforcement after the state of nature is revealed, they are tempted not to enforce if the payments to foreigners are high enough. We ensure this temptation is always present by moving to the other extreme and assuming governments cannot commit to enforce at all:

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 debtors when enforcing payments. Assume, for instance, that governments choose ex-post which particular payments to enforce so that they can fully discriminate between debtors when enforcing payments. 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. As a result, asset markets would be geographically segmented because there would not be trade in assets between two residents of different

[11] With perfect commitment, the equilibrium would be identical to the complete-markets model and would therefore be fully described by Equations (6), (7), (8) and (12).

regions during youth.[12]

If discrimination is less than perfect, lack of enforcement affects both domestic and international transactions simultaneously and this creates new and interesting interactions between domestic and international risk sharing. We take a first step towards analyzing these interactions by going to the other polar case and assume that governments cannot discriminate among debtors. In particular, we assume:

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

This assumption is crucial for the results of this paper. Once again, we construct next the competitive equilibrium recursively going backwards in time.

2.2 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 by their own residents independently, it is not sufficient to know the overall asset holdings of an individual, but also the residence of the issuer.

Unlike section 1.2, 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 (3) for the following one:

$$\int_0^1 p_s^{j(i)}(z) \cdot c_{is}(z) \cdot dz \leq y_{is} + e_s^H \cdot x_{H,is} + e_s^F \cdot x_{F,is} \quad \text{for all } s \in S \text{ and } i \in I^W. \tag{16}$$

where e_s^j is an indicator variable that takes 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, governments take 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 satisfies:

$$e_s^j = \begin{cases} 1 & \text{if } v_s^j(\text{enforce}) > v_s^j(\text{not enforce}) \\ 0 & \text{if } v_s^j(\text{enforce}) < v_s^j(\text{not enforce}) \end{cases} \quad \text{for all } s \in S \text{ and } j \in \{H, F\}. \tag{17}$$

[12] With perfect discrimination without commitment, there would still be trade in goods since such trade is arms' length and, thus, not affected by sovereign 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 (6), (7) and (8) with asset holdings $x_{is} = y_s^{j(i)} - y_{is}$ for all $s \in S$ and $i \in I^W$.

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.

A competitive equilibrium during old age consists of a set of goods prices and quantities such that individuals maximize their utility –Equation (1)– subject to their budget constraint –Equation (16)–, governments enforce so as to maximize average utility of their region –Equation (17)– and goods markets clear –Equations (4) and (5). Once again, the state variables of this problem are individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{j,is}\}_{j\in\{H,F\},i\in I^W}$.

To compute this equilibrium, replace

$$x_{is} = e_s^H \cdot x_{H,is} + e_s^F \cdot x_{F,is} \tag{18}$$

in Equations (6), (7) and (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 productions $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{j,is}\}_{j\in\{H,F\},i\in I^W}$.

The competitive equilibrium during old age need not be unique. For given enforcement decisions, the consumption allocations are unique. But there might be many equilibria in the game between governments for some arbitrary asset holdings. This multiplicity will not play any role in what follows however. As we shall see, the equilibrium is always unique if asset holdings are not arbitrary, but instead constitute a competitive equilibrium during youth. We turn to the determination of these equilibrium asset holdings next.

2.3 Asset markets

During youth, individuals trade in asset markets. The individual maximization problems are as in section 1.3, except that now agents can only sell securities which pay in states in which their government enforces payments. Let $E^j \subseteq S$ be the set of states in which government j decides to enforce payments for $j \in \{H, F\}$. Then, the solvency constraints in Equation (10) are replaced by

$$x_{j(i),is} \geq -\hat{y}_{is} \text{ for all } s \in S \text{ and } i \in I^W, \tag{19}$$

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

$$\hat{y}_{is} = \begin{cases} y_{is} & \text{if } s \in E^{j(i)} \\ 0 & \text{if } s \notin E^{j(i)} \end{cases} \quad \text{for all } s \in S \text{ and } i \in I^W. \tag{20}$$

Equations (19) and (20) state that individuals cannot pledge income in states in which their government does not enforce payments. For example, a Home resident might want to sell assets that pay in a state, say s, in which his/her production is high in order to purchase assets that pay in states in which his/her production is low. However, if in that state 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, Home production 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.

A competitive equilibrium during youth consists of a set of asset prices and quantities such that individuals maximize expected utility –Equation (2)– subject to their budget and solvency constraints –Equations (9), (19) and (20)– and asset markets clear –Equation (11). Naturally, when maximizing their utility, individuals take as given how their individual consumption during old age depends on their individual asset holdings.

Typically, there are many such equilibria. We focus on equilibria with the following properties:

1. *Absence of two-way payments.* 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 sovereign risk, the 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 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 all $s \in S$. 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.

2. *Symmetry.* Define a coarse partition of states of nature based on sets of productions in Home and Foreign as opposed to individual productions. Abusing notation, we refer to the set of states $\left\{s \in S : \{y_{is}(\cdot)\}_{i \in I^H} = \overline{Y} \text{ and } \{y_{is}(\cdot)\}_{i \in I^F} = \underline{Y}\right\}$ as a single "state" characterized by regional sets of productions $\left(\overline{Y}, \underline{Y}\right)$. 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 productions can be distributed among residents within each region. Given our assumption of symmetry between regions, each state s characterized by sets of

productions $(\overline{Y}, \underline{Y})$ has a corresponding symmetric state s' with the same probability and characterized by sets of productions $(\underline{Y}, \overline{Y})$. We focus on symmetric equilibria, in the sense that enforcement sets are defined over this coarser partition of states and $(\overline{Y}, \underline{Y}) \subset E^H$ if and only if $(\underline{Y}, \overline{Y}) \subset E^F$. This restriction is not without loss of generality, since the model has also asymmetric equilibria.[13] But it delivers a high payoff 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 analyze 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 focus on 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:

<u>*STEP 1:*</u> We check whether in equilibrium both regions can enforce payments simultaneously.[14] Assume this is the case. Then, asset holdings are as in the complete-markets model and consumptions are given by Equation (14). Using these consumption allocations and the fact that utility is logarithmic, we find that the enforcement condition is given by:

$$-\int_{i\in I^j} \ln\left(\frac{y_{is}^{N^j} + x_{-j,is}}{y_s^{j,N^j} + x_{-j,s}^j}\right) \geq \tau \cdot \ln\left(\frac{y_s^{j,N^j} + x_{-j,s}^j}{y_s^{W,N^j}}\right) \quad \text{for all } s \in E^j \text{ and } j \in \{H, F\}, \tag{21}$$

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 nonnegative 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 incentive to deviate. Has the rich region an incentive to deviate? Let R be the rich region. Since nobody in this region holds assets issued by residents of the poor region, i.e. $x_{is}^P = 0$ for all $i \in I^R$, individual and regional incomes of the rich region if it deviates are obtained by setting $x_{is} = 0$ in Equations (7) and (8). If, given these values of productions, Equation (21) holds we conclude that the government of the rich region enforces payments. In this case, $s \in E^H \cap E^F$. Otherwise, we move to the next step.

[13] These equilibria are interesting because they generate inequality between regions that are identical 'ex-ante' and receive the same shock 'ex-post'. But since they are hard to analyze, we leave them for another paper.

[14] Since states s and s' are symmetric, we just perform these steps on state s.

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 R and P be the rich and poor regions. Then, we have that asset holdings are given by

$$x_{is} = \begin{cases} \max\left\{y_s^P + x_s^P - y_{is}, 0\right\} & \text{if } i \in I^R \\ y_s^P + x_s^P - y_{is} & \text{if } i \in I^P \end{cases} \tag{22}$$

and the market clearing condition in Equation (11). These asset holdings imply that there is full risk sharing among those individuals for which the solvency 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 (6), (7) and (8), we obtain incomes and consumption allocations. Moreover, this allows us to write the enforcement condition for the poor region as:

$$-\int_{i\in I^P} \ln\left(\frac{y_{is}^{N^P}}{y_s^{P,N^P}}\right) \geq \tau \cdot \left[\ln\left(\frac{y_s^{P,N^P}}{y_s^{W,N^P}}\right) - \ln\left(\frac{y_s^P + x_{P,s}^P}{y_s^W}\right)\right] \quad \text{for all } s \in E^P. \tag{23}$$

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 residents of the rich region. Both the left and right hand sides are nonnegative. 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 (7) and (8). If, given these values of productions, Equation (23) holds, we conclude that $s \in E^P - E^R$. 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,

$$x_{j,is} = 0 \quad \text{for all } i \in I^W \text{ and } j \in \{H, F\} \tag{24}$$

We then obtain incomes and consumption allocations by substituting Equation (24) into Equations (6), (7) and (8).

This procedure delivers the best symmetric 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.

We can generate other symmetric equilibria by switching the order in which we perform the three steps above.[15] For instance, moving step one to the end and then alternating between starting the procedure in steps two and three generates equilibria in which there is at least one missing market. Or moving step two to the end and then alternating between starting the procedure in steps one and three generates equilibria in which there are either two open markets or none. It is clear therefore that expectations play an important role in this world. But we shall not emphasize this feature in what follows. Instead, we focus exclusively on the equilibrium that arises if individuals have the most optimistic expectations and the maximum number of markets are open. As argued, this equilibrium yields the best possible outcome.

We have now a complete description of the sovereign-risk (best symmetric) equilibrium. For a given set of individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$ and asset holdings $\{x_{j,is}\}_{j\in\{H,F\},i\in I^W}$, Equations (6), (7), (8), (17), and (18) describe the consumption allocation that come out of goods markets during old age. For a given set of individual productions $\{y_{is}(\cdot)\}_{i\in I^W}$, the three-step procedure described above provides the asset holdings that come out from asset markets during youth under the maintained assumption that individuals coordinate to the best symmetric equilibrium.

To simplify the exposition, we will focus on equilibria that also feature a third property:

3. *No reverse payments.* A somewhat surprising feature of the sovereign risk equilibrium is that it can account for "reverse payments," or payments from residents of the poor region to residents of the rich region. Although this is a potentially interesting result, to simplify the exposition we avoid equilibria with reverse payments in what follows. That is, we focus on equilibria in which there exists no state such that the three-step procedure stops in the second step and, as a result, there is enforcement either in both regions or in neither, i.e. $E^H = E^F \equiv E$. This restriction is not without loss of generality, but it delivers a high payoff in terms of tractability since it allows us to write closed-form solutions for consumption and welfare.[16]

[15] Following this procedure until we have tried all possible orderings allows us to construct all symmetric equilibria except for those in which the rich region enforces but the poor region does not. If we added an additional step in which we checked whether the rich region enforces payments while the poor region does not, the procedure would generate the entire set of symmetric equilibria.

[16] Note that an equilibrium with $E^H = E^F \equiv E$ always exists. We can generate it by moving step two to the end, as explained in the previous paragraph. But it might not be the best symmetric equilibrium.

2.4 Domestic and international risk sharing with sovereign risk

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

$$c_{is}(z) = \begin{cases} y_s^W(z) & \text{if } z \in [0,\tau] \\ \phi_s^{j(i)}(z) \cdot y_s^W(z) & \text{if } z \in (\tau,1] \end{cases} \quad \text{for all } s \in E \text{ and } i \in I^W, \tag{25}$$

$$c_{is}(z) = \begin{cases} \phi_{is} \cdot \phi_s^{j(i)} \cdot y_s^W(z) & \text{if } z \in [0,\tau] \\ \phi_{is} \cdot \phi_s^{j(i)}(z) \cdot y_s^W(z) & \text{if } z \in (\tau,1] \end{cases} \quad \text{for all } s \notin E \text{ and } i \in I^W. \tag{26}$$

where $\phi_{is} \equiv \int_0^\tau \phi_{is}(z) \cdot \frac{\phi_s^{j(i)}(z)}{\phi_s^{j(i)}} \cdot dz + \int_\tau^1 \phi_{is}(z) \cdot dz$ and $\phi_s^j \equiv \frac{1}{\tau} \cdot \int_0^\tau \phi_s^j(z) \cdot dz$. To interpret these expressions, note that Equations (7) and (8) imply that:

$$\frac{y_{is} + x_{is}}{y_s^W} = \begin{cases} 1 & \text{for all } s \in E \\ \phi_{is} \cdot \phi_s^{j(i)} & \text{for all } s \notin E \end{cases} \quad \text{and } i \in I^W \tag{27}$$

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 $\frac{1}{2} \cdot \left(\phi_s^H + \phi_s^F\right) = 1$ for all $s \notin E$. In those states in which there asset markets are open these income risks are shared. But this is not possible in those states in which asset markets are closed. Plugging the consumption allocations in Equations (25) and (26) into Equation (2), we obtain 'ex-ante' utilities:

$$\begin{aligned} U_i = & \int_0^1 \left(\int_{s \in S} \pi_s \cdot \ln y_s^W(z) \right) \cdot dz + \int_\tau^1 \left(\int_{s \in S} \pi_s \cdot \ln \phi_s^{j(i)}(z) \right) \cdot dz + \\ & + \int_{s \notin E} \pi_s \cdot \left(\tau \cdot \ln \phi_s^{j(i)} + \ln \phi_{is} \right) \cdot dz \end{aligned} \tag{28}$$

Finally, rewriting Equation (21) using the production decomposition in Equation (13), we find the enforcement set:

$$E = \left\{ s \in S : -\int_{i \in I^R} \ln \phi_{is} \geq \tau \cdot \ln \phi_s^R \right\}, \tag{29}$$

where R is the rich region in the corresponding state.

Equations (25), (26), (28) and (29) provide a full description of consumption and welfare. Now there is imperfect domestic sharing of all goods and international sharing of tradable goods are both imperfect. This is because individuals are forced to consume goods for the value of their production in those states in which the corresponding asset market is closed. The sovereign-risk consumption allocations are therefore 'ex-ante' Pareto inefficient. This is shown in Equation (28) which differs from (15) by the last integral. Jensen's inequality shows that the two terms of this integral are negative. The first term reflects the welfare loss from not being able to perfectly share tradable goods between regions, while the second term reflects the welfare loss from not being able to perfectly share all goods within regions.

The complete-markets equilibrium can now be re-interpreted as the special case of the sovereign-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. $E \subseteq S$, and markets are incomplete. The number of asset markets that are closed and therefore the inefficiency created by sovereign risk negatively depends on the discrepancy between the enforcement set E and the set of all states S. 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, raising 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, lowering incentives to enforce and therefore the size of the enforcement set.[17]

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

But the sovereign 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 analyzed as the sum of two different effects. For a given enforcement set, higher volatility in individual and regional tradable production 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 risk always lowers welfare. But higher volatility in individual and tradable production 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

[17] 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 disproportionally poor individuals and reduces the enforcement set. Similarly, it is also possible that a mean-preserving spread in $\phi_s^j(z)$ benefits disproportionally the poor region and increases the enforcement set.

welfare. Therefore, the first and second effects tend to reinforce each other in the case of regional risk on tradable goods.

The sovereign-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. 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. Sovereign risk generates interesting interactions between domestic and international risk sharing. The more domestic risk sharing that is needed, the more asset markets that are open and the more international risk sharing that is possible. After all, it is the fear to destroy domestic risk sharing that induces governments to enforce international payments and thus sustain asset markets. Similarly, the more international risk sharing that is needed, the more asset markets that are closed and the less domestic risk sharing that is possible. After all, it is the temptation to default on foreigners that induces governments not to enforce payments and thus destroy asset markets. We are next going to use these interactions to provide a novel account of the effects of globalization.

3 The effects of globalization

Since globalization is a dynamic process, we now re-interpret the model as describing the life of a typical generation in a world with overlapping generations. The world has many generations, $t = 0, 1, ..., T(\leq +\infty)$. Generation t members are born at time t, with a project that pays at $t + 1$. They maximize expected utility from consumption at $t + 1$. At time t they trade in assets to diversify their production 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 are not willing to trade assets either. As a result, individuals diversify their production risk as much as they can by trading assets with other members of the same generation. The process of globalization consists of an increase over time of τ. In particular, we assume $\tau_0 = 0$, $\tau_{t+1} \geq \tau_t$, and $\lim\limits_{t\to T} \tau_t = 1$.[18]

We measure the gains from globalization in terms of consumption. More formally, define $G_i(\tau) \equiv U_i(\tau) - U_i(0)$. A generation born in autarky would be indifferent between experiencing growth in world production (of all goods in all states) by a factor $\exp\{G_i(\tau)\}$ and experiencing an increase

[18] We focus on equilibria of this many-period model in which the present actions of governments and/or individuals are independent of their past actions. In this case, the consumption and welfare of each generation is identical to that of the two-period model of section 2, and is fully described by Equations (25), (26), (28) and (29). It is well known that the many-period model might also have additional equilibria in which governments and/or individuals condition their current actions to their past actions. We analyze these additional equilibria in section 4.2.

in the fraction of traded goods from 0 to τ. It follows from Equation (15) that:

$$G_i(\tau) = \int_{s \in E} \pi_s \cdot \int_0^{\tau} \ln\left(\frac{1}{\phi_s^{j(i)}(z)}\right) \cdot dz + \int_{s \notin E} \pi_s \cdot \left[\int_0^{\tau} \ln\left(\frac{\phi_s^{j(i)}}{\phi_s^{j(i)}(z)}\right) \cdot dz + \ln \phi_{is}\right] \tag{30}$$

Equation (30), together with Equations (29), provides a full description of the gains from globalization. In autarky, sovereign risk is not a problem and all asset markets are open. There is perfect domestic risk sharing of all goods, but technological constraints to trade prevent international risk sharing. As a result i's consumption of good z fluctuates across states following regional production. Globalization removes technological constraints to trade but also creates sovereign 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 integral in Equation (30). 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 first and second term inside the second integral in Equation (30) capture this gain and loss from globalization. In this section, we study how all of these forces combine to determine the dynamic effects of globalization on risk sharing and welfare.[19]

3.1 Globalization without terms-of-trade effects

Globalization cannot affect individual or regional production bundles since we have assumed that $\{y_{is}(\cdot)\}_{i \in I^W}$ is taken as exogenous to the analysis, Therefore, the relative values of individual and regional production, i.e. $\frac{y_{is}}{y_s^{j(i)}}$ and $\frac{y_s^j}{y_s^W}$, can only be affected by globalization through changes in goods prices. When this is the case, we say that globalization has terms-of-trade effects.

It is useful to start the analysis with the case in which globalization has no terms-of-trade effects. This requires that, at each stage of globalization, the marginal tradable good has the same regional risk as the average tradable good:

$$\phi_s^j(z) = \phi_s^j \text{ for all } z \in [0,1], \; s \in S, \text{ and } j \in \{H, F\}. \tag{31}$$

[19] With 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. $G_i(\tau) = \int_{s \in S} \pi_s \cdot \int_0^{\tau} \ln\left(\frac{1}{\phi_s^{j(i)}(z)}\right) \cdot dz$. With 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. $G_i(\tau) = \int_{s \in S} \pi_s \cdot \int_0^{\tau} \ln\left(\frac{\phi_s^{j(i)}}{\phi_s^{j(i)}(z)}\right) \cdot dz$. Both of these polar cases therefore yield a smooth and conventional picture of globalization.

When this condition applies, there is no international goods trade and globalization has no effect on goods prices. This implies that $\frac{\partial \phi_{is}}{\partial \tau} = 0$ and $\frac{\partial \phi_s^j}{\partial \tau} = 0$, that is, individual and regional incomes are not affected by globalization even in those states in which asset markets are closed (Of course, incomes are never affected by globalization in those states in which asset markets are open, as shown in Equation (27). Moreover, we can then write the gains from globalization as follows:

$$G_i(\tau) = \int_{s \in E} \pi_s \cdot \ln \left(\frac{1}{\phi_s^{j(i)}} \right)^{\tau} + \int_{s \notin E} \pi_s \cdot \ln \phi_{is} \tag{32}$$

For a given enforcement set, $G_i(\tau)$ is non-decreasing in τ. In those states in which asset markets are open, i.e. $s \in E$, globalization permits international sharing in a growing measure of goods. In those states in which asset markets are closed, i.e. $s \notin E$, globalization does not affect domestic and international sharing of goods.

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

$$\tau_s^* = \frac{-\int_{i \in I^R} \ln \phi_{is}}{\ln \phi_s^R} \tag{33}$$

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 in which $\tau_t > \tau_s^*$ and it never reopens again

Our symmetry assumptions allow us to study the contribution to overall welfare of each pair of symmetric states separately. The bottom panel shows how the contribution of a pair of states s and s' changes as globalization proceeds. Assume $\tau_s^* < 1$ and let t_s^* be the generation such that $\tau_{t^*} < \tau_s^* \leq \tau_{t^*+1}$. All generations born at date $t \leq t_s^*$ open the asset markets for this pair of states. Therefore globalization allows international risk 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 $t > t_s^*$ 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. This is shown in Figure 2. Assume there are many pairs of symmetric states $S = \{(s_1, s_1'), (s_2, s_2'), ..., (s_P, s_P')\}$. 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 $\tau_t \leq \tau_p^*$. 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 possible effects of globalization on welfare are illustrated in the three panels of Figure 2.[20] 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 $t \leq t_1^*$ 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. The leads to a discrete loss of welfare that persists forever since these asset markets never re-open. 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. And this process continues until the world is fully globalized.

This special case illustrates the interplay between two effects of globalization on welfare. On the one hand, globalization removes technological constraints to trade and improves international risk sharing in those states in which asset markets remain open. On the other hand, globalization creates sovereign risk and destroys domestic and international risk sharing in those states in which asset markets close. The top panel of Figure 2 shows the case in which the balance of these effects is always positive and welfare increases monotonically over time. The middle panel shows the opposite case in which the balance of these effects is negative and welfare falls monotonically as globalization proceeds. 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.

[20] The jagged line shows the case of a finite number of states (as explained in the text) while the smooth line shows the limiting case in which the number of states approaches infinity. EXPLAIN HOW WE CONSTRUCTED THIS CASE.

3.2 Terms-of-trade effects

If condition (31) fails globalization creates changes in the terms of trade that affect the relative values of individual and regional production, i.e. $\dfrac{y_{is}}{y_s^{j(i)}}$ and $\dfrac{y_s^j}{y_s^W}$. These terms-of-trade effects substantially complicates the analysis of globalization since now individual and regional incomes are affected by an increase in τ in those states in which asset markets are closed, i.e. $\dfrac{\partial \phi_{is}}{\partial \tau} \neq 0$ and $\dfrac{\partial \phi_s^j}{\partial \tau} \neq 0$.

For a given enforcement set, $G_i(\tau)$ no longer needs to be non-decreasing in τ, as shown by Equation (30). Increases in τ still permit international sharing of a larger fraction of goods in all states and this raises welfare. But now, in addition, globalization affects domestic sharing of goods in those states in which the corresponding asset market is closed, i.e. $s \notin E$. For instance, a change in the terms of trade that increases individual risk worsens domestic sharing of goods and lowers welfare.

Terms-of-trade effects also have implications for the shape of the enforcement set, as shown by Equation (29). Without terms-of-trade effects we found that, for any pair of symmetric states $\{s, s'\}$, enforcement only takes place at low values of τ. This was because the cost of enforcement grows proportionally with globalization, while the benefit of enforcement is not affected by globalization. But this need not be the case if globalization creates terms-of-trade effects. For instance, it is possible that terms-of-trade effects reduce regional risk sufficiently fast that the cost of enforcement falls with globalization. Or it could also be possible that terms-of-trade effects increase individual risk and the benefit from enforcement grows with globalization. Enforcement in a pair of symmetric states $\{s, s'\}$ might now change many times with globalization.

An interesting special case is that in which, at each stage of globalization, the marginal tradable good has the same individual risk as the average tradable good:

$$\phi_{is}(z) = \phi_{is} \quad \text{for all } z \in [0,1]\,,\ s \in S, \text{ and } i \in I^W. \tag{34}$$

When this condition applies, there is no domestic goods trade and changes in goods prices do not affect individual risk, i.e. $\dfrac{\partial \phi_{is}}{\partial \tau} = 0$. For a given enforcement set, $G_i(\tau)$ is non-decreasing in τ as 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 unlike the previous section now the enforcement set can take a variety of different shapes.

Since condition (34) ensures that $\dfrac{\partial \phi_{is}}{\partial \tau} = 0$, 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 regional risk, the cost of enforcement will increase more than proportionally with τ. If globalization reduces regional risk, the cost of enforcement will increase less than proportionally with τ and might even fall. Whether globalization increases or reduces regional risk depends on whether the marginal tradable good contains more regional production risk than the average tradable one. To see this, note that differentiating the definition of ϕ_s^j we find:

$$\frac{\partial \phi_s^R}{\partial \tau} = \frac{1}{\tau} \cdot \left(\phi_s^R(\tau) - \frac{1}{\tau} \cdot \int_0^\tau \phi_s^R(z) \cdot dz \right) \tag{35}$$

If the cost of enforcement is monotonically non-decreasing in τ, the analysis of the enforcement set is essentially the same as that in the previous section (and the picture is almost identical to that in the top panel of Figure 1). But if the cost of enforcement is not monotonic in τ, the shape of the enforcement set might be quite different.

To develop further intuition, consider a pair of states in which one region's production bundle is abundant in low-index goods, while the other region's production bundle is abundant in high-index goods. In particular, assume that $\phi^R(z) \equiv \phi^R(L) > 1$ for all $z \in [0, 0.5]$, and $\phi^R(z) \equiv \phi^R(H) = 2 - \phi^R(L)$ for all $z \in (0.5, 1]$. The top panel of Figure 3 shows that the cost of enforcement grows proportionally with τ until $\tau = 0.5$, but then starts declining and reaches zero when $\tau = 1$. This follows immediately from Equation (35). Naturally, the benefit of enforcement is independent of τ since condition (34) applies. If individual risk is not too high, i.e. $-\int_{i \in I^R} \ln \phi_{is} < 0.5 \cdot \ln \phi^R(L)$; enforcement takes place at low and high levels of globalization, but not at intermediate levels. The threshold values at which enforcement changes are labelled τ_s^* and τ_s^{**}.

The contribution of this pair of states to welfare at different stages of globalization is shown in the bottom panel of Figure 3. Let t_s^* and t_s^{**} be the generations such that $\tau_{t^*} < \tau_s^* \leq \tau_{t^*+1}$ and $\tau_{t^{**}} < \tau_s^{**} \leq \tau_{t^{**}+1}$, respectively. Let also $t_s^{0.5}$ be the generation such that $\tau_{t_s^{0.5}} < 0.5 \leq \tau_{t_s^{0.5}+1}$. All generations born at date $t \leq t_s^*$ open the asset markets for this pair of states. Therefore globalization allows international risk 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 reduces domestic sharing of all goods. The contribution of this pair of states to welfare drops discretely to a level that is below that of autarky. All the generations born in $t \in \left[t_s^*, t_s^{0.5}\right)$ share this very low level of welfare. Generations born in $t \in [t_s^{0.5}, t_s^{**})$ benefit from globalization. Although asset markets remain closed, goods markets now allow imperfect international sharing of tradable goods. Note also that changes in the terms-of-trade raise the relative income of the poor region and reduce the payments that would be required to achieve perfect international sharing of tradable goods. When generation t_s^{**} arrives, these payments are low enough and enforcement is possible again. Asset markets re-open and both domestic and international sharing is reestablished. This leads to a discrete increase in welfare. For $t \geq t_s^{**}$, asset markets are always open and globalization enlarges the fraction of goods that can be shared internationally.[21]

If we relax condition (34), globalization creates changes in the terms of trade that affect individual risk. Rather than performing a long and tedious discussion of this general case, we shall illustrate the new forces at work using a simple modification of the previous example. Instead of assuming that all individuals within a region produce the same bundle of goods, assume now that half of the residents produce only low-index goods while the other half produces only high-index goods. Namely,

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

Note that, in this example, full domestic sharing of all goods is achieved in autarky without the need of asset markets, since the value of the production bundle of all the residents of a region is the same.

The top panel of Figure 4 shows the benefit and cost of enforcement both as functions of τ. The cost of enforcement is as in the previous case, since it only depends on regional risk. But the benefit of enforcement now depends on τ since changes in τ affect individual risk. This benefit starts at zero when $\tau = 0$ since asset markets are not used in autarky. Globalization does not create any trade in this example when $\tau \leq 0.5$ and, as a result, the relative prices of high- and low-index goods are not affected in this range. Without terms-of-trade effects, the benefit of enforcement continues being zero throughout this range. When $\tau > 0.5$, regions start to trade and terms-of-trade effects start to kick in. In particular, international trade in goods raises the prices of low-index goods relative to high-index ones. This reduces domestic sharing and increases the benefit of enforcement. As τ increases, terms-of-trade effects grow stronger and the benefit of enforcement increases. There is therefore a threshold level τ_s^* such that there is enforcement only for $\tau \geq \tau_s^*$.

The bottom panel shows how the contribution to welfare of this pair of states changes with

[21] Note that asset markets are not used when globalization has been completed. The model of Cole and Obstfeld (1991) can be re-interpreted as the limiting case of this example in which $\phi^R(L) \to 2$ and $\tau \to 1$.

globalization. Generations born in $t \leq t_s^{0.5}$ are not affected by globalization. There is no enforcement but goods prices are such that there is perfect domestic sharing of all goods. As discussed above, there is no international sharing of tradable goods. Globalization has two opposing effects on the welfare of generations born in $t \in [t_s^{0.5}, t_s^*)$. On the one hand, globalization improves sharing of tradable goods between regions. On the other hand, globalization worsens domestic sharing of nontradable goods.[22,23] In this range, the negative effect of globalization on domestic sharing raises the benefit of enforcement. Also, the cost of enforcement declines as the same terms-of-trade effects that increase individual risk also reduce regional risk. When generation t_s^* arrives, the benefit of enforcement has increased enough and the cost of enforcement has decreased enough that enforcement becomes possible again and asset markets open. At this point there is a discrete increase in welfare as both domestic and international risk sharing are again possible. All generations born after t_s^* open asset markets and benefit from globalization as it enlarges the fraction of goods that can be shared internationally.

These examples show that terms-of-trade effects alter sometimes quite dramatically the relationship between globalization and asset market incompleteness. Without terms-of-trade effects, asset markets are open only in the early stages of globalization. This need not be the case however if globalization creates terms-of-trade effects. Figures 3 and 4 show situations in which asset markets are open only at intermediate and only at later stages of globalization, respectively. This therefore theory captures a rich set of interactions between globalization and the workings of asset markets.

4 The role of governments

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 contribute to domestic sharing of goods and therefore raises welfare. This trade-off determines the states of nature in which governments choose to enforce payments during old age and, therefore, the set of assets that can be traded during youth.

In this section, we explore the effects of different government policies aimed at relaxing this trade-off. First, we allow governments to intervene in asset markets by setting issuance taxes. As usual, sovereign risk leads to overborrowing and these taxes attenuate the problem. Second, we allow governments to set enforcement policies cooperatively and exploit the repeated nature of their

[22] The net effect is positive in this case but one can construct more complicated examples in which it is negative.

[23] This negative effect of globalization on domestic sharing of goods as a result of terms-of-trade effects was first studied by Newbery and Stiglitz (1984).

interactions. As usual, international cooperation creates additional incentives for enforcement and improves the workings of asset markets. Although these asset market interventions and international cooperation are both welfare improving, they have surprisingly little effect on the picture of globalization developed in the last couple of sections.

4.1 Dealing with overborrowing

The sovereign risk equilibrium that we have analyzed in the last two sections is not Pareto efficient because sovereign risk destroys both domestic and international risk sharing for $s \notin E$. Sovereign risk not only imposes constraints on the size of international payments governments are willing to enforce ex-post, but also introduces an important source of externalities in ex-ante asset trade. In particular, when individuals trade in assets during youth they take as given asset prices and enforcement decisions. As a result, individuals do not internalize that by selling too many assets they might induce their government not to enforce payments, thereby destroying asset markets. In other words, individuals overborrow.[24]

Can governments solve the overborrowing problem by introducing issuance taxes? In this section we show that borrowing taxes can be useful. However, they fall short of solving the overborrowing problem and the qualitative results described above are still true. The reason is that individuals borrow too much from foreigners, not from other domestic residents. So governments would like to reduce international asset trade without affecting domestic asset trade.[25] We assume that, for the same reasons that governments cannot discriminate ex-post when enforcing payments, they cannot discriminate ex-ante when restricting asset trade. In particular, we assume that governments can impose asset-specific issuance taxes, denoted ι_s, but these taxes affect not only asset trade with foreigners but also asset trade with other domestic residents.[26]

We want to characterize the optimal issuance taxes and the properties of the equilibrium under such optimal taxes. As before, we can analyze pairs of symmetric states independently. Equilibrium

[24] This is an old problem in international economics. See Caballero and Krishnamurthy (2001), Tirole (2003), Kehoe and Perri (2002b), and Wright (2006).

[25] There is a fundamental difference between domestic and international risk sharing. While both domestic and international risk sharing raise the average utility of domestic residents ex-ante, only domestic risk sharing raises the average utility of domestic residents ex-post. That is why the time-inconsistency problem arises as a result of international risk sharing.

[26] Here we consider the case in which governments can discriminate when imposing issuance taxes. It is easy to show that the optimal tax on sales of assets to domestic residents is zero, because such taxes both destroy domestic risk sharing and reduce ex-post incentives to enforce payments. Taxes on sales of assets to foreign residents, on the other hand, increase ex-post incentives to enforce payments.

If the tax on sales of assets to foreign residents is ι_s^d, equilibrium in asset markets is characterized by

$$x_{is} = \begin{cases} \left(1+\iota_s^d\right)\cdot\left(y_s^P + x_s^P\right) - y_{is} & \text{if } i \in I^R \\ y_s^P + x_s^P - y_{is} & \text{if } i \in I^P \end{cases} \quad \text{for all } s \in S \tag{36}$$

and the asset market clearing conditions $x_s^R + x_s^P = 0$. It is easy to show that the optimal issuance tax on foreign in asset markets in state s is characterized by

$$x_{is} = \begin{cases} (1+\iota_s)\cdot\left(y_s^P + x_s^P\right) - y_{is} & \text{if } (1+\iota_s)\cdot\left(y_s^P + x_s^P\right) < y_{is} \\ 0 & \text{if } y_s^P + x_s^P \le y_{is} \le (1+\iota_s)\cdot\left(y_s^P + x_s^P\right) \\ y_s^P + x_s^P - y_{is} & \text{if } y_{is} < y_s^P + x_s^P \end{cases} \quad \text{if } s \in E \text{ and } i \in I^R, \tag{37}$$

$$x_{is} = y_s^P + x_s^P - y_{is} \quad \text{if } s \in E \text{ and } i \in I^P, \tag{38}$$

and $x_{is} = 0$ if $s \notin E$ and $i \in I^W$; 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. Issuance taxes 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 issuance taxes. Let $x_{is}(\iota_s)$ be the amount of assets individual i purchases when issuance taxes are ι_s, if all individuals expect enforcement. It is clear that $x_s^P(\iota_s) \equiv \int_{i\in I^P} x_{is}(\iota_s)$ 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 is also clear 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 tax for state s. Let ι_s^E be the set of issuance taxes such that enforcement takes place, namely

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

Let the optimal issuance tax be denoted ι_s^*. It is clear that $[\bar{\iota}_s, \infty) \subseteq \iota_s^E$ and that, since the optimal issuance taxes are those that maximize asset trade, $\iota_s^* \le \bar{\iota}_s$. The optimal issuance taxes will be such that there is enforcement in all states except in those in which the issuance taxes need to be so large for enforcement to be possible that no issuance takes place (i.e. $\iota_s^E = [\bar{\iota}_s, \infty)$ and

sale of assets is equal to

$$\iota_s^d = \begin{cases} 0 & \text{if } s \in E \\ \dfrac{\phi_s^{R,C}}{2-\phi_s^{R,C}} - 1 & \text{if } s \notin E \end{cases}.$$

where $\phi_s^{R,C} \equiv \phi_s^R \cdot \exp\left(\frac{1}{\tau}\cdot\int_{i\in I^R} \ln\phi_{is}\right) \in \left(1, \phi_s^R\right]$ is the lowest regional income in the rich region consistent with the corresponding government being willing to enforce payments ex-post.

Globalization with such optimal discriminatory issuance taxes is always welfare improving and results in (constrained) international risk sharing and perfect domestic risk sharing.

$x_{is}(\bar{\iota}_s) \geq 0$ for all $i \in I^R$). The optimal issuance taxes are then given by

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

Clearly, $\iota_s^* = 0$ for those states in which there was enforcement in the equilibrium without issuance taxes, and $\iota_s^* \in [0, \bar{\iota}_s]$ for the other states. If $\min_{i \in I^R}\left\{x_{is}(0)\right\} < x_s^P(0)$, 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 $\min_{i \in I^R}\left\{x_{is}(0)\right\} < x_s^P(0)$ ex-ante utility is strictly higher with optimal issuance taxes than without them. In addition, there is some international sharing of goods since $x_s^P(\iota_s^*) > 0$. If $\min_{i \in I^R}\left\{x_{is}(0)\right\} \geq x_s^P(0)$, 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 tax $\iota_s < \bar{\iota}_s$ 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 issuance taxes sovereign risk still leads to imperfect domestic and international sharing of goods.

The effects of globalization with optimal issuance taxes are illustrated in Figure 5. The left two panels refer to the case of no terms of trade illustrated in Figure 1. The top panel shows the optimal issuance tax as a function of τ, $\iota_s^*(\tau)$. For $\tau \leq \tau_s^*$, issuance taxes are not needed for enforcement to take place so $\iota_s^*(\tau) = 0$. In addition, for τ sufficiently higher than τ_s^* issuance taxes are not usefull either since they they would need to be so high for enforcement to take place that no resident of the rich region would sell assets anyway. Issuance taxes are positive only for $\tau > \tau_s^*$ but τ not too different from 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 issuance taxes. The difference is that when generation $t_s^* + 1$ arrives, instead of asset trade disapearing the rich region imposes a positive issuance tax $\iota_s^*(\tau_{t_s^*+1})$. This introduces a wedge between the marginal utility of rich residents of the rich region and that of the poor residents of the rich region and residents of the poor region. Although asset markets remain open, there is imperfect domestic and international sharing of goods. Each new generation requires higher issuance taxes to keep enforcement. Conditional on issuance taxes and enforcement, globalization improves international sharing of tradable goods. However, domestic sharing of goods and international sharing of inframarginal tradable goods worsen as a result of higher issuance taxes. The net effects of globalization on welfare are ambiguous. At some point, the optimal issuance tax becomes zero and globalization eliminates all domestic and international sharing of goods. Issuance taxes only delay the time at which enforcement breaks down. But in general enforcement still breaks and for generations for which issuance taxes are positive international and domestic sharing of goods is imperfect.

The middle two panels refer to the case illustrated in Figure 3 in which there are terms of trade effects but there is no domestic trade in goods. The top panel shows that the optimal issuance tax is positive only for $\tau > \tau_s^*$ but not too different from τ_s^* and for $\tau < \tau_s^{**}$ but not too different from τ_s^{**}. The bottom panel shows that the effects of globalization on welfare for this pair of symetric states are not qualitatively affected by issuance taxes. Issuance taxes delay the time at which enforcement breaks down and bring forward the time at which enforcement reappears. The right two panels refer to the case illustrated in Figure 4 in which there are terms of trade effects and there is both domestic and international trade in goods. The top panel shows that the optimal issuance tax is positive only for $\tau < \tau_s^*$ but not too different from τ_s^*. Once again, the bottom panel shows that the effects of globalization on welfare for this pair of symetric states are not qualitatively affected by issuance taxes. Issuance taxes bring forward the time at which enforcement appears.

In general, issuance taxes can help with the overborrowing problem, but not much. The reason is that governments would like to reduce issuance of securities to foreign but not to domestic residents. In the absence of discrimination when imposing issuance taxes, this is not possible. Issuance taxes reduce the set of states in which there is no enforcement. But they do not eliminate this set and even for those states for which enforcement is gained as a result of of issuance taxes domestic and international sharing of goods is imperfect.

4.2 Building a reputation

We find a maximal enforcement set E^C, which satisfies $E \subseteq E^C \subseteq S$, that can be sustained as an equilibrium of a repeated game between governments. If U^N is the one-stage expected utility of the game when the enforcement set is E and U^C is the one-stage utility of the game when the enforcement set is E^C, the enforcement condition is now

$$E^C = \left\{ s \in S : \frac{\beta}{1-\beta}\left(U^C - U^N\right) - \int_{i \in I^R} \ln \phi_{is} \geq \tau \cdot \ln \phi_s^R \right\}, \tag{39}$$

where β^{s-t} is the factor at which governments discount the welfare of generation s at date t. Since subtracting states from E^C makes enforcement less likely in other states, we can find the maximal E^C by successively eliminating states in which the enforcement condition is violated.

5 Final Remarks

This paper has presented a theoretical study of the effects of globalization on risk sharing and welfare. Throughout, we have adopt a "technological" view of the globalization process. That is, we model this process as consisting of a gradual (and exogenous) increase in the fraction of goods that are tradable. For a given degree of asset market incompleteness, globalization improves international sharing of goods but has ambiguous effects on domestic sharing of goods. In those states of nature in which asset markets are open, globalization leads to perfect international sharing of newly traded goods without affecting domestic sharing of goods. In those states of nature in which asset markets are closed, globalization still improves international sharing of tradable goods but, unlike in the other polar cases, globalization might now also improve or worsen domestic sharing of goods. More importantly, globalization also affects the degree of asset market incompleteness. If the newly tradable goods are similar to the old ones, globalization increases international payments without affecting domestic payments. This leads to the closing of some asset markets. If the newly tradable goods are sufficiently different from the old tradable goods, globalization might lead to the opening of some asset markets if it results in smaller international payments and/or larger domestic payments.

There are, at least, two important directions in which the theory presented here can be extended. First, the theory abstracts form other sources of market incompleteness, most notably asymmetric information. These might explain the reduced menu of assets observed in reality. What are the interactions between sovereign risk and these other sources of market incompleteness? How do these interactions affect the account of globalization presented here? Second, the theory abstracts from production choices. Although we talk about production bundles throughout the paper, this is a bit of an abuse, since the production process involves no choices by the so-called "producers". How are the results affected if we introduce a meaningful production structure? More precisely, would the changes in production induced by globalization amplify or dampen the effects on risk sharing discussed in this paper? These are all open questions.

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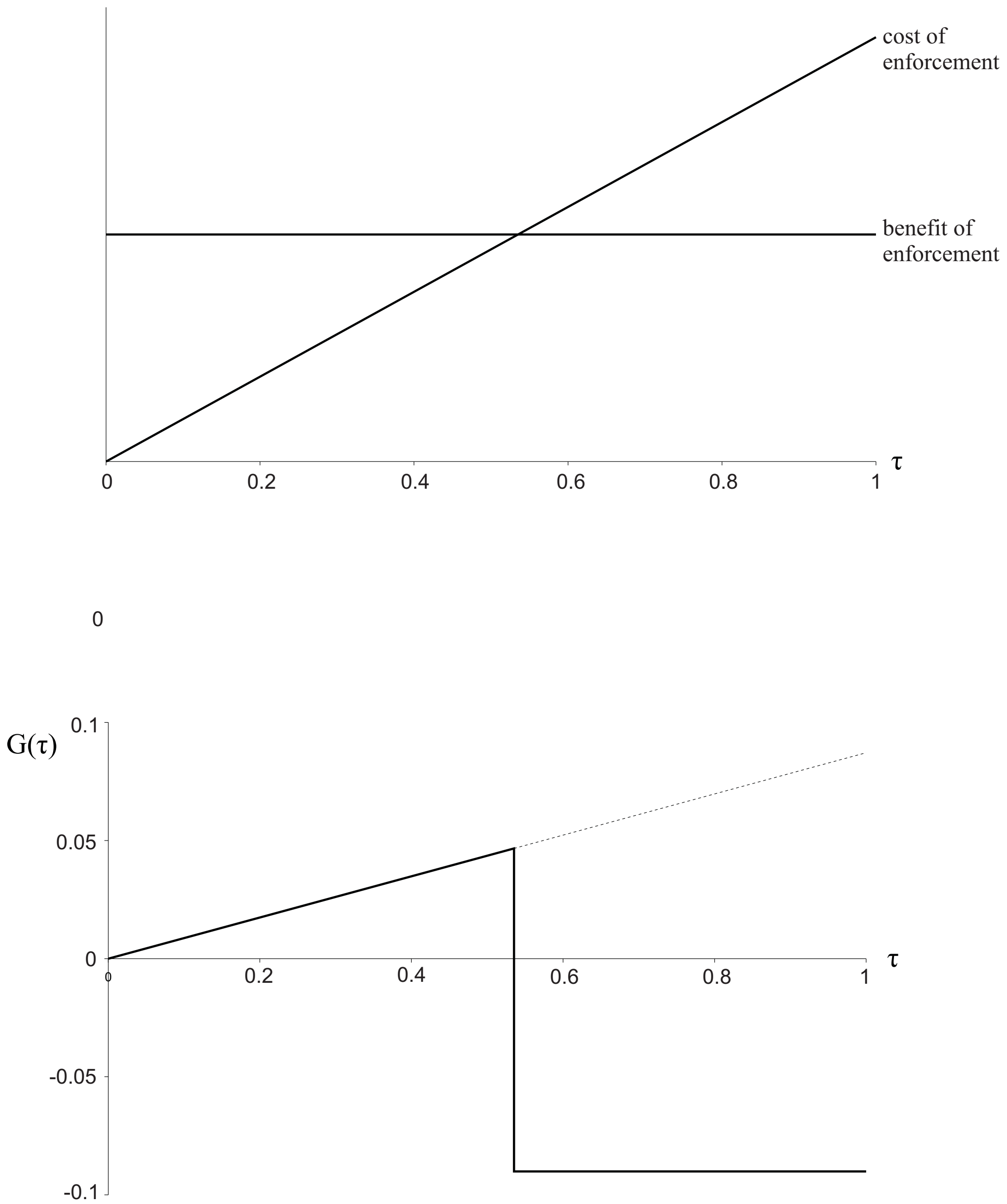
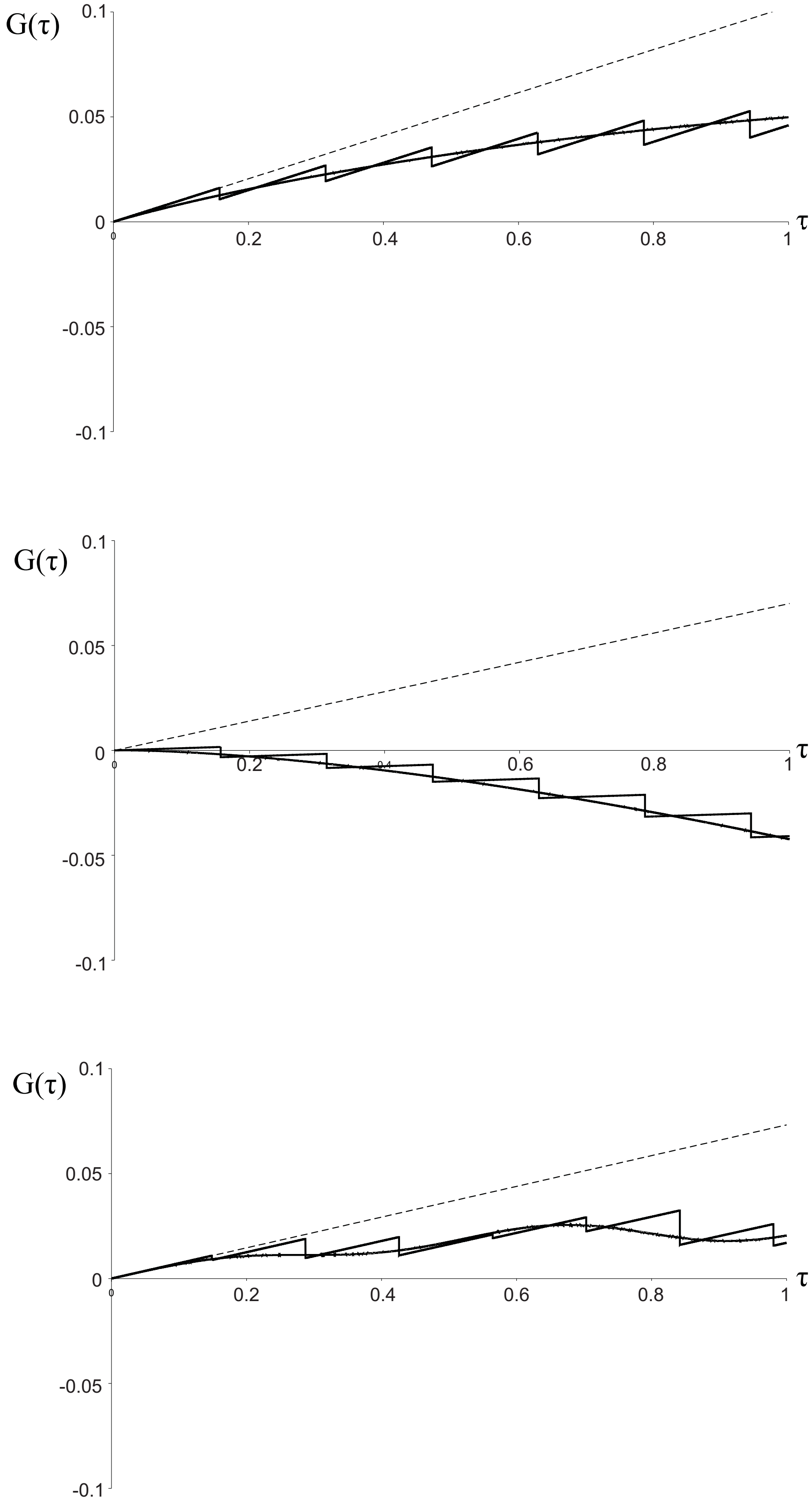
Figure 1



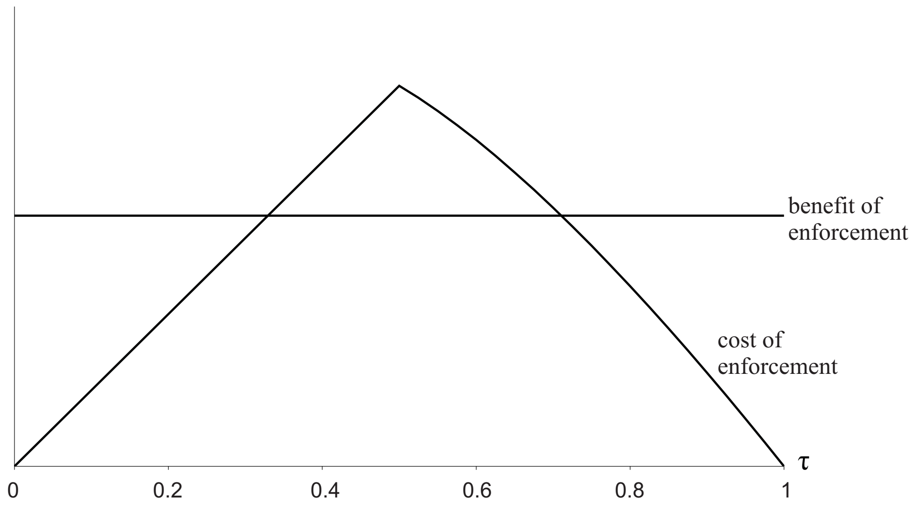
This case is constructed setting in equation (13) $\phi^{R}(z) = 1.4$; $^{P}(z) = 0.4$ for all $z\epsilon[0,1]$; $\phi^{R}_{is}(z) = 1.55$ for half of the residents in R and $\phi^{R}_{is}(z) = 0.45$ for the other half.

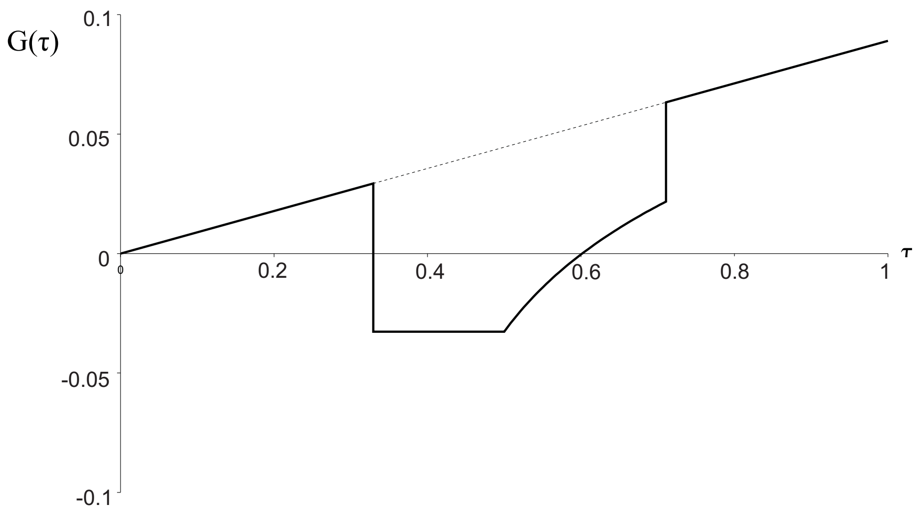
Figure 2



Top and middle panels are done using uniformly distributed pairs of states (14 for the jagged line and 20,000 for the smooth line). The bottom panel is constructed with the same number of states as before but distributed according to a sinusoidal density function.

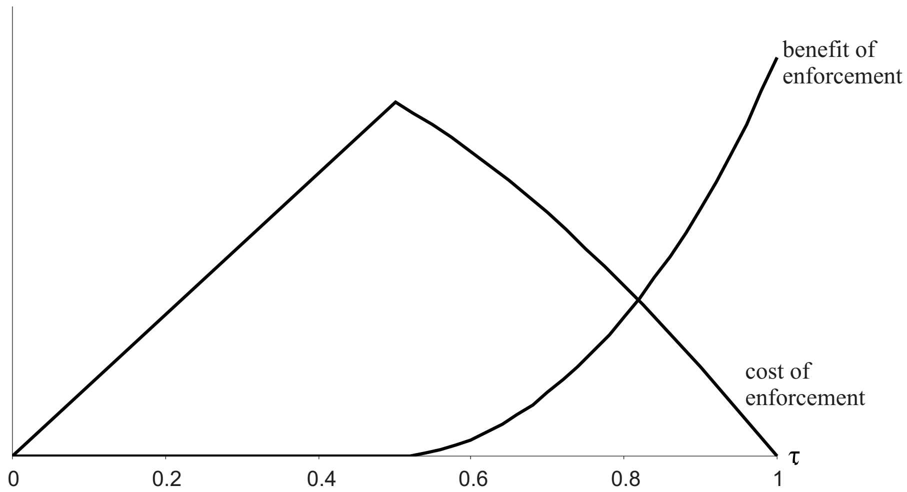
Figure 3

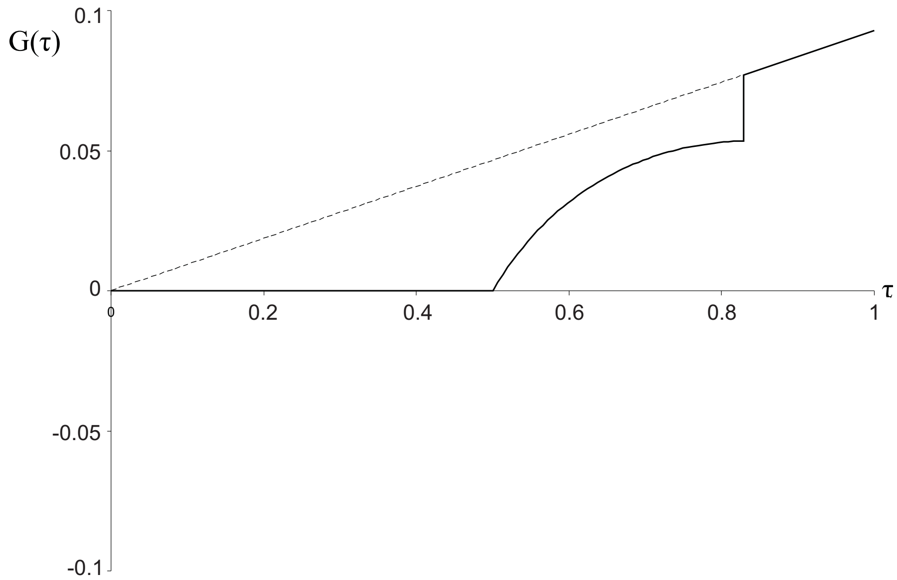




This case is constructed by setting $\phi^R(L)$=1.58; half of the residents in R have ϕ^R_{is} = 1.51 and the rest ϕ^R_{is} = 0.49

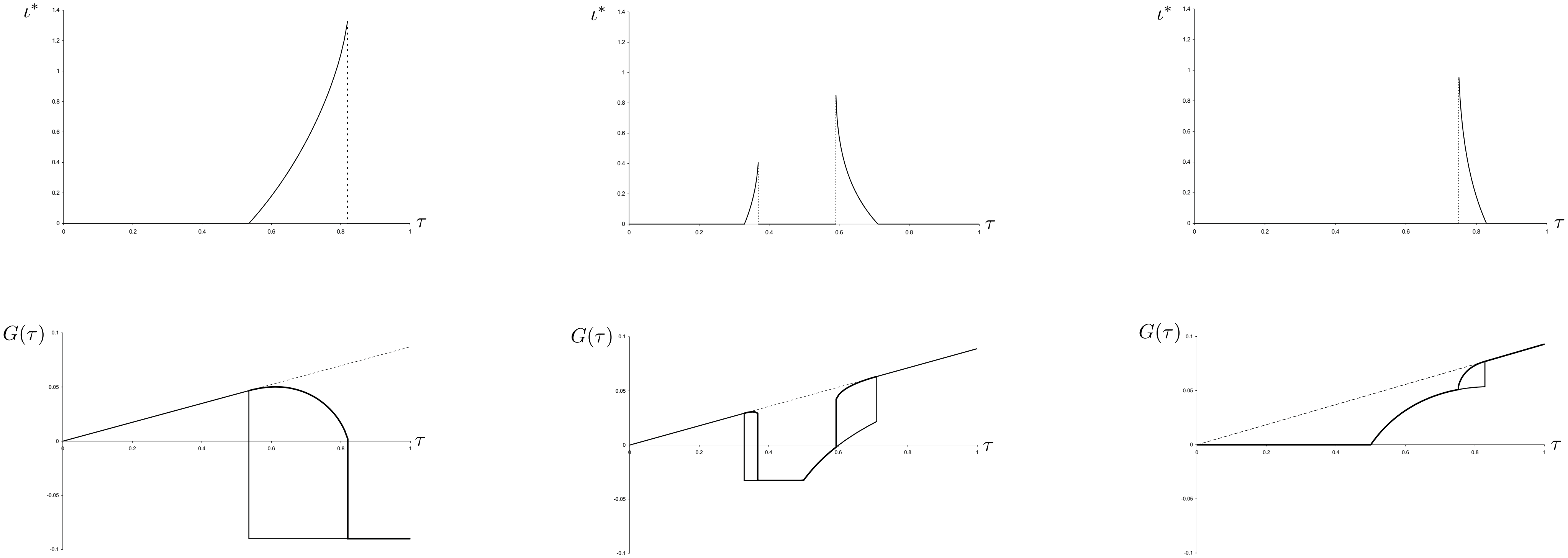
Figure 4





This case is constructed by setting $\phi^{R}(L)=1.58$

Figure 5



No trade in goods

International trade in goods

International and domestic trade in goods