The Growth and Welfare Effects of Macroeconomic Volatility

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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) reduction in the costs of shipping goods across different regions of the world. 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 does improve the workings of goods markets, we also find that it can either improve or worsen the workings of asset markets. The net effect on 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) reduction in the costs of shipping goods across different regions of the world. 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 does improve the workings of goods markets, we also find that it can either improve or worsen the workings of asset markets. The net effect on 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.

We study a world with two regions. The basic setup also has two periods, although we sometimes re-interpret it as an infinite-period model with an overlapping-generations structure. During youth, all individuals are identical since they all have the same preferences over different goods and they all have access to the same technology to produce them. But this technology is random and generates differences across individuals in the quantity and types of goods produced during old age. This creates a role for asset markets during youth that can help individuals pool or share risks. Crucial for the functioning of these markets is that, during old age, governments enforce the trades agreed upon during youth. We assume that governments choose enforcement so as to maximize the utility of the average or representative individual of their region. An implication of this assumption is that, during old age, governments would like to enforce payments from domestic residents to other domestic residents, but not payments from domestic to foreign residents.[1]

There are two polar cases that deliver well-known results in this setup. The first one is the perfect commitment model. If governments have the ability to credibly commit during youth to enforce all payments during old age, they will always choose to do so and asset markets work well. In this case, globalization raises welfare because it improves the workings of goods markets without affecting the (perfect) workings of asset markets. The other polar case is the perfect discrimination model without commitment. If governments have the ability to choose during old age which payments to enforce, they will never enforce payments from domestic residents to foreign ones and asset markets are geographically segmented. In this case globalization improves the workings of goods markets but does not affect the (imperfect) workings of asset markets, also raising welfare. These polar cases are clearly stylized since real governments have neither the credibility assumed by the perfect commitment model, nor the technical sophistication assumed by

[1] Payments are always made by individuals that have a low marginal utility of consumption to individuals that have a high marginal utility of consumption. If the individual receiving the payment is domestic, the payment raises the average utility of the region. If the individual receiving the payment is a foreign resident, the payment lowers the average utility of the region.

the perfect discrimination model.

Although it is often instructive to study polar cases, we think that assuming either perfect commitment or perfect discrimination leaves behind the most interesting part of the story. To show this, we study here a third polar case in which there is neither commitment nor discrimination. In particular, governments choose during old age whether to enforce all payments by domestic residents or none of them.[2] As a result, governments face 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 lowering domestic consumption and welfare. On the other hand, enforcement increases payments between domestic residents that contribute to domestic risk sharing and this raises welfare. This trade-off determines which asset markets are open and which are not.

This trade-off gives rise to crucial interactions between domestic and international risk sharing. On the one hand, the more domestic risk sharing is needed, the larger is the set of asset markets that are open and the more international risk sharing that is possible. In fact, it is the fear to destroy domestic risk sharing that induces governments to enforce international payments and therefore sustain international risk sharing. On the other hand, the more international risk sharing is needed, the smaller is the set of asset markets that are open 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 destroy domestic risk sharing.[3]

In this environment, globalization affects welfare in two ways. On the one hand, by increasing the range of goods that can be shipped internationally, globalization increases the scope for international risk sharing. Conditional on a given level of enforcement, this tends to raise welfare.[4] On the other hand, globalization affects the trade-off governments face when deciding whether to enforce payments. On average, globalization increases the size of international payments, which tends to reduce enforcement and lower welfare. But depending on the type of goods that become tradable, under some conditions globalization can increase enforcement by reducing the size of international payments or by worsening domestic risk sharing in case of no enforcement.

[ONE PARAGRAPH OR TWO ON OVERBORROWING AND POLICY, SUMMARIZING

[2] The appendix generalizes the model to consider the possibility of partial commitment and partial discrimination. This generalized model delivers the three polar cases by taking appropriate limits. The results presented in the main text are then shown to be robust as they only vanish in the limiting cases in which there is either perfect commitment or perfect discrimination.

[3] [DESCRIBE BRIEFLY LITERATURE] There is a literature that focuses on the relationship between domestic and foreign financial markets. See Chang and Velasco (1999), Caballero and Krishnamurthy (2001), ...

[4] This is not always the case though. We show that globalization can have price effects that reduce domestic risk sharing without affecting enforcement. Under some conditions, this negative effect dominates the positive effect of globalization on international risk sharing.

SECTION 4][5]

Our work is related to a strand of literature that asks whether a reduction in trade costs can increase individual risk and lead to a loss of welfare if asset markets are incomplete. This literature started with Newbery and Stiglitz (1984), who developed a model in which, by assumption, there are no asset markets to pool individual risks. When transport costs are high, movements in goods prices provide domestic risk sharing as they tend to re-distribute from those individuals with high production to those with low production. When transport costs are lowered, these beneficial effects of price movements are reduced and so is domestic risk sharing. Newbery and Stiglitz concluded that globalization reduces risk sharing and can be welfare reducing. However, Dixit (1987, 1989a, and 1989b) showed that this result does not hold if the absence of asset markets is not simply assumed, but instead endogenously derived by introducing private information. Here we propose instead to endogenize the absence of asset markets by introducing lack of commitment. Without (or with sub-optimal) capital controls, the result of Newbery and Stiglitz that globalization can reduce risk sharing and lower welfare survives (and can even be stronger). With optimal capital controls, we instead recover Dixit's result that globalization cannot lower welfare.

Our work is also related to an extensive literature on sovereign risk that tries to explain why governments enforce payments from domestic to foreign residents. See Eaton and Gersovitz (1981), Bulow and Rogoff (1989a and 1989b), Cole and Kehoe (1997), Kletzer and Wright (2000), Wright (2002), and Amador (2003). These studies adopt the polar case of perfect discrimination and study the equilibrium of a repeated game between governments. The desire to keep a good reputation generates some international risk sharing in this setup. Here we show instead that international risk sharing is possible even in the absence of reputational considerations if governments cannot perfectly discriminate among creditors. To emphasize this point, we present the basic insights in the context of a two-period model in which reputational considerations play no role.

The paper is organized as follows. Section one develops the model and studies the complete markets equilibrium. Section two introduces sovereign risk and studies how its implications for risk sharing and welfare. Section three uses the sovereign risk equilibrium to study the effects of globalization. Section four examines the role of capital controls. Finally, section five concludes. The appendix generalizes the model to allow for partial commitment and partial discrimination.

[5] [DISCUSS BRIEFLY LITERATURE] There is a literature that focuses on this possibility of overborrowing and its consequences. See Tirole (2003), Caballero and Krishnamurthy (2001), Wright (2006), ...

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 smooth 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 in two steps, 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:

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

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.

The 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 $\{x_{is}\}_{i\in I^W}$.

It follows from individual maximization that consumption demands are given by $c_{is}(z) = \dfrac{y_{is}+x_{is}}{p_s^{j(i)}(z)}$ 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 $p_s^W(z) = \dfrac{y_s^W}{y_s^W(z)}$ for $z \in [0,\tau]$ and $p_s^j(z) = \dfrac{y_s^j + x_s^j}{y_s^j(z)}$ 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:

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

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

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:

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

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

The 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 his/her utility, an individual i takes as given how consumption depends on asset holdings, i.e. Equations (6), (7) and (8).

To find the equilibrium, notice that log preferences imply that a young individual i will choose asset holdings $\{x_{is}\}_{s\in S}$ such that $y_{is} + x_{is} = \lambda_i^{-1}\frac{\pi_s}{q_s}$ 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 $\lambda^{-1} = \frac{q_s}{\pi_s} y_s^W$. As a result, asset trade leads to the following income distribution during old age:

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

Equation (12) says that during old age income is always equally distributed among residents of both regions.[10]

[10] Equations (6), (7) and (8) hold throughout the paper since all individuals will always have access to all goods markets. When we introduce sovereign risk, we shall see however that some individuals loose access to some asset markets and this affects their ability to distribute income across states of nature. Therefore, Equation (12) does not hold in general throughout the paper.

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, combine 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 international sharing of tradable goods, but only perfect domestic sharing of nontradable ones. Naturally, this is because transport costs make it physically impossible 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.[11]

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

[11] 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 (**??**) as "the" Pareto efficient consumption allocations, even though we recognize that there exist other asymmetric ones.

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 consumption 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 physical constraints to trade in goods, 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 goods for goods, while in asset markets individuals trade promises for promises. Unlike goods, 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 is usually referred to as sovereign risk, and the goal of this section is to analyze how it affects risk sharing.

2.1 The model with sovereign risk

Assume 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 forced to choose enforcement before the state of nature is revealed, they would always choose to enforce all payments and the complete-markets equilibrium would apply. This sharp result depends on the extreme or polar assumption of perfect commitment. 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 after the state of nature has been revealed.*

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. In the context of our model, this type of perfect discrimination would imply that governments would never enforce ex-post any payment from a domestic resident to a foreign one. As a result, no assets between residents of different regions would be exchanged ex-ante and no international trade in assets would take place.[12]

[12] With perfect discrimination, 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. The equilibrium of the perfect discrimination model is

This sharp result crucially depends, of course, on the extreme assumption that governments can perfectly discriminate between domestic and foreign residents when enforcing claims. 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 extreme and assuming that governments cannot discriminate at all among debtors. In particular, we assume:

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

Assumptions (1) and (2) are somewhat extreme but analytically convenient. Moreover, the insights gained with these two assumptions are robust when we weaken them. This is shown in the appendix where we generalize the model to the case of partial commitment and partial discrimination.

Note that enforcement decisions can be summarized defining the following enforcement sets:

$$E^j \equiv \{s \in S : \text{government of region } j \text{ enforces payments}\} \text{ for } \; j \in \{H, F\}\,. \tag{16}$$

Conditional on enforcement sets E^H and E^F, the individual maximization problems are as in the previous section, except that agents can only sell securities which pay in states in which their government enforces payments. As a result, the solvency constraints in Equation (10) are replaced by

$$x_{is} \geq -y_{is}^P \text{ for all } s \in S \text{ and } i \in I^W, \tag{17}$$

where y_{is}^P is now pledgable income, defined as

$$y_{is}^P = \begin{cases} y_{is} & \text{if } s \in E^{j(i)} \\ 0 & \text{if } s \notin E^{j(i)} \end{cases} \quad \text{for all } s \in S \text{ and } i \in I^W. \tag{18}$$

Equations (17) and (18) 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

fully described by Equations (6), (7) and (8) and the following income distribution during old age:

$$y_{is} + x_{is} = y_s^{j(i)} \text{ for all } s \in S \text{ and } i \in I^W.$$

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.

Sovereign risk does not affect any of the budget constraints or market clearing conditions, and Equations (3), (4), (5), (9) and (11) still apply. Together with Equations (17) and (18), this set of Equations allows us to find the consumption allocations for exogenously given sets E^H and E^F.[13]

But enforcement decisions are in turn a function of the patterns of consumption and asset holdings. Ex post, governments simultaneously choose whether to enforce payments or not so as to maximize the average utility of domestic residents. That is, an equilibrium can be characterized by enforcement sets E^H and E^F if and only if the resulting equilibrium allocations are such that

$$v_s^j \geq v_s^{j,Nj} \quad \text{for all } s \in E^j \text{ and } j \in \{H, F\}, \tag{19}$$

where $v_s^{j,Nj}$ is the average utility of region j that would result if its government (unexpectedly) chose not to enforce payments in state s. Note that it is not necessary to check that governments choose not to enforce payments when agents expect non-enforcement since in this case agents would not have sold any assets resulting in the government being indifferent between enforcing and not enforcing.

Using the consumption allocations given by Equation (6) and the fact that utility is logarithmic we can simplify the enforcement conditions as follows:

$$\int_{i \in I^j} \ln\left(\frac{y_{is} + x_{is}}{y_s^j + x_s^j}\right) - \int_{i \in I^j} \ln\left(\frac{y_{is}^{Nj} + x_{is}^{Nj}}{y_s^{j,Nj} + x_s^{j,Nj}}\right) \geq \tau \cdot \left[\ln\left(\frac{y_s^{j,Nj} + x_s^{j,Nj}}{y_s^{W,Nj}}\right) - \ln\left(\frac{y_s^j + x_s^j}{y_s^W}\right)\right] \tag{20}$$

for all $s \in E^j$ and $j \in \{H, F\}$, where x^{Nj} stands for assets not sold by residents of region j and y^{Nj} stands for the value of income in case of unexpected non-enforcement by the government of region j. Conditions (20) have an intuitive interpretation. The left hand side shows the loss in average

[13] There are equilibria that share the same enforcement sets, prices, and quantities, but differ in the distribution of assets. With complete markets, 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 will impose the condition that there not be state in which Home residents receive payments from Foreign and Foreign residents receive payments from Home. This 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. In addition, we do not need to consider all the possible distribution of assets that satisfy this condition. The reason is that under this condition when a region is a recipient of international payments the government always enforces payments and when a region is a source of international payments the distribution of assets among domestic residents does not affect the enforcement decision.

utility of eliminating payments from domestic residents to other domestic residents, while the right hand side shows the gain in average utility of eliminating payments from domestic residents to foreign ones. Governments enforce payments if the former exceeds the later.

2.2 Equilibrium

To simplify the exposition, we 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 $\left(\overline{Y}, \underline{Y}\right)$ has a corresponding symmetric state s' with the same probability and characterized by sets of productions $\left(\underline{Y}, \overline{Y}\right)$. We focus on symmetric equilibria, in the sense that enforcement sets are defined over this coarser partition of states and $\left(\overline{Y}, \underline{Y}\right) \subset E^H$ if and only if $\left(\underline{Y}, \overline{Y}\right) \subset E^F$. As a result, residents in both regions have the same budget constraint multipliers λ during youth and we can analyze such 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, consumptions are given by Equation (14) and the enforcement conditions in Equation (20) become:

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

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

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

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. $x_{is}^{N^R} = 0$ 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.

<u>*STEP 2:*</u> 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 in Equation (20) as:

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

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, $x_{is}^{N^P} = 0$ for all $i \in I^P$. As a result, 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.

<u>*STEP 3:*</u> If we arrive to this step, it means that none of the regions enforce payments and, as a

result,

$$x_{is} = 0 \quad \text{for all } i \in I^W \tag{24}$$

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

The equilibrium obtained by following this procedure is unique and 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.

A somewhat surprising feature of the model is that it can account for "reverse flows," or payments from residents of the poor region to residents of the rich region. Although this is a potentially interesting result, we avoid equilibria with reverse flows in what follows. The reason is simply that these equilibria are much harder to analyze. In particular, we assume throughout that:

Assumption 3. *NO REVERSE FLOWS: In equilibrium, there is enforcement either in both regions or in neither. In other words, we assume $E^H = E^F \equiv E$.*

The best equilibrium of the model will satisfy $E^H = E^F$ if individual risk is sufficiently procyclical. In particular, this will obviously be the case if there is no individual risk in the poor region.[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 $E^H = E^F$ always exists. We can generate it by moving step two to the end, as explained in the previous paragraph. But the "best" equilibrium does not always have $E^H = E^F$.

2.3 Domestic and international risk sharing with sovereign risk

Sovereign risk destroys some asset markets, and the remaining ones can only partially allow individuals to share production risks among them. We study next the effects of this endogenous market incompleteness on domestic and international risk sharing.

With sovereign risk, 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 $\phi_s^j \equiv \frac{1}{\tau} \cdot \int_0^\tau \phi_s^j(z) \cdot dz$. And plugging these consumption allocations in Equation (2), we obtain 'ex-ante' utilities:

$$\begin{aligned} U_i = & \int_0^1 \left(\int_{s \in S} \pi_s \cdot \ln y_s^W(z) \right) \cdot dz + \int_\tau^1 \left(\int_{s \in S} \pi_s \cdot \ln \phi_s^{j(i)}(z) \right) \cdot dz + \\ & + \tau \cdot \int_{s \notin E} \pi_s \cdot \ln \phi_s^{j(i)} + \int_{s \notin E} \pi_s \cdot \ln \phi_{is} \cdot dz \end{aligned} \tag{27}$$

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

$$E = \left\{ s \in S : -\int_{i \in I^R} \ln \phi_{is} \geq \tau \cdot \ln \phi_s^R \right\}, \tag{28}$$

where R is the rich region in the corresponding state. To interpret these expressions, note that Equations (7) and (8) imply that $\phi_{is} = \frac{y_{is}}{y_s^{j(i)}}$ and $\phi_s^j = \frac{y_s^j}{y_s^W}$ for all $s \notin E$. That is, ϕ_{is} and ϕ_s^j simply measure the individual and regional components of the values of production (and incomes) when there is no enforcement.

Equations (25), (26), (27) and (28) provide a full description of consumption and welfare. Now there is imperfect international sharing of tradable goods, and imperfect domestic sharing of nontradable goods. This is because individuals are forced to consume the goods for the value of their production in those states in which the corresponding asset market is missing. The sovereign-risk consumption allocations are therefore 'ex-ante' Pareto inefficient. This is shown in Equation (27) which differs from (15) by the last two terms. Jensen's inequality shows that these terms are negative reflecting the welfare loss that results from not being able to share production in those states with missing markets.

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 missing markets 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.

The enforcement set is non-decreasing with the risk that individuals would face in the rich region in the absence of enforcement and non-increasing with the regional risk in the production of tradables. 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 and this raises government incentives to enforce. A mean-preserving spread in ϕ_s^j raises the gains in average utility that result from not paying debts to foreigners and this lowers incentives to enforce.[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.[18]

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

[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 the individual component of production of a given good benefits disproportionally poor individuals and reduces the enforcement set. Similarly, it is also possible that a mean-preserving spread in the regional component of a given tradable good benefits disproportionally the poor region and increases the enforcement set.

[18] This is true because we focus on symmetric equilibria. It is possible that world production and the regional component of production of nontradable goods affect the enforcement set in asymmetric equilibria.

The sovereign-risk equilibrium provides a rich description of international trade in assets. Lack of commitment or trust destroys markets and constitutes an impediment to asset 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 physical constraints to trade. The lack of commitment also generates interesting interactions between domestic and international risk sharing. The more domestic risk sharing that is needed, the larger is the set of available markets 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 smaller is the set of available markets 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 now has infinite time periods, $t = 0, 1, ..., +\infty$. Generation t agents 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 agents cannot trade assets with agents in 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, agents diversify their production risk as much as they can by trading assets with other agents in 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 $\lim_{t\to\infty} \tau_t = 1$. The sets of productions and associated probabilities are identical for all generations. To simplify notation, from now on we omit time subscripts.[19]

Formally, we write the effect of a marginal increase in τ on welfare as $\Delta U_i = \int_0^1 \left(\int_{s\in S} \pi_s \cdot \Delta \ln c_{is}(z)\right) \cdot dz$, where we have used Δ to denote a possibly discrete change in a variable, as opposed to d, which denotes an infinitesimal change in a variable. Then, the cumulated effect of globalization on welfare

[19] It is well known that, with infinite periods, this model might have equilibria with bubbles in asset markets and/or equilibria in which governments enforce payments to keep a reputation for good behavior. We rule out both of these possibilities here. Formally, consider the equivalent finite-period economy with $t = 0, 1, ..., T$. We consider the equilibrium of the finite-period economy as $T \to \infty$. We know that this is always an equilibrium of the infinite-period economy. We leave the analysis of the additional equilibria of the infinite-period economy for another paper.

can be written as $U(\tau) - U(0) \equiv \int_0^\tau \Delta U_i$. Define $G(\tau) \equiv \exp\{U(\tau) - U(0)\} - 1$. This quantity measures the percentage increase in consumption (of all goods in all states) that would make individuals indifferent between staying in autarky or moving to a world where globalization has reached a level τ. If globalization lowers welfare, then $G(\tau) < 0$.

If markets are complete, i.e. $E = S$, ex-ante welfare is given by Equation (15). Taking the derivative with respect to τ, we find the welfare effects of allowing international trade in good τ:

$$\Delta U_i = \left(-\int_{s \in S} \pi_s \cdot \ln \phi_s^{j(i)}(\tau) \right) \cdot d\tau. \tag{29}$$

From Jensen's inequality, it is clear that $\Delta U_i \geq 0$ since $\int_{s \in S} \pi_s \cdot \phi_s^{j(i)}(\tau) = 1$. Naturally, the higher the volatility of the marginal tradable good τ, the higher the gains from globalization. With complete markets, globalization is always welfare improving because the reduction of trade costs allows perfect international risk sharing on a larger set of goods. Figure 1 shows the effects of globalization in this case. As trade costs decline, successive generations enjoy higher ex-ante welfare.

If markets are incomplete, i.e. $E \subset S$, globalization has two additional effects on welfare. For a given enforcement set, globalization affects relative prices and the distribution of risk across individuals in states in which the corresponding asset market is missing. Moreover, globalization also affects the number of markets and this affects both domestic and international risk sharing.

The remainder of this section analyzes all of these effects. To streamline the presentation, section 3.1 analyzes the special case in which the regional components of production are constant across goods:

$$\phi_s^j(z) = \bar{\phi}_s^j \text{ for all } z \in [0,1], \ s \in S, \text{ and } j \in \{H, F\}. \tag{30}$$

This condition implies that both regions produce the same production bundle and there is no international trade in goods. When this condition holds, ϕ_{is} and ϕ_s^j are not affected by globalization and this simplifies the analysis considerably. Section 3.2 then tackles the general case and summarizes its implications.

3.1 The case of no international goods trade

If condition (30) holds, we can write the welfare effects of a marginal increase in τ as follows:

$$\Delta U_i = \left\{ -\int_{s \in E(\tau)} \pi_s \cdot \ln \bar{\phi}_s^{j(i)} \right\} \cdot d\tau + \int_{s \in \Delta E^-(\tau, d\tau)} \pi_s \cdot \left(\ln \phi_{is} + \tau \cdot \ln \bar{\phi}_s^{j(i)} \right) \tag{31}$$

where $\Delta E^{-}(\tau, d\tau) \equiv \{s \in S : s \in E(\tau) \text{ and } s \notin E(\tau + d\tau)\}$ is the set of states in which enforcement is lost as a result of the increase in τ. Let $\Delta E^{+}(\tau, d\tau) \equiv \{s \in S : s \notin E(\tau) \text{ and } s \in E(\tau + d\tau)\}$ be the set of states in which enforcement is gained as a result of the increase in τ. This set does not appear in Equation (31) because condition (30) implies that $\Delta E^{+}(\tau, d\tau) = \varnothing$.

A comparison between Equations (31) and (29) reveals two ways in which the welfare effects of globalization change as a result of market incompleteness. First, the removal of trade costs has now a smaller effect on international risk sharing. This follows from the first term of Equation (31). When asset markets are closed there is no sharing of tradable goods and, as a result, making a nontradable good tradable has no effects on welfare. Second, globalization now reduces the number of markets and this has a negative effect on both domestic and international risk sharing. This follows from the second term in Equation (31). When asset markets close it is now longer possible to share risks and individuals are forced to consume the value of their production.

We conclude therefore that, if markets are incomplete, the positive effects of globalization on welfare are reduced and could even be negative. We illustrate this next with the help of a couple of examples.

Example 1: One pair of symmetric states

Let $S = \{s, s'\}$. The top panel of Figure 2 shows the benefit and cost of enforcement (see Equation (28)) both as functions of τ. The benefit of enforcement does not depend on τ, since condition (30) ensures that $\dfrac{\partial \phi_{is}}{\partial \tau} = 0$. The cost of enforcement is proportional to τ since condition (30) also ensures that $\dfrac{\partial \phi_s^j}{\partial \tau} = 0$. Therefore, there exists a threshold level of $\bar{\tau}$ such that, if $\tau \leq \bar{\tau}$ both asset markets exists, but if $\tau > \bar{\tau}$ both asset markets are missing. This threshold level is given by

$$\bar{\tau} \equiv \frac{-\int_{i \in I^R} \ln \bar{\phi}_{is}}{\ln \bar{\phi}_s^R}.$$

Note that $\bar{\tau}$ is the same in both states given our symmetry assumptions. To make the discussion interesting, we also assume that $\bar{\tau} < 1$.

The effects of globalization on welfare are illustrated in the bottom panel of Figure 2. Let T be the period such that $\tau_{T-1} \leq \bar{\tau} < \tau_T$. All generations born at date $t \leq T$ benefit from globalization, since markets are complete and successive reductions in τ allow them to achieve perfect international risk sharing on a growing number of goods. But this also requires growing debt payments between regions. When generation T arrives, these payments would have grown too large and the temptation to default would have been irresistible. Since individuals anticipate this, asset markets close leading to a complete breakdown of both domestic and international risk sharing. As a result, welfare drops discretely to a level that is below that of autarky. All the generations born at dates $t > T$ share this very low level of welfare.

Example 2: Many pairs of symmetric states

Let $S = \{(s_1, s'_1), (s_2, s'_2), ..., (s_P, s'_P)\}$, where (s_p, s'_p) is a pair of symmetric states. Let $\bar{\tau}_p$ be defined as above for the pair of states (s_p, s'_p). To make the discussion interesting, we assume that there exists some (s_p, s'_p) such that $\bar{\tau}_p < 1$. In a given date t, asset markets exist for the pair of states (s_p, s'_p) if and only if $\tau_t \leq \bar{\tau}_p$. Without loss of generality, we order pairs of symmetric states according to $\bar{\tau}_p$, i.e. $\bar{\tau}_1 \leq \bar{\tau}_2 \leq \cdots \leq \bar{\tau}_P$.

The possible effects of globalization on welfare are illustrated in the three panels of Figure 3 (see the jagged line in each of the panels). Let T_p be the period such that $\tau_{T_p - 1} \leq \bar{\tau}_p < \tau_{T_p}$. All generations born in date $t \leq T_1$ benefit from globalization because asset markets are complete and globalization enlarges the set of goods for which there is perfect international risk sharing. At $t = T_1$, the asset markets corresponding to the pair of symmetric states (s_1, s'_1) close and there is a breakdown of both domestic and international risk sharing in these states. The leads to a discrete loss of welfare that persists forever since these asset markets will 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 in which there is perfect international risk sharing. Note however that this effect is smaller than in earlier generations because the new 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 (but less than earlier generations) from further globalization until the following pair of asset markets close. And this process continues until the world is fully globalized.

These examples illustrate the interplay between two effects of globalization on welfare. On the one hand, globalization improves international risk sharing in those states in which asset markets remain open. This welfare gain from globalization is reflected in the first integral of Equation (31). On the other hand, globalization destroys domestic and international risk sharing in those states in which asset markets close. This welfare loss from globalization is reflected in the second integral of Equation (31). The top panel of Figure 3 shows the case in which the balance of these effects is positive and welfare increases over time. The middle panel shows the opposite case in which welfare falls as globalization proceeds. Finally, the lower panel shows a case in which globalization raises welfare during some periods, but lowers it in some other periods.[20]

[20] The examples in Figure 3 provide very simple and clear intuitions of the effects of globalization on risk sharing and welfare. They might however give the wrong impression that changes in the number of markets always lead to

3.2 The general case

If we relax assumption (30), the welfare effects of a marginal increase in τ are given by:

$$\begin{aligned}\Delta U_i = & \left\{ -\int_{s\in E(\tau)} \pi_s \cdot \ln \phi_s^{j(i)}(\tau) + \int_{s\notin E(\tau)} \pi_s \cdot \left(-\ln \frac{\phi_s^{j(i)}(\tau)}{\phi_s^{j(i)}} + \tau \cdot \frac{\partial \ln \phi_s^{j(i)}}{\partial \tau} \right) \right\} \cdot d\tau + \\ & + \left\{ \int_{s\notin E(\tau)} \pi_s \cdot \frac{\partial \ln \phi_{is}}{\partial \tau} \right\} \cdot d\tau + \\ & + \int_{s\in \Delta E^-(\tau,d\tau)} \pi_s \cdot \left(\ln \phi_{is} + \tau \cdot \ln \phi_s^{j(i)} \right) - \int_{s\in \Delta E^+(\tau,d\tau)} \pi_s \cdot \left(\ln \phi_{is} + \tau \cdot \ln \phi_s^{j(i)} \right)\end{aligned} \tag{32}$$

Each of the lines in Equation (32) describes a different channel through which globalization affects risk sharing and welfare. We describe each of them in turn.

The first line describes the direct effect of reducing trade costs on international risk sharing. The first integral is always positive and measures the increase in welfare that results from better sharing of the marginal tradable good in states in which asset markets are open. In those states, regions perfectly share the inframarginal tradable goods and globalization does not affect this. The second integral has two terms and it is always positive, too. The first term measures how globalization changes the sharing of the marginal tradable good in states in which asset markets are closed. Note that this term is positive (negative) if the marginal tradable good is less (more) procyclical than the average tradable good. The second term measures how globalization changes the sharing of the inframarginal tradable goods in states in which asset markets are closed. This term is positive (negative) if the marginal tradable good is more (less) procyclical than the average tradable good. The second integral captures the expected gains from international trade in goods. These gains are larger the more different the regional components of the marginal and average tradable goods are. These gains are zero only if the marginal tradable good has the same cyclicality as the average one. This is why in the case of Section 3.1 the second integral was zero, because the assumption (30) says that the marginal tradable good has the same cyclicality as the average one.

The second line of Equation (32) describes the direct effect of globalization on domestic risk. This effect operates through the effect of globalization on goods prices and, consequently, on the value of individual productions. The integral in this line can be either positive or negative. When asset markets are open, there is perfect domestic risk sharing and changes in relative prices do not affect the individual component of consumption and welfare. This is why the second line vanishes

'jumps' in ex-ante welfare. This need not be so however. While it is correct that changes in the number of markets always lead to 'jumps' in ex-post welfare, these jumps must be multiplied by their probability to determine their effects on ex-ante welfare. In the previous examples we assumed that there is a finite state space and therefore the probability of each state is discrete. The 'smooth' lines in the different panels of Figure 3 show what happens if we choose instead a continuous state space so that the probability of each state is negligible.

as $E \to S$. When asset markets are closed, each individual must consume goods for a value that does not exceed the value of its production bundle. But the latter depends on relative prices, which in turn depend on how globalized the world economy is. In the case of Section 3.1 the second line did not exist, because the assumption (30) implies that globalization has no effects on relative prices in the absence of enforcement. This is no longer true in the general case, as we shall show in the examples below.

The third line of equation (32) describes the effect of globalization on domestic and international risk sharing that works through changes in the number of markets. The first integral is always negative and measures the welfare effects of a breakdown in domestic and international risk sharing when asset markets close. The second integral is always positive and measures the welfare effects of the creation of domestic and international risk sharing when asset markets open. In the case of section 3.1 the second integral did not exist, because the assumption (30) implies that the benefits of enforcement are constant, while the costs of enforcement grow proportionally with τ. This is no longer true in the general case since now the benefits and costs of enforcement can both be increasing or decreasing with τ, as we shall show in the examples below.

We now provide a couple of examples that illustrate some of the possible effects of globalization on risk sharing and welfare when there is a role for international trade in goods.

Example 3: A two-sector economy without domestic trade in goods

Let $S = \{s, s'\}$. Assume that the individual component of production does not depend on z so there is no role for domestic trade in goods. In particular, assume

$$\phi_i(z) = 1 \quad \text{for all } z \in [0,1]\,,\ s \in S, \text{ and } i \in I^P, \tag{33}$$

$$\phi_i(z) = \bar{\phi}_i \quad \text{for all } z \in [0,1]\,,\ s \in S, \text{ and } i \in I^R. \tag{34}$$

Also assume that the regional component of production is such that goods $z \in \left(\frac{1}{2}, 1\right]$ are perfectly countercyclical to goods $z \in \left[0, \frac{1}{2}\right]$, namely

$$\phi^R(z) \equiv \phi^R(L) > 1 \quad \text{for all } z \in \left[0, \frac{1}{2}\right], \tag{35}$$

$$\phi^R(z) \equiv \phi^R(H) = 2 - \phi^R(L) \quad \text{for all } z \in \left(\frac{1}{2}, 1\right]. \tag{36}$$

The top panel of Figure 5 shows the benefit and cost of enforcement, both as functions of τ. The benefit of enforcement does not depend on τ because, in the absence of domestic trade in goods,

$\dfrac{\partial \phi_i}{\partial \tau} = 0$. The cost of enforcement is an inverted-U shaped function of τ. For $\tau < \dfrac{1}{2}$, an increase in τ increases the cost of making international payments needed for international risk sharing as in the case of Section 3.1. For $\tau > \dfrac{1}{2}$, on the other hand, an increase in τ reduces the cost of making international payments needed for international risk sharing since the difference in the value of production of tradables in the two regions becomes smaller. In fact, when $\tau = 1$ the cost of making international payments needed for international risk sharing is zero since the value of production of tradables in the two regions is the same.

The effect of globalization depends on whether for $\tau = \dfrac{1}{2}$ there is enforcement. If $-\int_{i\in I^R} \ln \bar{\phi}_{is} \geq \dfrac{1}{2} \cdot \ln \phi^R(L)$ there is enforcement for all τ, and the effect of globalization on welfare is as in the complete markets case. If $-\int_{i\in I^R} \ln \bar{\phi}_{is} < \dfrac{1}{2} \cdot \ln \phi^R(L)$ there are two thresholds levels $\bar{\tau} \in \left(0, \dfrac{1}{2}\right)$ and $\bar{\tau}' \in \left(\dfrac{1}{2}, 1\right)$ such that there is enforcement for $\tau \in [0, \bar{\tau}] \cup [\bar{\tau}', 1]$ and there is no enforcement for $\tau \in (\bar{\tau}, \bar{\tau}')$. The threshold levels satisfy

$$-\int_{i\in I^R} \ln \bar{\phi}_{is} = \bar{\tau} \cdot \ln \phi^R(L)$$
$$-\int_{i\in I^R} \ln \bar{\phi}_{is} = \bar{\tau}' \cdot \ln \left((2 - \phi^R(L)) + \frac{1}{\bar{\tau}'} \cdot \left(\phi^R(L) - 1\right) \right)$$

The effects of globalization on welfare are illustrated in the bottom panel of Figure 5. Let T be the period such that $\tau_{T-1} \leq \bar{\tau} < \tau_T$, $T_{1/2}$ be the period such that $\tau_{T_{1/2}-1} \leq \dfrac{1}{2} < \tau_{T_{1/2}}$, and T' be the period such that $\tau_{T'-1} \leq \bar{\tau}' < \tau_{T'}$. All generations born at date $t \leq T$ benefit from globalization, since markets are complete and successive reductions in τ allow them to achieve perfect international risk sharing on a growing number of goods. But this requires and also growing amount of debt payments between regions. When generation T arrives, these payments would have grown too much for enforcement to take place. As a result, asset markets close and there is a breakdown in both domestic and international risk sharing. Welfare drops discretely to a level that is below that of autarky. The generations born at date $T < t \leq T_{1/2}$ are not affected by globalization. Generations born at date $T_{1/2} < t \leq T'$ benefit from globalization since globalization increases the number of goods that have different regional components of production and are thus traded internationally. When generation T' arrives, the values of production of tradable goods in the two regions are close enough and the payments that would be needed for perfect international risk sharing are low enough that enforcement is possible again. Asset markets re-open and both domestic and international risk sharing is reestablished. This leads to a discrete increase in welfare. In fact, welfare increases up to the same level it would have with complete markets. For $t > T'$, there is enforcement and globalization has the same positive effects as in the complete markets case.

This example highlights two new effects of globalization. First, it shows that when marginal tradable goods are countercyclical enough globalization reduces the cost of enforcement. As a result, globalization can lead to asset markets opening. This welfare gain from globalization is reflected in the second integral in the third line of Equation (32) and takes place when generation T' is born. Second, it shows that in the absence of enforcement, globalization can lead to gains from international trade in goods. For there to be gains from international trade in goods, marginal and average tradable goods must have different regional components of production, in the same way that in a traditional trade model there are no gains from trade if autarky relative prices coincide. This welfare gain from globalization is reflected in the second integral in the first line of Equation (32) and takes place for $T_{1/2} < t \leq T'$.

Example 4: A two-sector economy with domestic trade in goods

We now consider an economy identical to the one in Example 4, except that we introduce a role for domestic trade in goods. In particular, in the rich region one half of the residents produces goods $z \in \left[0, \frac{1}{2}\right]$ and one half of the residents produces goods $z \in \left(\frac{1}{2}, 1\right]$. Namely,

$$\phi_i(z) = 1 \quad \text{for all } z \in [0,1] \text{ and } i \in I^P, \tag{37}$$

$$\phi_i(z) = \begin{cases} 2 \text{ for } z \in \left[0, \frac{1}{2}\right] \text{ and } 0 \text{ for } z \in \left(\frac{1}{2}, 1\right] & \text{with prob. } \frac{1}{2} \\ 0 \text{ for } z \in \left[0, \frac{1}{2}\right] \text{ and } 2 \text{ for } z \in \left(\frac{1}{2}, 1\right] & \text{with prob. } \frac{1}{2} \end{cases} \quad \text{for all } i \in I_1^R. \tag{38}$$

The regional component of production is still as in Equations (35) and (36).

Figure (6) panel (a) shows the benefit and cost of enforcement as functions of τ. The benefit of enforcement depends now on τ because, when there is both domestic and international trade in goods, $\frac{\partial \phi_i}{\partial \tau} \neq 0$. For $\tau < \frac{1}{2}$, there is full domestic risk sharing even in the absence of enforcement so the benefit of enforcement in zero. This is because residents of the rich region spend the same fraction of their income on all goods thereby equalizing the value of production of all residents. For $\tau > \frac{1}{2}$, this is not the case. International trade in goods raises the prices of goods $z \in \left[0, \frac{1}{2}\right]$ and lowers the prices of goods $z \in \left(\frac{1}{2}, \tau\right]$. This increases the value of production of those residents that produce goods $z \in \left[0, \frac{1}{2}\right]$ and reduces the value of production of those that produce $z \in \left(\frac{1}{2}, 1\right]$. As a result, the benefit of enforcement is positive for $\tau > \frac{1}{2}$. As τ increases, this effect becomes stronger and the benefit of enforcement thus increases. The cost of enforcement is the same inverted-

U shaped function of τ as in Example 4.

There is a threshold levels $\bar{\tau} \in \left(\frac{1}{2}, 1\right)$ such that there is enforcement only for $\tau \geq \bar{\tau}$. The threshold level satisfies

$$\phi^R(L) \cdot \left(4 - 3 \cdot \phi^R(L) + \frac{2}{\bar{\tau}} \cdot (\phi^R(L) - 1)\right) = \left(2 - \phi^R(L) + \frac{1}{\bar{\tau}} \cdot \left(\phi^R(L) - 1\right)\right)^{2 \cdot (1 - \bar{\tau})}.$$

The effects of globalization on welfare are illustrated in the bottom panel of Figure 6. Let T be the period such that $T_{1/2}$ be the period such that $\tau_{T_{1/2}-1} \leq \frac{1}{2} < \tau_{T_{1/2}}$, and T be the period such that $\tau_{T-1} \leq \bar{\tau} < \tau$. Generations born at $t \leq T_{1/2}$ are not affected by globalization. There is no enforcement but goods prices are such that there is perfect domestic risk sharing. Generations born at $T_{1/2} < t \leq T$ are hurt by globalization. This is because globalization worsens domestic risk sharing without affecting international risk sharing. In this case domestic risk sharing is lost not because of a reduction in enforcement but because it increases the number of goods whose prices do not move as required by domestic risk sharing. When generation T arrives, the benefit of enforcement has increases so much (and the cost of enforcement decrease so much) that enforcement becomes possible. At this point there is a discrete increase in welfare as both domestic and international risk sharing is established. In fact, welfare increases up to the level it would have under complete markets. For $t > T$, there is enforcement and globalization has the same positive effects as in the complete markets case.

This example highlights two new effects of globalization. First, it shows that when there is a role for both domestic and international trade in goods, globalization can affect domestic risk sharing directly when there is no enforcement. This effect can be either positive or negative, depending on whether the effect on goods prices favors residents with low or high values of production. This welfare effect from globalization is reflected in the second line of Equation (32) and takes place for $T_{1/2} < t \leq T$. Second, it shows that when globalization affects negatively domestic risk sharing and, thus, increases the benefit of enforcement, globalization can lead to asset markets opening. This welfare gain from globalization is reflected in the second integral in the third line of Equation (32) and takes place when generation T is born.

4 Overborrowing and policy implications

[TO BE DONE]

5 Final Remarks

There are, at least, three important directions in which the theory presented here can be extended. First, in this paper we do not analyze reputational equilibria. Are there any interactions between our mechanism and reputation?

Second, the theory abstracts form other sources of market incompleteness. 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?

Third, the theory abstracts from production choices. Although we talk about production 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?

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7 Appendix

[TO BE DONE]

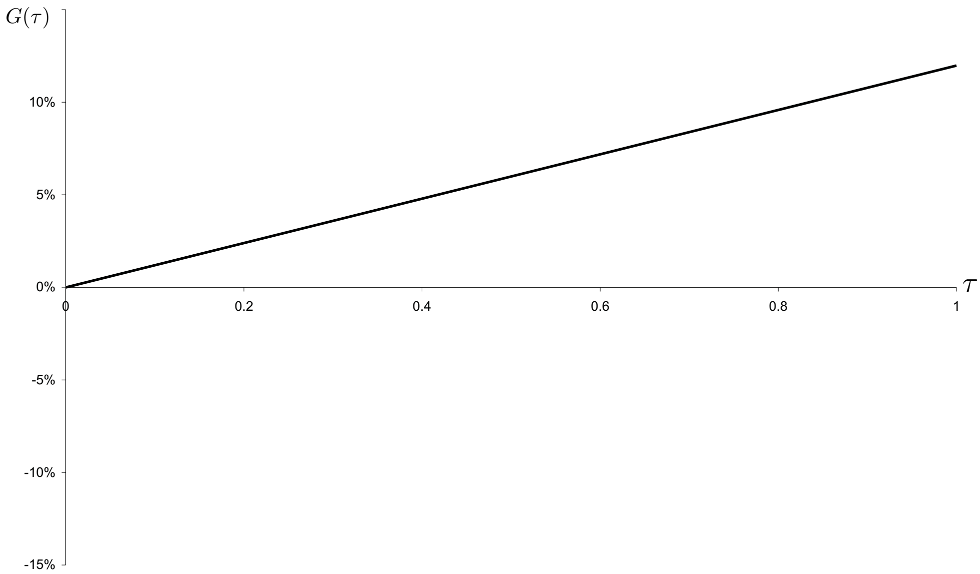

Figure 1: Complete markets

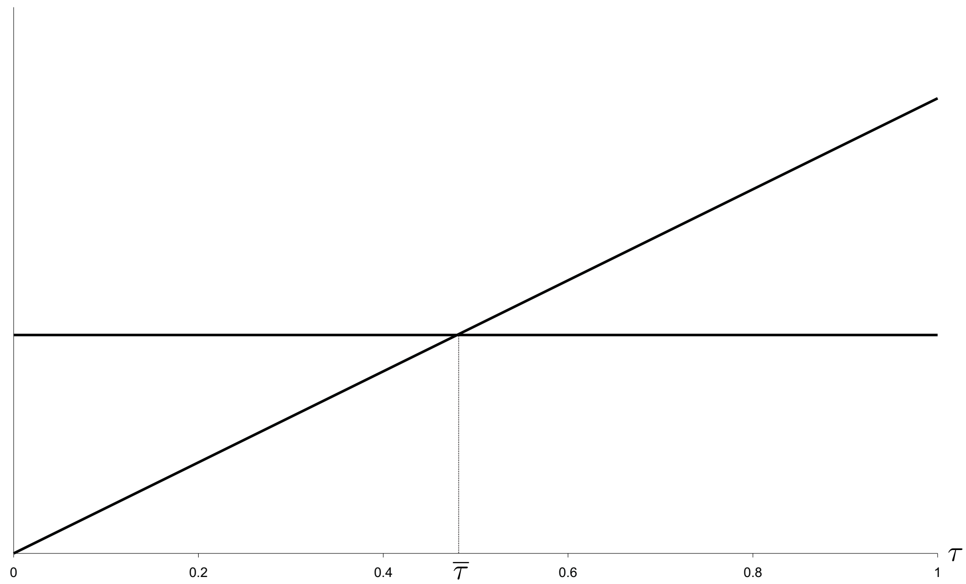

Figure 2: panel (a), costs and benefits of enforcement

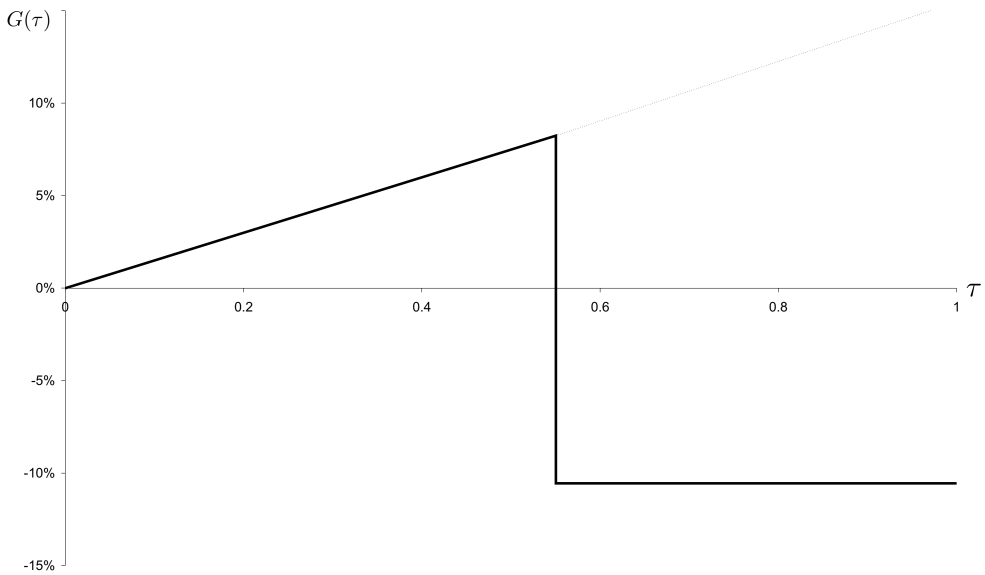

Figure 2: panel (b), welfare

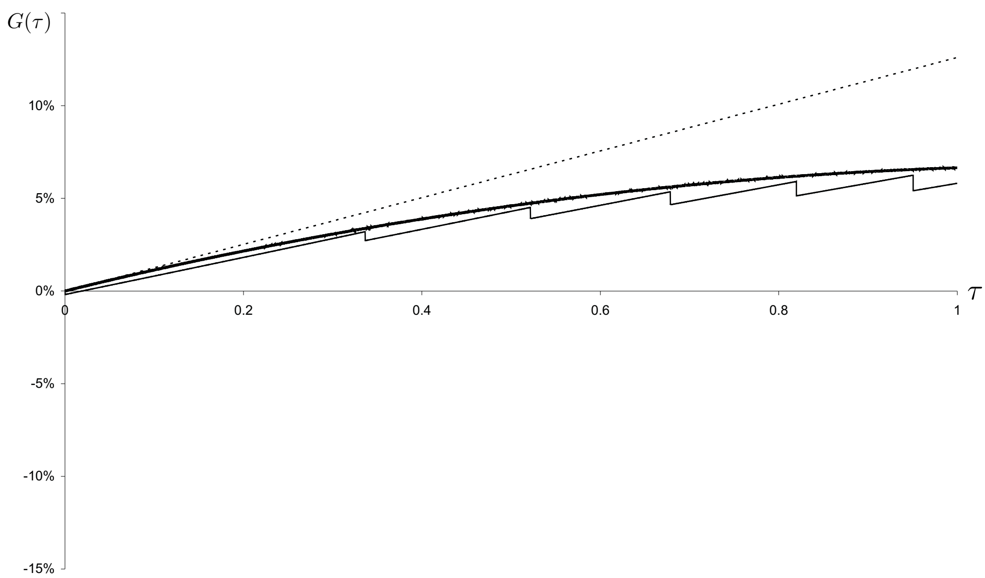

Figure 3: panel (a)

Figure 4: panel (a), Costs and benefits of enforcement

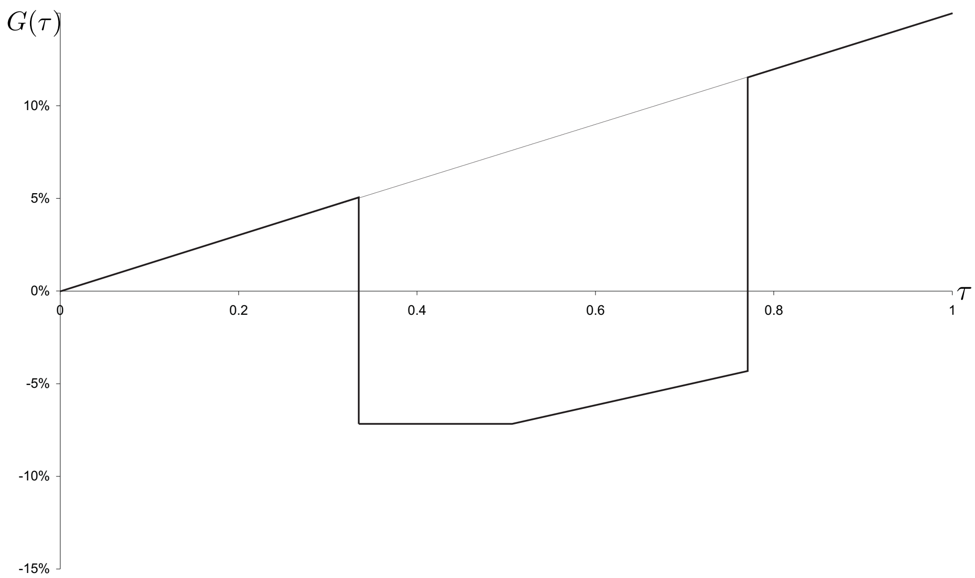

Figure 4: panel (b), welfare

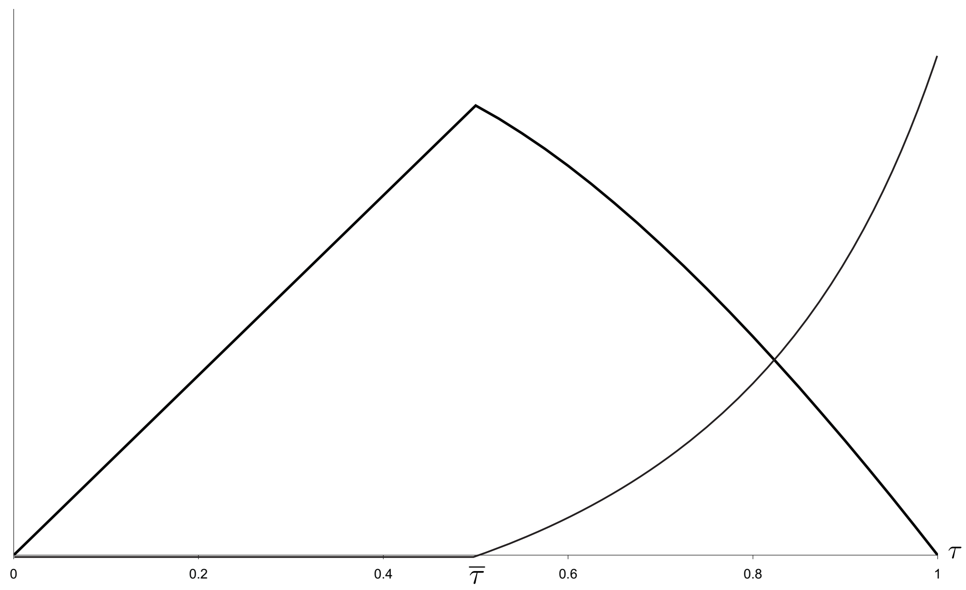

Figure 5: panel (a), costs and benefits of enforcement

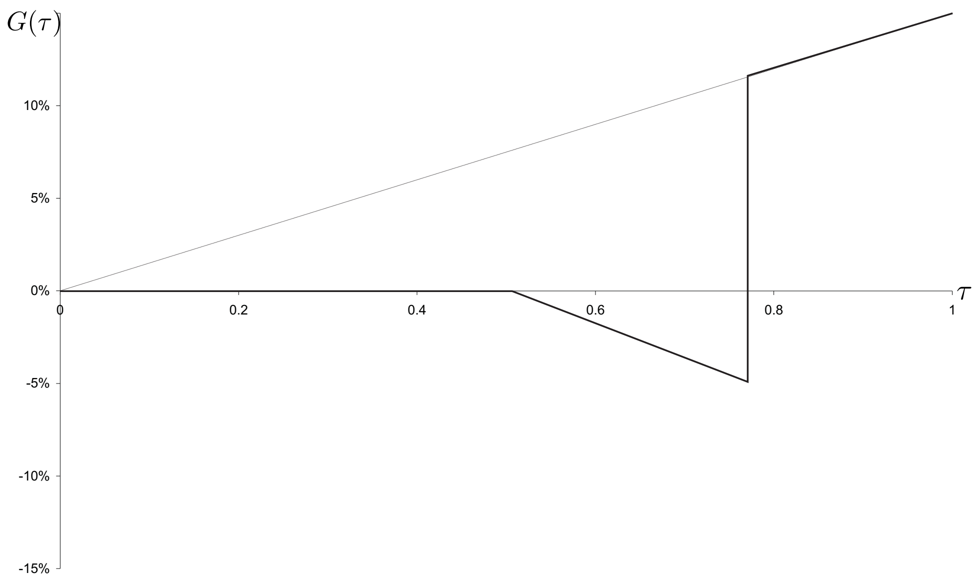

Figure 5: panel (b), welfare