INCOMPLETE INTERREGIONAL RISK SHARING WITH COMPLETE MARKETS*

Marco Celentani,[†] José Ignacio Conde-Ruíz[‡] and Klaus Desmet[§]

February 2002

Abstract: We analyze risk sharing and fiscal spending in a two-region model with complete markets. Fiscal policy is determined by majority voting. When policy setting is decentralized, regions choose pro-cyclical fiscal spending in an attempt to manipulate securities prices to their benefit. This leads to incomplete risk sharing, despite the existence of complete markets and the absence of aggregate risk. When a fiscal union centralizes fiscal policy, securities prices can no longer be manipulated and complete risk sharing ensues. If regions are homogeneous, median income residents of both regions prefer the fiscal union. If they are heterogeneous, the median resident of the rich region prefers the decentralized setting.

Keywords: Fiscal policy, voting, risk sharing.

JEL classification numbers: C72, D72, E61.

---

*Marco Celentani acknowledges the financial support of MCYT (Spain) under project PB98-00024. José-Ignacio Conde-Ruiz acknowledges the financial support of MECD (Spain) under project EX2001-02885993E. Klaus Desmet acknowledges the financial support of the Commission for Cultural, Educational and Scientific Exchange between the United States of America and Spain (Project 7-42) and the Comunidad de Madrid (Project 06/0064/2000). We thank Vincenzo Galasso, Andy Neumeyer, and Ignacio Ortuño Ortín for useful discussions and suggestions.

†Corresponding author. Department of Economics, Universidad Carlos III de Madrid, Getafe (Madrid) 28903, Spain; fax +34-91-624 9875; celentan@eco.uc3m.es.

‡Department of Economics and Business, Universitat Pompeu Fabra, Ramon Trias Fargas 25-27, 08005 Barcelona, Spain; fax +34-93-542 1746; ignacio.conde-ruiz@econ.upf.es.

§Department of Economics, Universidad Carlos III de Madrid, Getafe (Madrid) 28903, Spain, and CEPR; fax +34-91-624 9875; desmet@eco.uc3m.es.

1 Introduction

In countries with a federal structure fiscal spending generally happens at two levels: at the regional level there is redistribution amongst individuals, and at the federal level there is redistribution amongst regions (Persson and Tabellini, 1996). Transfers between regions are typically justified as a risk sharing device against asymmetric shocks (Persson and Tabellini, 1996; Alesina and Perotti, 1995). In the United States, for instance, Sala-i-Martin and Sachs (1992) estimate that the federal government compensates any $1 decrease in regional income by 40 cents.

The need for fiscal transfers between regions is based on the assumption that private capital markets are at best incomplete, if not inexistent (Persson and Tabellini, 1996). Though the empirical evidence supports the view of incomplete markets,[1] this statement needs to be qualified along two dimensions. First, risk sharing through decentralized markets is much larger across regions than across countries: whereas Asdrubali, Sørensen and Yosha (1996) find that in the United States 39% of shocks to gross state product are smoothed through capital markets,[2] Sørensen and Yosha (1998) find an insignificant figure in the case of OECD countries.[3] Second, over the last decades risk sharing through private capital markets has been increasing (Obstfeld, 1994a): whereas during the period 1964-1970 only 27% of shocks to state income in the U.S. were smoothed through capital markets, this figure rose to 48% in the period 1981-1990 (Asdrubali, Sørensen and Yosha, 1996). These stylized facts support the view that risk sharing through private capital markets increases as markets become more integrated (Lewis, 1996).

In spite of the undeniable tendency towards further capital market integration, especially among regions, most theoretical work on fiscal transfers has continued to focus on the extreme case of inexistent private capital markets (see, e.g., Persson and Tabellini, 1996). In this paper we go to the other extreme by assuming complete private capital markets. In this case, one might expect fiscal policy to become fully decentralized: since complete risk sharing between regions could be ensured through private capital markets, there would be no need for inter-regional fiscal transfers.

However, this intuition may be misleading, because it fails to take into account how decentralized fiscal spending distorts private risk sharing. It is well known from the literature on fiscal cooperation that countries or regions may use government spending to improve their terms of trade: Devereux (1991), for instance, shows that by inflating fiscal spending, demand for importables drop, and the relative price of exportables rises. In our model a similar mechanism applies to securities: regions use decentralized fiscal policy to manipulate the relative price of securities to their benefit. This leads to incomplete risk sharing, despite the existence of complete markets and the absence of aggregate risk. In other words, complete markets need not imply complete risk sharing, nor need they make fiscal unions redundant.

To analyze these issues, we study a two-region model with no aggregate risk. Residents of both regions can insure themselves against region-specific shocks in complete security markets. We start by looking at the case of decentralized fiscal policy. If tax rates are set when individuals have not exhausted the gains from risk sharing, fiscal policy can be used to manipulate security prices, an incentive we refer to as the *manipulation motive*. In particular, a region setting a high (low) level of spending in a given state of nature decreases (increases) the net supply of securities

[1] Market incompleteness is one of the explanations for the observed lack of risk sharing, as suggested by low cross-country consumption correlations (Backus, Kehoe and Kydland, 1992; Baxter and Crucini, 1995) and a strong home bias in portfolio allocation (Tesar and Werner, 1992).

[2] See, however, Del Negro (2002), who claims that some of the smoothing in Asdrubali et al. may be due to measurement error.

[3] For further references, see Atkeson and Bayoumi (1993) and Athanasoulis and van Wincoop (2000).

making a payment in that state. This implies that fiscal policy affects the relative prices of securities, so that optimal tax setting has to take this manipulation motive into account. As a result, in equilibrium we get pro-cyclical public spending and incomplete risk sharing. This tends to lead to a drop in welfare (van Wincoop, 1994).[4]

Our results show how competitive tax setting in a decentralized system leads to a fiscal externality problem by creating distortions in insurance markets. A federal fiscal policy may provide a solution to this problem. When regions form a fiscal union, the absence of aggregate uncertainty implies there is only one state of nature at the federal level. If this means there is only one tax rate, then manipulating security prices via fiscal policy becomes impossible, and we return to complete risk sharing. This suggests that if regions are fairly similar, the median income residents in both regions prefer the fiscal union to the decentralized system: they benefit from full insurance, while inter-regional net transfers remain limited. However, if regions are relatively different, the median income resident in the region which experiences the positive shock with higher probability is likely to prefer the decentralized system: the benefits from increased risk sharing in the fiscal union do not compensate for the higher net transfers to the other region and for the cost of a less preferred tax rate.

As mentioned before, our paper draws on previous work related to the effect of fiscal policy on the terms of trade (see Persson and Tabellini, 1995, for a survey). Whereas Devereux (1991) studies how fiscal spending affects the relative price of exportables, Razin and Sadka (1991) mention how government spending may be used to manipulate the world interest rate.[5] Though related, our paper deviates from that literature by focusing on the effect of fiscal policy on security markets and risk sharing. This leads to a number of novel insights. First, the manipulation of security prices causes incomplete risk sharing, despite complete markets and the absence of aggregate risk. This implies that having complete markets is not sufficient to ensure complete risk sharing. Second, fiscal unions may still have a role to play in risk sharing even when markets are complete. Third, the manipulation of prices makes agents underinvest in securities of the other region. This adds one more element to the list of possible explanations of the home bias (see Lewis, 1995, for a survey).

The paper is organized as follows. Section 2 introduces the model. Section 3 analyzes the equilibrium for the decentralized case. Section 4 considers the case of a fiscal union and compares it to the decentralized case. Section 5 summarizes and concludes. Appendix A provides the proofs of all results in the paper.

2 Setup of the Model

Consider two regions, West and East. We will mainly focus on the West, and we will denote variables referring to the East by an asterisk ("*"). Each region has a unit mass of heterogeneous individuals, whose types y are distributed according to the same cumulative distribution function[6] $G(y)$ with mean $\overline{y}$ and median y^m.

There is no aggregate risk at the federal level, though each region is subject to perfectly negatively correlated shocks. This gives us two states of nature which we label with respect to the West: if the West experiences a positive shock and the East is hit by a negative shock, we are

[4] In addition to the direct costs to risk averse agents, a drop in risk sharing may also have a negative effect on economic growth (Obstfeld, 1994b; Kalemli-Ozcan, Sørensen and Yosha, 2001).

[5] The use of policy to affect terms of trade is of course an old hand in international economics: whereas Johnson (1953) focused on optimal tariffs, Nurkse (1945) looked at competitive devaluations.

[6] We assume the same distribution of type for the two regions only to simplify notation but all our results are valid with different type distributions.

in the good state ($s = \gamma$); if, instead, the West receives a negative shock and the East a positive shock, we are in the bad state ($s = \beta$). The probability of the good state is denoted by π. For notational convenience, variables are indexed by γ or β, depending on which state they refer to.

An individual from the West with type y has endowment $y(1+\varepsilon)$ in the good state and endowment $y(1-\varepsilon)$ in the bad state; similarly, an individual from the East with type y has endowment $y(1-\varepsilon)$ in the good state and endowment $y(1+\varepsilon)$ in the bad state. This stochastic structure provides a simple framework to study risk sharing between regions. Assuming less-than-perfect positive correlation within regions or less-than-perfect negative correlation across regions would complicate the algebra without leading to qualitatively different results.

There is only one commodity that can either be consumed or transformed into a publicly provided good at a constant marginal cost of 1 (in terms of the commodity). Fiscal policy is nondiscriminatory: publicly provided goods are consumed in equal quantities by all individuals of a same region. It is therefore unimportant whether the publicly provided goods are private or public.

To guarantee that fiscal policy does not have a direct impact on the allocation of private consumption risk, we assume that the utility function is separable in private consumption c and public consumption g:

$$U(c,g) = V(c) + W(g)$$

We make the following additional assumptions on preferences:

ASSUMPTION 1 *1. $V(.)$ is twice continuously differentiable, it is homogeneous and*

$$V'(.) > 0, V''(.) < 0.$$

2. $W(.)$ is twice continuously differentiable and

$$W'(.) > 0, W''(.) < 0.$$

The strict inequalities on $V''(.)$ and $W''(.)$ reflect aversion to private and public consumption risk. The separability of the utility function implies that the marginal rate of substitution between private consumption in different states of nature is independent of government consumption, so that efficient risk sharing leads to private consumption being constant across states whenever there is no aggregate uncertainty in disposable income.[7] Moreover, the homogeneity of $V(.)$, together with the separability of $U(.)$, implies that an equilibrium exists despite the multidimensionality of fiscal policies.[8]

To insure themselves against regional shocks, individuals trade in "elementary securities," each paying one unit of endowment in one state of nature, and zero in the other (Arrow, 1964). We assume that an elementary security exists for each of the two states of nature, so that markets are complete. From now on, we will refer to the elementary security making a unit payment in state s as security s.

Government spending is decided under majority rule and is financed through proportional taxation. Since we only consider one period, governments maintain balanced budgets. To keep the algebra tractable, we take the tax base to be the endowment *gross* of the payments of securities; in other words, gains or losses deriving from security trades are tax exempt. This somewhat extreme

[7] Cf. Canova and Ravn (1996), page 582.

[8] When preferences do not satisfy these conditions, it is possible to show that incomplete risk sharing results in structure induced equilibria under milder conditions. For the notion of structure induced equilibrium, see Shepsle (1979).

assumption is justified by the observation that capital gains in most countries are taxed at a lower rate than other forms of income.[9]

As is standard with nondiscriminatory fiscal policy, the equilibrium allocation will generically be inefficient. When the publicly provided goods and services are private, $V''(.) < 0$ prevents the marginal rates of substitution between private and public consumption to be equated across individuals; and when they are public, there is no guarantee that the Bowen-Lindahl-Samuelson conditions hold.

Analyzing the efficiency properties of nondiscriminatory fiscal policy is not the goal of this paper though. Instead, we aim to study the impact of fiscal policy on risk sharing. In particular, we will show that if fiscal policy is set when individuals can still gain from sharing risk, they have an incentive to manipulate security prices through fiscal spending, causing incomplete risk sharing.

We therefore focus on the following timing of events: fiscal policy is decided under majority rule, and *then* individuals are allowed to trade in elementary securities.[10] Our results depend crucially on this particular timing. To see this, we compare our findings to a benchmark case where trading in securities happens *before* setting fiscal policy. Under this alternative timing, the manipulation motive disappears, and we get complete risk sharing in equilibrium.

To be more precise, we define *complete risk sharing* as a situation in which risk in both private and public consumption is efficiently shared. Note that since individuals can hedge risk by trading in securities markets, sharing of risk in disposable income is always efficient, but complete risk sharing requires that also risk in government spending be shared efficiently. Given we have assumed that aggregate endowment is constant across states of nature, Assumption 1 implies that complete risk sharing requires both private and public consumption to be constant across states.

3 Risk Sharing with Decentralized Fiscal Policy

In this section there is no federal government: fiscal policies are set at the regional level and executed by regional governments. Since constraining the tax rate to be constant across states of nature would introduce an inefficiency by hampering risk sharing, we allow tax rates to be contingent on the state of nature. This implies that fiscal policy in each region is defined by two tax rates: one for the good state, and another for the bad state.

We define the *risk sharing game* as the game where individuals trade securities and the *policy game* as the game in which fiscal policies are set under majority rule. As mentioned before, we will consider two timings:

- The *manipulation game*: the policy game takes place *before* the risk sharing game.

  We will refer to the *equilibrium of the manipulation game* as the tax rates, the prices, and the allocations of the path of a subgame perfect Nash equilibrium of the manipulation game.

- The *benchmark game*: the policy game takes place *after* the risk sharing game.

[9] An additional standard argument in favor of our assumption is that the effective tax rate on capital gains is lower than the official one, because taxes are paid upon the realization of gains, rather than accrual. See, e.g., Atkinson and Stiglitz (1987, page 116). Note, moreover, that the qualitative results would not change if the tax base were to be defined as the endowment *net* of the gains or losses deriving from the security trade, or in other words, if we assumed that (capital) gains from security trades were subject to the same tax rates. Results for this case are available from the authors upon request.

[10] This timing of events is a reasonable description of a situation in which uncertainty is spanned by trade in few securities (short- or long-lived) requiring subsequent adjustments as uncertainty unfolds. See, e.g., Guesnerie and Jaffray (1974) and Kreps (1982).

The *equilibrium of the benchmark game* is defined as the tax rates, the prices, and the allocations of the path of a subgame perfect Nash equilibrium of the benchmark game.

In what follows we start by analyzing the risk sharing game (subsection 3.1) and the policy game (subsection 3.2), and we then take a closer look at how timing matters by analyzing the benchmark game (subsection 3.3) and the manipulation game (subsection 3.4). To illustrate the main results, we end by giving a numerical example (subsection 3.5).

3.1 The Risk Sharing Game: Security Markets Equilibrium

Equilibria in security markets are determined by individual optimality and market clearing conditions, given a pair of state contingent tax rates for each region. These tax rates are either observed or expected, depending on whether we are in the manipulation game or in the benchmark game.[11] Let c_γ and c_β denote private consumption in the good and the bad state, and let x_γ and x_β represent net demands of securities γ and β. Furthermore, let P_γ and P_β denote the prices of the securities, and call $P = P_\beta/P_\gamma$ the relative price of security β. We can now write down the optimization problem of an individual from West with type y:

$$\begin{aligned} \max_{c_\gamma, c_\beta, x_\gamma, x_\beta} \quad & \pi\left[V(c_\gamma) + W(g_\gamma)\right] + (1-\pi)\left[V(c_\beta) + W(g_\beta)\right] \\ \text{s.t.} \quad & x_\gamma + P x_\beta \leq 0 \\ & c_\gamma \leq y\,(1+\varepsilon)\,(1-t_\gamma) + x_\gamma \\ & c_\beta \leq y\,(1-\varepsilon)\,(1-t_\beta) + x_\beta \end{aligned} \tag{1}$$

By Assumption 1 the solution to the previous problem satisfies the constraints with equality as well as the following condition[12]

$$\frac{(1-\pi)\,V'(c_\beta)}{\pi V'(c_\gamma)} = P. \tag{2}$$

Similarly, the solution to the maximization problem of an individual from the East with type y satisfies the constraints with equality as well as the following condition

$$\frac{(1-\pi)\,V'(c^*_\beta)}{\pi V'(c^*_\gamma)} = P. \tag{3}$$

Combining individual optimality with market clearing conditions, we get the following equilibrium conditions:

$$\begin{aligned} z_\gamma(P) &= \int x_\gamma\left(t_\gamma, t_\beta, y, P\right) dG(y) + \int x^*_\gamma\left(t^*_\gamma, t^*_\beta, y, P\right) dG(y) = 0 \\ z_\beta(P) &= \int x_\beta\left(t_\gamma, t_\beta, y, P\right) dG(y) + \int x^*_\beta\left(t^*_\gamma, t^*_\beta, y, P\right) dG(y) = 0 \end{aligned} \tag{4}$$

Given that Assumption 1 implies that preferences over lotteries of private consumption are continuous, strictly convex, strongly monotone, and homothetic, a security markets equilibrium exists and is unique.

[11] More particularly, in the benchmark game they refer to the expected tax rates in the subsequent policy game. Because no individual has an impact on equilibrium prices and allocations, and therefore on preferences over tax rates in the subsequent policy game, in the risk sharing game stage of the benchmark game individuals take their expectations over tax rates as given.

[12] Notice in particular that Assumption 1 guarantees that the second order condition is satisfied and that the maximum exists and is interior.

3.2 *The Policy Game*

Consider an individual from West with type y and with demands (x_γ, x_β). Again, depending on whether we are in the manipulation or the benchmark game, these demands should be interpreted as expected or observed. Given the tax base is endowment gross of the net payments of securities, the individual's preferred tax rates (t_γ, t_β) will be given by the solution to the following problem:

$$\max_{t_\gamma, t_\beta} \pi \left[V\left(y\left(1+\varepsilon\right)\left(1-t_\gamma\right)+x_\gamma\right)+W\left(g_\gamma\right)\right]+\left(1-\pi\right)\left[V\left(y\left(1-\varepsilon\right)\left(1-t_\beta\right)+x_\beta\right)+W\left(g_\beta\right)\right]$$
$$\text{s.t. } g_\gamma = \overline{y}\left(1+\varepsilon\right)t_\gamma \text{ and } g_\beta = \overline{y}\left(1-\varepsilon\right)t_\beta \qquad (5)$$

where $\overline{y}(1+\varepsilon)$ and $\overline{y}(1-\varepsilon)$ are the aggregate endowments in state γ and β.

The following Lemma states that both in the benchmark and the manipulation game it suffices to consider the preferred tax rates of the median type. To see this, note that the only source of heterogeneity among residents of a region is their type y. Moreover, the homogeneity of $V(.)$ implies that y enters linearly in individual expected utilities. This means that individuals' preferences in the bidimensional policy space — two different tax rates — can be mapped into a one-dimensional parameter space, so that the median voter theorem can be applied.[13] This in turn implies that equilibrium tax rates can be derived by maximizing the expected utility functions of the individuals with the median types of the two regions.

LEMMA 1 *Under Assumption 1 in both the manipulation and the benchmark game the equilibrium tax rates are given by the tax rates preferred by the individuals with median types in each region.*

PROOF. See Appendix A.1.

3.3 *The Benchmark Game: Complete Risk Sharing*

If fiscal policy is set after individuals have exhausted the gains from risk sharing by trading in securities, the equilibrium tax rates in the West $(\widehat{t}_\gamma, \widehat{t}_\beta)$ are given by the solution to (5) for its median type individual:[14]

$$V'\left(y^m\left(1+\varepsilon\right)\left(1-\widehat{t}_\gamma\right)+x_\gamma\right)y^m\left(1+\varepsilon\right)-W'\left(\overline{y}\left(1+\varepsilon\right)\widehat{t}_\gamma\right)\overline{y}\left(1+\varepsilon\right) = 0 \qquad (6)$$
$$V'\left(y^m\left(1-\varepsilon\right)\left(1-\widehat{t}_\beta\right)+x_\beta\right)y^m\left(1-\varepsilon\right)-W'\left(\overline{y}\left(1-\varepsilon\right)\widehat{t}_\beta\right)\overline{y}\left(1-\varepsilon\right) = 0 \qquad (7)$$

where x_γ and x_β come from (2) and (3) and are taken as given. Symmetric first order conditions determine the equilibrium tax rates in the East $(\widehat{t}^*_\gamma, \widehat{t}^*_\beta)$.

An equilibrium of the benchmark game requires that the expected tax rates used to determine the demand for securities in the risk sharing game correspond to the tax rates determined in the subsequent policy game. The following proposition states that there exists a unique equilibrium of the benchmark game:

PROPOSITION 1 *Suppose Assumption 1 is satisfied. There exists a unique equilibrium of the benchmark game characterized by:*

1. $\widehat{P} = (1-\pi)/\pi$;

[13] In this case policy preferences belong to the class of "intermediate preferences." Cf. Grandmont (1978).

[14] Notice that after trading has taken place the preferred fiscal policy of any individual is independent of the fiscal policy of the other region, so that $\left(\widehat{t}^*_\gamma, \widehat{t}^*_\beta\right)$ do not appear in the equilibrium conditions for $\left(\widehat{t}_\gamma, \widehat{t}_\beta\right)$.

2. $\widehat{c}_\gamma(y) = c_\gamma\left(y, \widehat{P}\right) = \widehat{c}_\beta(y) = c_\beta\left(y, \widehat{P}\right)$ *for all* y, $\widehat{c}^*_\gamma(y) = c^*_\gamma\left(y, \widehat{P}\right) = \widehat{c}^*_\beta(y) = c^*_\beta\left(y, \widehat{P}\right)$ *for all* y*;*
3. $\widehat{t}_\gamma = \widehat{t}_\beta \frac{1-\varepsilon}{1+\varepsilon}$ *and* $\widehat{t}^*_\gamma = \widehat{t}^*_\beta \frac{1+\varepsilon}{1-\varepsilon}$*;*
4. $\widehat{g}_\gamma = \widehat{g}_\beta$ *and* $\widehat{g}^*_\gamma = \widehat{g}^*_\beta$*.*

PROOF. See Appendix A.2.

The equilibrium conditions in Proposition 1 are easy to understand. Given that fiscal policy is set after trading, it cannot affect the demand functions for securities, and therefore the securities prices. The absence of a manipulation motive and the perfectly negatively correlated regional shocks allow agents to fully insure both private and public consumption. This implies that the tax rate — but not the tax revenue — will be higher in the bad state than in the good state. As a final remark, note that we would get the same outcome if individuals were to vote on government spending, rather than on tax rates: to see this, simply re-write maximization problem (5) in terms of government spending.

3.4 The Manipulation Game: Incomplete Risk Sharing

We now turn our attention to the manipulation game where agents trade securities after taxes are set. We solve the problem backwards: first we obtain the equilibrium demands for securities from the risk sharing game; those security demands, which are a function of tax rates, are then substituted into the objective function of the policy game. Agents will therefore take into account the effect of taxes on security demands — and prices — when voting on fiscal policy. More particularly, they will use tax policy to manipulate security prices to their benefit.

To see this, consider the equilibrium of the risk sharing game for a given vector of regional fiscal policies $t = (t_\gamma, t_\beta, t^*_\gamma, t^*_\beta)$.[15] Denote the corresponding equilibrium demands in West and East for security s by $\widetilde{x}_s(t, y)$ and $\widetilde{x}^*_s(t, y)$; likewise denote the equilibrium consumption in state s by $\widetilde{c}_s(t, y)$ and $\widetilde{c}^*_s(t, y)$. Focusing on the West and taking into account the manipulation motive, the preferred tax rates of the median type are determined by the following first order conditions of maximization problem (5):

$$\pi\left[V'(\widetilde{c}_\gamma) y^m (1+\varepsilon) - W'\left(\overline{y}(1+\varepsilon)\widetilde{t}_\gamma\right)\overline{y}(1+\varepsilon)\right] - \pi V'(\widetilde{c}_\gamma)\frac{\partial \widetilde{x}_\gamma}{\partial t_\gamma} - (1-\pi) V'(\widetilde{c}_\beta)\frac{\partial \widetilde{x}_\beta}{\partial t_\gamma} = 0 \quad (8)$$

$$(1-\pi)\left[V'(\widetilde{c}_\beta) y^m (1-\varepsilon) - W'\left(\overline{y}(1-\varepsilon)\widetilde{t}_\beta\right)\overline{y}(1-\varepsilon)\right] - \pi V'(\widetilde{c}_\gamma)\frac{\partial \widetilde{x}_\gamma}{\partial t_\beta} - (1-\pi) V'(\widetilde{c}_\beta)\frac{\partial \widetilde{x}_\beta}{\partial t_\beta} = 0 \quad (9)$$

To simplify, let $\widetilde{P}(t) = \widetilde{P}\left(t_\gamma, t_\beta, t^*_\gamma, t^*_\beta\right)$ denote the equilibrium price ratio as a function of the state contingent tax rates. Given that

$$\widetilde{x}_\beta = -\frac{\widetilde{x}_\gamma}{\widetilde{P}},$$

we can write

$$\frac{\partial \widetilde{x}_\beta}{\partial t_\gamma} = -\frac{\frac{\partial \widetilde{x}_\gamma}{\partial t_\gamma}\widetilde{P}(t) - \widetilde{x}_\gamma \frac{\partial \widetilde{P}(t)}{\partial t_\gamma}}{\left(\widetilde{P}(t)\right)^2}. \quad (10)$$

[15] Recall that a unique equilibrium of the risk sharing game exists.

Given budget balance

$$\begin{aligned}
\widetilde{g}_\gamma &= \overline{y}\,(1+\varepsilon)\,\widetilde{t}_\gamma \\
\widetilde{g}_\beta &= \overline{y}\,(1-\varepsilon)\,\widetilde{t}_\beta
\end{aligned}$$

and given (10), we can rewrite (8) and (9) as:

$$\pi\left[V'\left(\widetilde{c}_\gamma\right)y^m\left(1+\varepsilon\right)-W'\left(\widetilde{g}_\gamma\right)\overline{y}\left(1+\varepsilon\right)\right]-\frac{\left(1-\pi\right)V'\left(\widetilde{c}_\beta\right)\widetilde{x}_\gamma\frac{\partial\widetilde{P}(\widetilde{t})}{\partial t_\gamma}}{\left(\widetilde{P}\left(\widetilde{t}\right)\right)^2} = 0 \quad (11)$$

$$\left(1-\pi\right)\left[V'\left(\widetilde{c}_\beta\right)y^m\left(1-\varepsilon\right)-W'\left(\widetilde{g}_\beta\right)\overline{y}\left(1-\varepsilon\right)\right]-\frac{\left(1-\pi\right)V'\left(\widetilde{c}_\beta\right)\widetilde{x}_\gamma\frac{\partial\widetilde{P}(\widetilde{t})}{\partial t_\beta}}{\left(\widetilde{P}\left(\widetilde{t}\right)\right)^2} = 0 \quad (12)$$

These conditions take into account the effect of tax rates on net demands of securities — and thus on equilibrium prices.[16]

More specifically, agents prefer a higher price of the security paying a unit of endowment when their region experiences a positive shock, because in equilibrium they are net sellers of these securities. By the same token, agents prefer a lower price of the security corresponding to the state in which their region receives a negative shock, because in equilibrium they are net buyers of these securities. They therefore inflate tax rates — and government spending — whenever their region experiences a positive shock: this reduces the supply of securities, and pushes up their price. They do the opposite whenever their region is hit by a negative shock: by deflating tax rates — and government spending — the demand for securities drops, lowering their price. As stated in the following proposition, this leads to pro-cyclical (and therefore volatile) fiscal spending and incomplete risk sharing.

PROPOSITION 2 *Under Assumption 1 in equilibrium*

1. $\widetilde{g}_\gamma > \widetilde{g}_\beta$
2. $\widetilde{g}^*_\gamma < \widetilde{g}^*_\beta$
3. *There is incomplete risk sharing.*

PROOF. See Appendix A.3.

In addition to government spending becoming more volatile, under certain conditions average government spending may actually increase. This result is shown in the next proposition for the case where regions are ex ante sufficiently similar. (As a notational reminder, variables with a hat refer to the equilibrium of the benchmark game and variables with a tilde refer to the manipulation game.)

PROPOSITION 3 *Suppose Assumption 1 is satisfied and* $W'''(.) \geq 0$*. Then there exists a* $\underline{\pi} \in \left(\frac{1}{2}, 1\right]$ *such that if* $\pi \in \left[\frac{1}{2}, \underline{\pi}\right)$*:*

1. $\widetilde{g}^*_\beta + \widetilde{g}_\beta > \widehat{g}^*_\beta + \widehat{g}_\beta$

[16] When fiscal policy is set after trading, it has no impact on equilibrium prices and expressions (11) and (12) simplify to (6) because $\frac{\partial\widetilde{P}(t)}{\partial t_\gamma} = 0$ and $\frac{\partial\widetilde{P}(t)}{\partial t_\beta} = 0$.

2. $\widetilde{g}_\gamma^* + \widetilde{g}_\gamma > \widehat{g}_\gamma^* + \widehat{g}_\gamma$

PROOF. See Appendix A.4.

Notice that $W'''(.) \geq 0$, or, in other words, the convexity of the marginal utility of government consumption, is implied by D.A.R.A. and that it is a sufficient condition for the results of Proposition 3 to hold but it is not necessary.

Proposition 2 stated that regional fiscal spending is higher when a region experiences a positive shock than when it receives a negative shock. Building on the results of Proposition 3, the following corollary says something more: when a region experiences a positive (negative) shock, its tax rate and its fiscal spending are higher (lower) in the manipulation game than in the benchmark game.

COROLLARY 1 *Suppose Assumption 1 is satisfied and* $W'''(.) \geq 0$ *. Then there exists a* $\underline{\pi} \in \left(\frac{1}{2}, 1\right]$ *such that if* $\pi \in \left[\frac{1}{2}, \underline{\pi}\right)$*:*

1. $\widetilde{t}_\gamma > \widehat{t}_\gamma$, $\widetilde{t}_\beta < \widehat{t}_\beta$;

2. $\widetilde{t}_\beta^* > \widehat{t}_\beta^*$, $\widetilde{t}_\gamma^* < \widehat{t}_\gamma^*$;

3. $\widetilde{g}_\gamma > \widehat{g}_\gamma = \widehat{g}_\beta > \widetilde{g}_\beta$;

4. $\widetilde{g}_\beta^* > \widehat{g}_\beta^* = \widehat{g}_\gamma^* > \widetilde{g}_\gamma^*$.

Before concluding this section, note one more thing. We have argued that in an attempt to affect security prices, the West inflates government spending in the good state and deflates it in the bad state. But of course the opposite happens in the East, so that the net effect on security prices may be quite small. In fact, when regions are completely symmetric ($\pi = 0.5$), security prices do not change at all. Even then, however, as stated by Proposition 2, there will be incomplete risk sharing.

3.5 An Example

To illustrate our results, we now turn to a numerical example. We consider utility function $U(c,g) = \frac{c^{1-\lambda}}{1-\lambda} + \theta \frac{g^{1-\mu}}{1-\mu}$, with $\lambda = 2$, $\mu = 2$ and $\theta = 1/3$. The size of regional shocks ε is set to 0.2. We furthermore assume that the type of individuals is distributed according to a generalized uniform distribution function $F(y) = \left(\frac{y}{y_{\max}}\right)^m$ on $(0, y_{\max}]$, with $y_{\max} = 1$ and $m = 0.7$. This gives a mean type of 0.4118, a median type of 0.3715 and a median to mean ratio of 0.9.[17]

As we hinted before, given that both regions try to manipulate security prices in opposite directions, the net effect on prices may be limited. Here we focus on an example where the change in the price ratio ranges from 0% when $\pi = 0.5$ to slightly more than 3% when π is far from 0.5 (Figure 1).

Figure 2 represents the equilibrium tax rates in West and East as a function of π, the probability that the West receives the positive shock. For comparison purposes, we plot the tax rates for both the case where fiscal policy is set before trading in securities (the manipulation game) and the case where fiscal policy is set after trading securities (the benchmark game). Given $W(g) = \frac{g^{1-\mu}}{1-\mu}$ exhibits D.A.R.A., and following Corollary 1, the equilibrium tax rates in the

[17] The left skewness of the endowment distribution is consistent with data on income or wealth distributions.

manipulation game are inflated (deflated) when regions are hit by a positive (negative) shock compared to the benchmark game: $\widetilde{t}_\gamma \geq \widehat{t}_\gamma$, $\widetilde{t}_\beta \leq \widehat{t}_\beta$, $\widetilde{t}^*_\beta \geq \widehat{t}^*_\beta$, $\widetilde{t}^*_\gamma \leq \widehat{t}^*_\gamma$.

Figure 3 plots the corresponding levels of government spending in West and East. By comparing with the equilibrium of the benchmark game, we highlight how the manipulation motive affects fiscal spending. In the equilibrium of the benchmark game (the thin line in Figure 3) fiscal spending is equal across states of nature to ensure complete risk sharing. As suggested by Proposition 3, in the manipulation game fiscal spending is inflated in the good state (the semi-continuous thick line) and deflated in the bad state (the dashed thick line): $\widetilde{g}_\gamma > \widehat{g}_\gamma = \widehat{g}_\beta > \widetilde{g}_\beta$; and $\widetilde{g}^*_\beta > \widehat{g}^*_\beta = \widehat{g}^*_\gamma > \widetilde{g}^*_\gamma$, for $\pi \in (0, 1)$.

Figure 4 plots expected government spending in the West, comparing the equilibrium of the manipulation game (the dashed line) to that of the benchmark game (the thin line). As suggested by Proposition 3, the manipulation motive leads to an increase of expected fiscal spending: $\widetilde{g} = \pi\widetilde{g}_\gamma + (1-\pi)\,\widetilde{g}_\beta$ is greater than $\widehat{g} = \pi\widehat{g}_\gamma + (1-\pi)\,\widehat{g}_\beta$.

Note that pro-cyclical fiscal spending also affects risk sharing in private consumption. To have complete risk sharing in private consumption, the sum of fiscal spending in West and East must be equal across states of nature: only then will there be no uncertainty in aggregate private consumption. Our benchmark game clearly satisfies this condition, since fiscal spending in each region is constant across states. However, pro-cyclical fiscal spending — incomplete risk sharing in public consumption — tends to lead to uncertainty in aggregate private consumption, and thus to incomplete risk sharing in private consumption. This can be seen in Figure 5, where we plot private consumption in the West in the good and the bad state.[18]

Though in the analytical part we have not explicitly talked about welfare, the presumption is that the distortion of security prices, with the corresponding drop in risk sharing, is welfare decreasing. This point is illustrated by Figure 6, where we compare expected welfare for the median type individual in the manipulation game (the dashed line) to that of the benchmark game (the thin line).

4 Risk Sharing and Fiscal Policy in a Fiscal Union

The previous section has shown that tax setting in a decentralized world may cause a fiscal externality problem, with distortions in government spending and incomplete risk sharing, despite market completeness and the absence of aggregate risk. We will now show that a fiscal union may provide a solution to these problems — although at a cost.

As pointed out by Persson and Tabellini (1996), federal constitutions often require residents in different regions to be treated equally. It is therefore reasonable to assume that in a fiscal union tax rates and spending are equal across regions. Moreover, there will now only be one tax rate across states, because the absence of uncertainty at the federal level implies there is only one relevant state of nature. Fiscal policy can therefore no longer be used to manipulate security prices.

The elimination of this manipulation motive presents clear benefits, since complete insurance arises, even when fiscal policy is set before trading in security markets. In that sense regions stand to gain from forming a fiscal union. But there is a second effect that needs to be taken into account when regions are ex ante different: a common level of spending with a same tax rate implies redistribution across regions, so that the region which is richer in expected terms is likely to benefit less from a fiscal union.

[18] Only when $\pi = 0.5$ do we get complete risk sharing in private consumption. This is obvious: when $\pi = 0.5$, both regions are completely symmetrical, so that $\widetilde{g}_\gamma = \widetilde{g}^*_\beta$ and $\widetilde{g}_\beta = \widetilde{g}^*_\gamma$, so that $\widetilde{g}_\gamma + \widetilde{g}^*_\gamma = \widetilde{g}_\beta + \widetilde{g}^*_\beta$.

To formalize this intuition, we analyze the case where the two regions set federal fiscal policy before all the gains from risk sharing have been realized. The tax base — defined again as endowment gross of net payments of securities — is constant across states of nature, and equal to $2\bar{y}$. As said before, spending is equal across regions, and the tax rate cannot be made contingent on the state of nature in each region. Fiscal spending per region is therefore constant, and equal to $\tau\bar{y}$. The preferred tax rate of an individual from the West with type y is then given by the solution to:

$$\max_{\tau} \pi \left[V\left(y\left(1+\varepsilon\right)\left(1-\tau\right)+\widetilde{x}_{\gamma}\left(y,\tau\right)\right)+W\left(\tau\overline{y}\right)\right]+\left(1-\pi\right)\left[V\left(y\left(1-\varepsilon\right)\left(1-\tau\right)+\widetilde{x}_{\beta}\left(y,\tau\right)\right)+W\left(\tau\overline{y}\right)\right] \tag{13}$$

Now consider the equilibrium of the risk sharing game for a given tax rate τ. Since aggregate fiscal spending is constant across states of nature, it is easy to see that in the equilibrium of the risk sharing game aggregate private consumption will also be constant across states of nature:

$$\widetilde{c}_{\gamma}\left(y,\tau\right)=\widetilde{c}_{\beta}\left(y,\tau\right)=\widetilde{c}\left(y,\tau\right)=y\left(1+\varepsilon(2\pi-1)\right)\left(1-\tau\right)$$

so that we get complete risk sharing. The first order condition that characterizes the solution to (13) can therefore be written as:

$$\frac{\left(1+\varepsilon(2\pi-1)\right)V'\left(\widetilde{c}\left(y,\tau\right)\right)}{W'\left(\tau\overline{y}\right)}=\frac{\overline{y}}{y}$$

Similarly, the first order condition that determines the preferred tax rate of an individual from East with type y is:

$$\frac{\left(1-\varepsilon(2\pi-1)\right)V'\left(\widetilde{c}^{*}\left(y,\tau\right)\right)}{W'\left(\tau\overline{y}\right)}=\frac{\overline{y}}{y}$$

Given preferences are single peaked, the equilibrium tax rate τ is the one preferred by the union's median voter. Let $\Gamma\left(\tau,\pi\right)$ denote the fraction of individuals in West whose preferred tax rate is less than or equal to τ and let $\Gamma^{*}\left(\tau,\pi\right)$ be the corresponding fraction of individuals in East. The equilibrium tax rate τ is then given by the solution to:

$$\Gamma\left(\tau,\pi\right)+\Gamma^{*}\left(\tau,\pi\right)=1.$$

As mentioned before, whether regions prefer a fiscal union to a decentralized system depends on how similar or how different regions are. If regions are quite similar (π close to $1/2$), they will fare better under a fiscal union: similar regions suffer the greatest distortions in a decentralized system, so they will reap the largest gains from a fiscal union with perfect risk sharing. However, if regions are relatively different (π far from $1/2$), the median type in the rich region prefers a decentralized system: the minor risk sharing gains in the fiscal union do not compensate for the cost of a less preferred fiscal policy and the cost of net transfers to the other region. The following proposition formalizes the previous arguments by characterizing individual preferences over the centralized and the decentralized system when regions are sufficiently similar or sufficiently different in ex ante terms.

PROPOSITION 4 *Suppose Assumption 1. Then there exist values $\underline{\pi}$, $\overline{\pi}$ with $\frac{1}{2}<\underline{\pi}<\overline{\pi}<1$ such that*

1. *If $\pi\in\left[\frac{1}{2},\underline{\pi}\right)$ (regions are ex-ante similar), at least 50% of the residents of each region strictly prefer the fiscal union over the decentralized system.*

2. *If $\pi \in (\overline{\pi}, 1]$ (regions are ex-ante different), at least 50% of the residents of the West strictly prefer the decentralized system over the fiscal union.*

PROOF. See Appendix A.5.

Using the same parameters as before, Figure 7 compares welfare in the decentralized system (dashed line) and the fiscal union (semi-continuous line) for the median income residents in the West and the East. As can be seen, in the vicinity of $\pi = 1/2$, both median income residents prefer the fiscal union. As regions become increasingly different, this consensus breaks down.

Notice that Proposition 4 makes no statement about the preferences of the Eastern median type resident for high values of π (or the Western median type resident for low values of π). In fact, this case is ambiguous: it is possible that the fiscal union leads to a higher equilibrium tax rate in the East compared to the decentralized system, so that the benefits of higher public consumption and complete risk sharing could be swept away by too high tax rates, depressing disposable income and private consumption. Although in the particular example of Figure 7 the median type resident of the East prefers the fiscal union to the decentralized system for all values of π higher than $1/2$, this need not be always the case.

5 Conclusions

In this paper we have studied risk sharing and fiscal spending in a decentralized two-region model. Despite the existence of complete markets, distortions arise if regional fiscal policies are set before all potential gains from risk sharing have been realized. In an attempt to improve the terms of trade of securities, each region chooses a pro-cyclical fiscal policy, inflating government spending when a positive shock occurs and deflating it when hit by a negative shock. These distortions lead to incomplete risk sharing and higher volatility of government spending.

We have then shown that a fiscal union eliminates such distortions and allows for complete risk sharing. However, if regions are ex ante quite different in terms of exposure to shocks, a fiscal union also has its costs, since it implies significant net transfers from the region more likely to experience a positive shock to the other one. To sum up, if regions are fairly similar, a majority of residents in each region fares better in a fiscal union; if, however, regions are fairly different, a majority of residents in the rich region prefers the decentralized system.

This paper has mainly focused on the effect of decentralized fiscal policy on risk sharing in complete markets. Given that markets are more complete at the national than the international level, we have centered our attention on risk sharing between regions rather than between countries. But the effects we discussed are likely to go through in an international setting, as long as there is some risk sharing through private capital markets. Moreover, since the manipulation motive leads agents to underinvest in foreign securities, our model may contribute to understanding the limited extent of international risk sharing.

A Appendix

A.1 Proof of Lemma 1

The proof will only be given for the manipulation game. The proof for the benchmark game follows by analogy.

From (2) the securities demand functions of an individual with type y are such that:

$$V'\left(y(1-\varepsilon)(1-t_\beta)-\frac{x_\gamma}{P}\right)=\frac{P\pi}{(1-\pi)}V'\left(y(1+\varepsilon)(1-t_\gamma)+x_\gamma\right) \tag{14}$$

If $V(\cdot)$ is homogeneous of degree $r+1$, $V'(\cdot)$ is homogeneous of degree r, and it is easy to see that (14) implies

$$x_\gamma = y\left[\frac{(1-\varepsilon)(1-t_\beta)-\left(\frac{P\pi}{(1-\pi)}\right)^{\frac{1}{r}}(1+\varepsilon)(1-t_\gamma)}{\left(\frac{P\pi}{(1-\pi)}\right)^{\frac{1}{r}}+\frac{1}{P}}\right]$$

so that x_γ can be rewritten as

$$x_\gamma = yf(t) \tag{15}$$

where $t=\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*\right)$ and $f(t)$ does not depend on y. Since from the budget constraint $x_\beta=-\frac{x_\gamma}{P}$ we also have that

$$x_\beta=-y\frac{f(t)}{P} \tag{16}$$

Given (15) and (16), indirect expected utility for an individual with type equal to y for a given $t=\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*\right)$ can be shown to be equal to

$$h(t,y)=y^{r+1}k(t)+z(t)$$

where

$$\begin{aligned} k(t) &= \left[\pi V\left(((1+\varepsilon)(1-t_\gamma)+f(t))\right)+(1-\pi)V\left(((1-\varepsilon)(1-t_\beta)+f(t))\right)\right] \\ z(t) &= \pi W(g_\gamma)+(1-\pi)W(g_\beta). \end{aligned}$$

is common to all individuals.

Consider the following two cases: $r+1\geq 0$ and $r+1<0$.

1. $r+1\geq 0$. Let $t=\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*\right)$ be such that (t_γ,t_β) is the most preferred fiscal policy of the Western individual with the median type, y^m, given the Eastern fiscal policy is $\left(t_\gamma^*,t_\beta^*\right)$ and let $t'=\left(t'_\gamma,t'_\beta,t_\gamma^*,t_\beta^*\right)$ with $\left(t'_\gamma,t'_\beta\right)\neq(t_\gamma,t_\beta)$ and otherwise arbitrary. Clearly, $h(t,y^m)-h(t',y^m)\leq 0$.

   Suppose that $k(t)-k(t')\leq 0$. Then if

   $$h(t,y^m)-h(t',y^m)=(y^m)^{r+1}\left[k(t)-k(t')\right]+\left[z(t)-z(t')\right]>0$$

   then there exists a $y'>y^m$, such that $h(t,y)-h(t',y)>0$ for any $y\leq y'$. It follows from the definition of the median that a majority of voters would prefer t to t'.

   Suppose now $k(t)-k(t')\geq 0$. Then if

   $$h(t,y^m)-h(t',y^m)=(y^m)^{r+1}\left[k(t)-k(t')\right]+\left[z(t)-z(t')\right]>0$$

then there exists a $y' < y^m$, such that $h(t,y) - h(t',y) > 0$ for any $y \geq y'$. It follows from the definition of the median that a majority of voters would prefer t to t'.

Because we can repeat the argument for any alternative allocation, t', t is the unique majority winner.

2. A similar argument shows that the same is true when $r+1<0$.

■

A.2 Proof of Proposition 1

Suppose that $\widehat{P} = \frac{1-\pi}{\pi}$. First order conditions (2) and (3) imply that $c_\gamma\left(y,\widehat{P}\right) = c_\beta\left(y,\widehat{P}\right)$ for all y and $c_\gamma^*\left(y,\widehat{P}\right) = c_\beta^*\left(y,\widehat{P}\right)$ for all y. From (6) and (7) we get $W'\left(\overline{y}(1+\varepsilon)\widehat{t}_\gamma\right) = W'\left(\overline{y}(1-\varepsilon)\widehat{t}_\beta\right)$, so that $g_\gamma = g_\beta$ and $\widehat{t}_\gamma = \widehat{t}_\beta\frac{1-\varepsilon}{1+\varepsilon}$. By analogy, for East we get $W'\left(\overline{y}(1-\varepsilon)\widehat{t}_\gamma^*\right) = W'\left(\overline{y}(1+\varepsilon)\widehat{t}_\beta^*\right)$, so that $g_\gamma^* = g_\beta^*$ and $\widehat{t}_\gamma^* = \widehat{t}_\beta^*\frac{1+\varepsilon}{1-\varepsilon}$. To prove that $\widehat{P} = \frac{1-\pi}{\pi}$, note that $\widehat{t}_\gamma = \widehat{t}_\beta\frac{1-\varepsilon}{1+\varepsilon}$ and $\widehat{t}_\gamma^* = \widehat{t}_\beta^*\frac{1+\varepsilon}{1-\varepsilon}$ imply that aggregate endowment net of tax revenues is constant across states, so that because of aversion to private consumption risk we have $c_\gamma\left(y,\widehat{P}\right) = c_\beta\left(y,\widehat{P}\right)$ for all y, $c_\gamma^*\left(y,\widehat{P}\right) = c_\beta^*\left(y,\widehat{P}\right)$ for all y.

Suppose now that an equilibrium exists with $\widehat{P} > \frac{1-\pi}{\pi}$. First order conditions (2) and (3) imply that $c_\gamma\left(y,\widehat{P}\right) > c_\beta\left(y,\widehat{P}\right)$ for all y and $c_\gamma^*\left(y,\widehat{P}\right) > c_\beta^*\left(y,\widehat{P}\right)$ for all y. From (6) and (7) we get $W'\left(\overline{y}(1+\varepsilon)\widehat{t}_\gamma\right) < W'\left(\overline{y}(1-\varepsilon)\widehat{t}_\beta\right)$, so that $g_\gamma > g_\beta$. By analogy, for East we get $W'\left(\overline{y}(1-\varepsilon)\widehat{t}_\gamma^*\right) < W'\left(\overline{y}(1+\varepsilon)\widehat{t}_\beta^*\right)$, so that $g_\gamma^* > g_\beta^*$ and it is easy to see that the feasibility constraints are violated.

A symmetric argument shows that no equilibrium can exist with $\widehat{P} < \frac{1-\pi}{\pi}$ and completes the proof. ■

A.3 Proof of Proposition 2

Denote the tax rates in the equilibrium of the manipulation game by $\widetilde{t} = \left(\widetilde{t}_\gamma, \widetilde{t}_\beta, \widetilde{t}_\gamma^*, \widetilde{t}_\beta^*\right)$ and let $\widetilde{g} = \left(\widetilde{g}_\gamma, \widetilde{g}_\beta, \widetilde{g}_\gamma^*, \widetilde{g}_\beta^*\right)$ denote the associated vector of government spending. The equilibrium tax rates are characterized by the following conditions

$$\pi\left[V'\left(\widetilde{c}_\gamma\right)y^m(1+\varepsilon) - W'\left(\widetilde{g}_\gamma\right)\overline{y}(1+\varepsilon)\right] - \frac{(1-\pi)V'\left(\widetilde{c}_\beta\right)\widetilde{x}_\gamma\frac{\partial\widetilde{P}(t)}{\partial t_\gamma}}{\left(\widetilde{P}\left(\widetilde{t}\right)\right)^2} = 0 \quad (17)$$

$$(1-\pi)\left[V'\left(\widetilde{c}_\beta\right)y^m(1-\varepsilon) - W'\left(\widetilde{g}_\beta\right)\overline{y}(1-\varepsilon)\right] - \frac{(1-\pi)V'\left(\widetilde{c}_\beta\right)\widetilde{x}_\gamma\frac{\partial\widetilde{P}(t)}{\partial t_\beta}}{\left(\widetilde{P}\left(\widetilde{t}\right)\right)^2} = 0 \quad (18)$$

$$\pi\left[V'\left(\widetilde{c}_\gamma^*\right)y^m(1-\varepsilon) - W'\left(\widetilde{g}_\gamma^*\right)\overline{y}(1-\varepsilon)\right] - \frac{(1-\pi)V'\left(\widetilde{c}_\beta^*\right)\widetilde{x}_\gamma^*\frac{\partial\widetilde{P}(t)}{\partial t_\gamma^*}}{\left(\widetilde{P}\left(\widetilde{t}\right)\right)^2} = 0 \quad (19)$$

$$(1-\pi)\left[V'\left(\widetilde{c}_\beta^*\right)y^m(1+\varepsilon)-W'\left(\widetilde{g}_\beta^*\right)\overline{y}(1+\varepsilon)\right]-\frac{(1-\pi)V'\left(\widetilde{c}_\beta^*\right)\widetilde{x}_\gamma^*\frac{\partial\widetilde{P}(\widetilde{t})}{\partial t_\beta^*}}{\left(\widetilde{P}\left(\widetilde{t}\right)\right)^2} = 0 \qquad (20)$$

To compute the sign of $\frac{\partial\widetilde{P}(t)}{\partial t_\beta}$, $\frac{\partial\widetilde{P}(t)}{\partial t_\gamma}$, $\frac{\partial\widetilde{P}(t)}{\partial t_\gamma^*}$ and $\frac{\partial\widetilde{P}(t)}{\partial t_\beta^*}$, let $z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)$ denote the aggregate demand function for security γ and totally differentiate the equilibrium condition

$$z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)=0$$

with respect to P and t_γ, t_β, t_γ^* and t_β^* respectively. For West we get

$$\frac{\partial\widetilde{P}\left(\widetilde{t}_\gamma,\widetilde{t}_\beta,\widetilde{t}_\gamma^*,\widetilde{t}_\beta^*\right)}{\partial t_\gamma} = -\frac{\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial t_\gamma}}{\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial P}} \qquad (21)$$

$$\frac{\partial\widetilde{P}\left(\widetilde{t}_\gamma,\widetilde{t}_\beta,\widetilde{t}_\gamma^*,\widetilde{t}_\beta^*\right)}{\partial t_\beta} = -\frac{\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial t_\beta}}{\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial P}} \qquad (22)$$

Since by definition

$$z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)=\int\left[x_\gamma\left(t_\gamma,t_\beta,P,y\right)+x_\gamma^*\left(t_\gamma^*,t_\beta^*,P,y\right)\right]dG(y)$$

we have

$$\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial t_\gamma} = \int\frac{\partial x_\gamma\left(t_\gamma,t_\beta,P,y\right)}{\partial t_\gamma}dG(y)$$

$$\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial t_\beta} = \int\frac{\partial x_\gamma\left(t_\gamma,t_\beta,P,y\right)}{\partial t_\beta}dG(y)$$

and from the first order conditions

$$V'\left(y(1-\varepsilon)(1-t_\beta)-\frac{x_\gamma}{P}\right)-\frac{P\pi}{1-\pi}V'\left(y(1+\varepsilon)(1-t_\gamma)+x_\gamma\right)=0$$

$$V'\left(y^m(1+\varepsilon)\left(1-t_\beta^*\right)-\frac{x_\gamma^*}{P}\right)-\frac{P\pi}{1-\pi}V'\left(y^m(1-\varepsilon)\left(1-t_\gamma^*\right)+x_\gamma^*\right)=0$$

we get

$$\frac{\partial x_\gamma\left(t_\gamma,t_\beta,P,y\right)}{\partial t_\gamma} = \frac{P\pi}{1-\pi}(1+\varepsilon)\frac{V''\left(\widetilde{c}_\gamma,y\right)y}{\frac{V''\left(\widetilde{c}_\beta,y\right)}{P}+V''\left(\widetilde{c}_\gamma,y\right)\frac{P\pi}{1-\pi}}>0$$

$$\frac{\partial x_\gamma\left(t_\gamma,t_\beta,P,y\right)}{\partial t_\beta} = -(1-\varepsilon)\frac{V''\left(\widetilde{c}_\beta,y\right)y}{\frac{V''\left(\widetilde{c}_\beta,y\right)}{P}+V''\left(\widetilde{c}_\gamma,y\right)\frac{P\pi}{1-\pi}}<0$$

which imply that

$$\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial t_\gamma} = \frac{P\pi}{1-\pi}(1+\varepsilon)\int\frac{V''\left(\widetilde{c}_\gamma,y\right)y}{\frac{V''\left(\widetilde{c}_\beta,y\right)}{P}+V''\left(\widetilde{c}_\gamma,y\right)\frac{P\pi}{1-\pi}}dG(y)>0 \qquad (23)$$

$$\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t_\gamma^*,t_\beta^*,P\right)}{\partial t_\beta} = -(1-\varepsilon)\int\frac{V''\left(\widetilde{c}_\beta,y\right)y}{\frac{V''\left(\widetilde{c}_\beta,y\right)}{P}+V''\left(\widetilde{c}_\gamma,y\right)\frac{P\pi}{1-\pi}}dG(y)<0 \qquad (24)$$

Given Assumption 1 implies that preferences over lotteries of private consumption are homothetic, $\frac{\partial z_\gamma\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta,P\right)}{\partial P} > 0$, for both the West and the East and a unique equilibrium price exists, $\widetilde{P}\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta\right)$ with

$$\frac{\partial\widetilde{P}\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta\right)}{\partial t_\gamma} < 0 \text{ and } \frac{\partial\widetilde{P}\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta\right)}{\partial t_\beta} > 0$$

In a similar way it can be shown that

$$\frac{\partial\widetilde{P}\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta\right)}{\partial t^*_\gamma} < 0 \text{ and } \frac{\partial\widetilde{P}\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta\right)}{\partial t^*_\beta} > 0$$

Now suppose that $\widetilde{x}_\gamma(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta,y^m) < 0$; then from (17)-(20), necessary conditions for equilibrium are

$$V'\left(\widetilde{c}_\gamma\right)y^m - W'\left(\widetilde{g}_\gamma\right)\overline{y} > 0 \tag{25}$$
$$V'\left(\widetilde{c}_\beta\right)y^m - W'\left(\widetilde{g}_\beta\right)\overline{y} < 0 \tag{26}$$
$$V'\left(\widetilde{c}^*_\gamma\right)y^m - W'\left(\widetilde{g}^*_\gamma\right)\overline{y} < 0 \tag{27}$$
$$V'\left(\widetilde{c}^*_\beta\right)y^m - W'\left(\widetilde{g}^*_\beta\right)\overline{y} > 0 \tag{28}$$

Even though we cannot determine the equilibrium price $\widetilde{P}\left(\widetilde{t}\right)$, we will show that for all values that it could get we would have $\widetilde{g}_\gamma \geq \widetilde{g}_\beta$ and $\widetilde{g}^*_\gamma \leq \widetilde{g}^*_\beta$.

1. If $\widetilde{P}\left(\widetilde{t}\right) = \frac{1-\pi}{\pi}$, this implies that $\widetilde{c}_\gamma = \widetilde{c}_\beta$ and $\widetilde{c}^*_\gamma = \widetilde{c}^*_\beta$, then from (25)-(28) we have $\widetilde{g}_\gamma \geq \widetilde{g}_\beta$ and $\widetilde{g}^*_\gamma \leq \widetilde{g}^*_\beta$.

2. If $\widetilde{P}\left(\widetilde{t}\right) > \frac{1-\pi}{\pi}$, this implies that $\widetilde{c}_\gamma > \widetilde{c}_\beta$ and $\widetilde{c}^*_\gamma > \widetilde{c}^*_\beta$. Inequalities (25) and (26) then imply that $\widetilde{g}_\gamma \geq \widetilde{g}_\beta$, and for $\widetilde{P}\left(\widetilde{t}\right) > \frac{1-\pi}{\pi}$ to be part of an equilibrium, the aggregate net endowment in state β must be less than aggregate net endowment in state γ, that is, $\widetilde{g}^*_\beta + \widetilde{g}_\beta > \widetilde{g}^*_\gamma + \widetilde{g}_\gamma$ which implies that $\widetilde{g}^*_\gamma \leq \widetilde{g}^*_\beta$.

3. If $\widetilde{P}\left(\widetilde{t}\right) < \frac{1-\pi}{\pi}$, this implies that $\widetilde{c}_\gamma < \widetilde{c}_\beta$ and $\widetilde{c}^*_\gamma < \widetilde{c}^*_\beta$. Inequalities (27) and (28) then imply that $\widetilde{g}^*_\gamma \leq \widetilde{g}^*_\beta$, and for $\widetilde{P}\left(\widetilde{t}\right) < \frac{1-\pi}{\pi}$ to be an equilibrium, the aggregate net endowment in state β must be greater than aggregate net endowment in state γ, that is, $\widetilde{g}^*_\beta + \widetilde{g}_\beta < \widetilde{g}^*_\gamma + \widetilde{g}_\gamma$ which implies that $\widetilde{g}_\gamma \geq \widetilde{g}_\beta$.

A similar argument shows that assuming that $\widetilde{x}_\gamma\left(t_\gamma,t_\beta,t^*_\gamma,t^*_\beta,y^m\right) \geq 0$ leads to a contradiction. ■

A.4 Proof of Proposition 3

Assumption 1 guarantees that the allocations of the equilibrium of the risk sharing game are interior. This implies that expected equilibrium payoffs are continuous in π and it is sufficient to show the claim when $\pi = 1/2$.

If regions are ex-ante identical, $\pi = 1/2$, by symmetry $\widetilde{g}_{\beta}^{*} = \widetilde{g}_{\gamma}$ and $\widetilde{g}_{\gamma}^{*} = \widetilde{g}_{\beta}$, which implies that $\widetilde{P}(t) = 1$ and therefore $\widetilde{c}_{\gamma} = \widetilde{c}_{\beta} = \widetilde{c}_{\gamma}^{*} = \widetilde{c}_{\beta}^{*} = \widetilde{c}$. When fiscal policies are set after trading in securities, in equilibrium $\widehat{c}_{\gamma} = \widehat{c}_{\beta} = \widehat{c}_{\gamma}^{*} = \widehat{c}_{\beta}^{*} = \widehat{c}$ and $\widehat{g}_{\beta}^{*} = \widehat{g}_{\beta} = \widehat{g}_{\gamma} = \widehat{g}_{\gamma} = \widehat{g}$. Then the statement of the proposition is equivalent to $\widehat{c} > \widetilde{c}$.

Since $\widetilde{c}_{\gamma} = \widetilde{c}_{\beta} = \widetilde{c}_{\gamma}^{*} = \widetilde{c}_{\beta}^{*} = \widetilde{c}$ then from (21), (22), (23) and (24) we get

$$
\begin{aligned}
\frac{\partial \widetilde{P}\left(\widetilde{t}_{\gamma}, \widetilde{t}_{\beta}, \widetilde{t}_{\gamma}^{*}, \widetilde{t}_{\beta}^{*}\right)}{\partial t_{\gamma}} &= -\frac{\int \frac{y(1+\varepsilon)}{2} dG(y)}{\frac{\partial z_{\gamma}\left(\widetilde{t}_{\gamma}, \widetilde{t}_{\beta}, \widetilde{t}_{\gamma}^{*}, \widetilde{t}_{\beta}^{*}, \widetilde{P}\right)}{\partial P}} \\
\frac{\partial \widetilde{P}\left(\widetilde{t}_{\gamma}, \widetilde{t}_{\beta}, \widetilde{t}_{\gamma}^{*}, \widetilde{t}_{\beta}^{*}\right)}{\partial t_{\beta}} &= \frac{\int \frac{y(1-\varepsilon)}{2} dG(y)}{\frac{\partial z_{\gamma}\left(\widetilde{t}_{\gamma}, \widetilde{t}_{\beta}, \widetilde{t}_{\gamma}^{*}, \widetilde{t}_{\beta}^{*}, \widetilde{P}\right)}{\partial P}}
\end{aligned}
$$

and substituting these into (17) and (18) we get

$$
W'\left(\widetilde{g}_{\gamma}\right)\overline{y} = V'\left(\widetilde{c}\right)\left[y^{m} + \frac{\frac{1}{2}\widetilde{x}_{\gamma}\overline{y}}{\frac{\partial z_{\gamma}\left(\widetilde{t}_{\gamma}, \widetilde{t}_{\beta}, \widetilde{t}_{\gamma}^{*}, \widetilde{t}_{\beta}^{*}, \widetilde{P}\right)}{\partial P}}\right]
$$

$$
W'\left(\widetilde{g}_{\beta}\right)\overline{y} = V'\left(\widetilde{c}\right)\left[y^{m} - \frac{\frac{1}{2}\widetilde{x}_{\gamma}\overline{y}}{\frac{\partial z_{\gamma}\left(\widetilde{t}_{\gamma}, \widetilde{t}_{\beta}, \widetilde{t}_{\gamma}^{*}, \widetilde{t}_{\beta}^{*}, \widetilde{P}\right)}{\partial P}}\right]
$$

which imply that

$$
W'\left(\widetilde{g}_{\gamma}\right)\overline{y} - V'\left(\widetilde{c}\right)y^{m} = V'\left(\widetilde{c}\right)y^{m} - W'\left(\widetilde{g}_{\beta}\right)\overline{y} \tag{29}
$$

We know that $V'\left(\widehat{c}\right) = W'\left(\widehat{g}\right)\frac{\overline{y}}{y^{m}}$. Now, suppose contrary to the claim that $\widehat{c} \leq \widetilde{c}$. By concavity of $V(.)$, this implies that $V'\left(\widehat{c}\right) \geq V'\left(\widetilde{c}\right)$ and this together with (29) implies that

$$
\overline{y}\left[W'\left(\widetilde{g}_{\gamma}\right) + W'\left(\widetilde{g}_{\beta}\right)\right] = 2y^{m}V'\left(\widetilde{c}\right) \leq 2y^{m}V'\left(\widehat{c}\right) = 2\overline{y}W'\left(\widehat{g}\right)
$$

which in turn implies that

$$
W'\left(\widetilde{g}_{\gamma}\right) + W'\left(\widetilde{g}_{\beta}\right) \leq 2W'\left(\widehat{g}\right) \tag{30}
$$

From Proposition 2 $\widetilde{g}_{\gamma} > \widetilde{g}_{\beta}$ and this implies that at least one of $\widetilde{g}_{\gamma} \neq \widehat{g}$, $\widetilde{g}_{\beta} \neq \widehat{g}$ holds. Given $W'''(.) > 0$, $W'(.)$ is convex and the previous result implies that

$$
W'\left(\widetilde{g}_{\gamma}\right) \geq W'\left(\widehat{g}\right) + W''\left(\widehat{g}\right)\left(\widetilde{g}_{\gamma} - \widehat{g}\right) \tag{31}
$$

$$
W'\left(\widetilde{g}_{\beta}\right) \geq W'\left(\widehat{g}\right) + W''\left(\widehat{g}\right)\left(\widetilde{g}_{\beta} - \widehat{g}\right) \tag{32}
$$

with at least one of the two inequalities holding strictly. Adding (31) and (32) we get

$$
W'\left(\widetilde{g}_{\gamma}\right) + W'\left(\widetilde{g}_{\beta}\right) - 2W'\left(\widehat{g}\right) > W''\left(\widehat{g}\right)\left(\widetilde{g}_{\gamma} + \widetilde{g}_{\beta} - 2\widehat{g}\right)
$$

From (30) we know that $W'\left(\widetilde{g}_{\gamma}\right) + W'\left(\widetilde{g}_{\beta}\right) - 2W'\left(\widehat{g}\right) \leq 0$ which implies that

$$
W''\left(\widehat{g}\right)\left(\widetilde{g}_{\gamma} - \widehat{g} + \widetilde{g}_{\beta} - \widehat{g}\right) < 0
$$

Since $W''\left(\widehat{g}\right) \leq 0$ then $\widetilde{g}_{\gamma} + \widetilde{g}_{\beta} > 2\widehat{g}$, and this implies that $\widehat{c} > \widetilde{c}$ leading to a contradiction. ■

A.5 Proof of Proposition 4

Part 1. Assumption 1 guarantees that the allocations of the equilibrium of the risk sharing game are interior. This implies that expected equilibrium payoffs are continuous in π and it is sufficient to show that when $\pi = 1/2$ at least half of the residents of each region strictly prefers the fiscal union to the decentralized system. Given $V(.)$ is homogeneous of degree $1+r$, the only source of heterogeneity among individuals is the parameter y^{1+r}, which enters linearly in individual preferences over policies. The argument used in the Proof of Lemma 1 clarifies that, if the individual with median type strictly prefers the fiscal union to the decentralized system, at least half of the resident of the same region prefer the fiscal union to the decentralized system. This in turn implies that to prove the claim it suffices to show that when $\pi = 1/2$ the individual with median type in each region strictly prefer the fiscal union to the decentralized system.

When $\pi = 1/2$, the equilibrium with the fiscal union replicates the equilibrium of the benchmark game. To see this, note that in the fiscal union private consumption and public consumption do not vary across states of nature (as in the equilibrium of the decentralized benchmark game). Moreover, $\pi = 1/2$ implies that the distribution of expected endowment is identical across regions, so that the median type individuals' most preferred tax rate (and government spending) are identical and this proves that the fiscal union is identical to the decentralized system (without distortions).

We now show that median type residents of the West and the East strictly prefer to equilibrium of the benchmark game to the equilibrium of the manipulation game.

Suppose the opposite is true. From Proposition 1 we know that in the equilibrium of the benchmark game

$$\begin{aligned} \widehat{c}_{\gamma}(y^m) &= \widehat{c}_{\beta}(y^m) \\ \widehat{g}_{\gamma} &= \widehat{g}_{\beta}. \end{aligned}$$

From Proposition 2 we know that when $\pi = 1/2$, in the equilibrium of the manipulation game

$$\begin{aligned} \widetilde{c}_{\gamma}(y^m) &= \widetilde{c}_{\beta}(y^m) \\ \widetilde{g}_{\gamma} &> \widetilde{g}_{\beta}. \end{aligned}$$

Consider now the following government expenditure vector

$$\widetilde{\widetilde{g}}_{\gamma} = \widetilde{\widetilde{g}}_{\beta} = \frac{\widetilde{g}_{\gamma} + \widetilde{g}_{\beta}}{2}.$$

Given by Assumption 1 $W''(.) < 0$, the median type resident of the West strictly prefers allocation $\left(\widetilde{c}_{\gamma}(y^m), \widetilde{c}_{\beta}(y^m), \widetilde{\widetilde{g}}_{\gamma}, \widetilde{\widetilde{g}}_{\beta}\right)$ to $(\widetilde{c}_{\gamma}(y^m), \widetilde{c}_{\beta}(y^m), \widetilde{g}_{\gamma}, \widetilde{g}_{\beta})$. Consider now the following two cases:

1. $\widetilde{\widetilde{g}}_{\gamma} = \widetilde{\widetilde{g}}_{\beta} = \widehat{g}_{\gamma} = \widehat{g}_{\beta}$. In this case a contradiction arises to the hypothesis that the median type individual prefers the equilibrium of the manipulation game to the equilibrium of the benchmark game.

2. $\widetilde{\widetilde{g}}_{\gamma} = \widetilde{\widetilde{g}}_{\beta} \neq \widehat{g}_{\gamma} = \widehat{g}_{\beta}$. In this case a contradiction arises to the hypothesis that $(\widehat{g}_{\gamma}, \widehat{g}_{\beta})$ is part of the equilibrium of the benchmark game, as the median type individual strictly prefers the equilibrium with $\left(\widetilde{\widetilde{g}}_{\gamma}, \widetilde{\widetilde{g}}_{\beta}\right)$.

Part 2. By the same arguments as above, to prove the claim it suffices to show that when $\pi = 1$ the individual of the West with median type strictly prefers the decentralized system over the fiscal union and the individual of the East with median type strictly prefers the fiscal union to the decentralized system.

When $\pi = 1$, no uncertainty exists and there is no gain in risk sharing in moving from a decentralized system to a fiscal union (because there is no need for risk sharing). Suppose the fiscal union and the decentralized manipulation game lead to the same equilibrium tax rates. Given fiscal policy is nondiscriminatory, this would imply a lower level of government consumption for Western residents in the fiscal union than in the decentralized system and in turn that the Western resident with median type would prefer the latter to the former. Suppose now the fiscal union and the decentralized system lead to the different equilibrium tax rates and consider the three following situations: a) Fiscal policy in the West is the decentralized manipulation game equilibrium tax rate; b) Fiscal policy in the West is the fiscal union equilibrium tax rate; c) Fiscal policy in the fiscal union is the fiscal union equilibrium tax rate. We want to show that the Western resident with median type prefers (a) to (c), while (b) is a hypothetical situation we consider for convenience. It is easy to see that by revealed preferences the median type Western resident prefers (a) to (b). It is also easy to see that given fiscal policy is nondiscriminatory disposable income for Western residents under (b) and (c) is the same but government consumption is lower in (c) than in (b). This implies that the Western resident with median type prefers (b) to (c) and ultimately proves that he prefers (a) to (c). ■

References

[1] Alesina, R. and R. Perotti (1995) "Economic Risk and Political Risk in Fiscal Unions", NBER working paper 4992.

[2] Arrow, K. J. (1964) "The Role of the Securities on the Optimal Allocations of Risk Bearing", *Review of Economic Studies*, 31, 91-96.

[3] Asdrubali, P., B. Sørensen, and O. Yosha (1996) "Channels of Interstate Risk Sharing: United States 1963-1990," *Quarterly Journal of Economics*, 111, 1081-1110.

[4] Athanasoulis, S. and E. van Wincoop (2000), "Risk Sharing within the United States," Review of Economics and Statistics, forthcoming.

[5] Atkeson, A. and T. Bayoumi (1993) "Do Private Capital Markets Insure Regional Risk? Evidence from the United States and Europe," *Open Economies Review*, 4, 303-324.

[6] Atkinson, A. B. and J. E. Stiglitz (1987) *Lectures on Public Economics*, McGraw-Hill International Edition, London, UK.

[7] Backus, D.K., P.J. Kehoe, and F.E. Kydland (1992) "International Real Business Cycles," *Journal of Political Economy*, 100(4), 745-775.

[8] Baxter, M. and M.J. Crucini (1995) "Business Cycles and the Asset Structure of Foreign Trade," *International Economic Review*, 36(4), 821-854.

[9] Canova, F. and M.O. Ravn (1996) "International Consumption Risk Sharing," *International Economic Review*, 37(3), 573-601.

[10] Del Negro, M. (2002) "Asymmetric Shocks among U.S. States," *Journal of International Economics*, 56, 273-297.

[11] Devereux, M. B.. (1991) "The Terms of Trade and the International Coordination of Fiscal Policy," *Economic Inquiry*, XXIX, 720-736.

[12] Grandmont, J. M. (1978) "Intermediate Preferences and the Majority Rule", *Econometrica*, 46, 317-330.

[13] Guesnerie, R. and J.Y. Jaffray (1974), "Optimality of Equilibrium of Plans, Prices, and Price Expectations" in J. Dreze, *Allocations Under Uncertainty: Equilibrium and Optimality*, New York, Wiley, 70-86.

[14] Johnson, H. G.. (1953) "Optimum Tariffs and Retaliation," *Review of Economic Studies*, 21(2), 142-53.

[15] Kalemli-Ozcan, S., Sørensen, B.E. and O. Yosha (2001) "Risk Sharing and Industrial Specialization: Regional and International Evidence," mimeo.

[16] Kreps, D. (1982) "Multiperiod Securities and the Efficient Allocation of Risk: A Comment on the Black-Scholes Option Pricing Model", in J. McCall (ed.) *The Economics of Uncertainty and Information*, Chicago University Press, Chicago, 203-232.

[17] Lewis, K. (1995) "Puzzles in International Financial Markets", in: G.M. Grossman and K. Rogoff (eds.) *Handbook of International Economics*, volume 3, Elsevier North-Holland, Amsterdam, 1913-71.

[18] Lewis, K. (1996) "What Can Explain the Apparent Lack of International Consumption Risk Sharing," *Journal of Political Economy*, 104(2), 267-297.

[19] Nurkse, R. (1945) "Conditions of International Monetary Equilibrium," Essays in International Finance No. 4, Princeton University.

[20] Obstfeld, M. (1994a) "Are Industrial Country Consumption Risks Globally Diversified?" in: L. Leiderman and A. Razin (eds.) *Capital Mobility: The Impact on Consumption, Investment and Growth*, Cambridge University Press, Cambridge, UK.

[21] Obstfeld, M. (1994b) "Risk-Taking, Global Diversification, and Growth," *American Economic Review*, 84, 1310-1329.

[22] Persson, T. and G. Tabellini (1995) "Double-Edged Incentives: Institutions and Policy Coordination," in: G.M. Grossman and K. Rogoff (eds.) *Handbook of International Economics*, volume 3, Elsevier North-Holland, Amsterdam, 1913-71.

[23] Persson, T. and G. Tabellini (1996) "Federal Fiscal Constitutions: Risk-Sharing and Redistribution", *Journal of Political Economy*, 104, No 51.

[24] Razin, A. and E. Sadka (1991) "International Fiscal Policy Coordination and Competition: An Exposition," NBER Working Paper No. 3779.

[25] Sachs, J. and X. Sala-i-Martin (1992) "Fiscal Federalism and Optimum Currency Area: Evidence for Europe from the United States" in M. Canzoneri, P. Masson and V. Grilli (eds.) *Establishing a Central Bank: Issues in Europe and Lessons from the US*, Cambridge University Press, Cambridge, UK.

[26] Shepsle, K. A. (1979), "Institutional Arrangements and Equilibrium in Multidimensional Voting Models", *American Journal of Political Science*, 23, 27-59.

[27] Sørensen, B.E. and O. Yosha (1998) "International Risk Sharing and European Monetary Union", *Journal of International Economics*, 45, 211-238.

[28] Tesar, L.L. and I. Werner (1995) "Home Bias and High Turnover," *Journal of International Money and Finance*, 14(4), 467-492.

[29] van Wincoop, E. (1994) "Welfare Gains from International Risk Sharing," *Journal of Monetary Economics*, 34, 175-200.

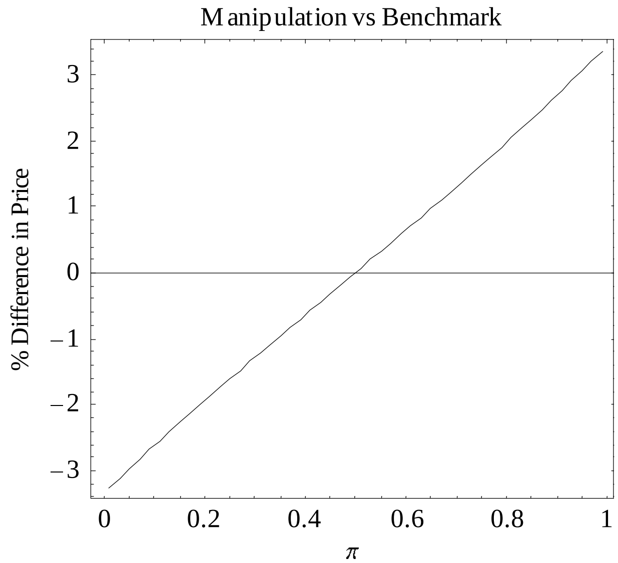

Figure 1: Percentage price difference between manipulation game and benchmark game

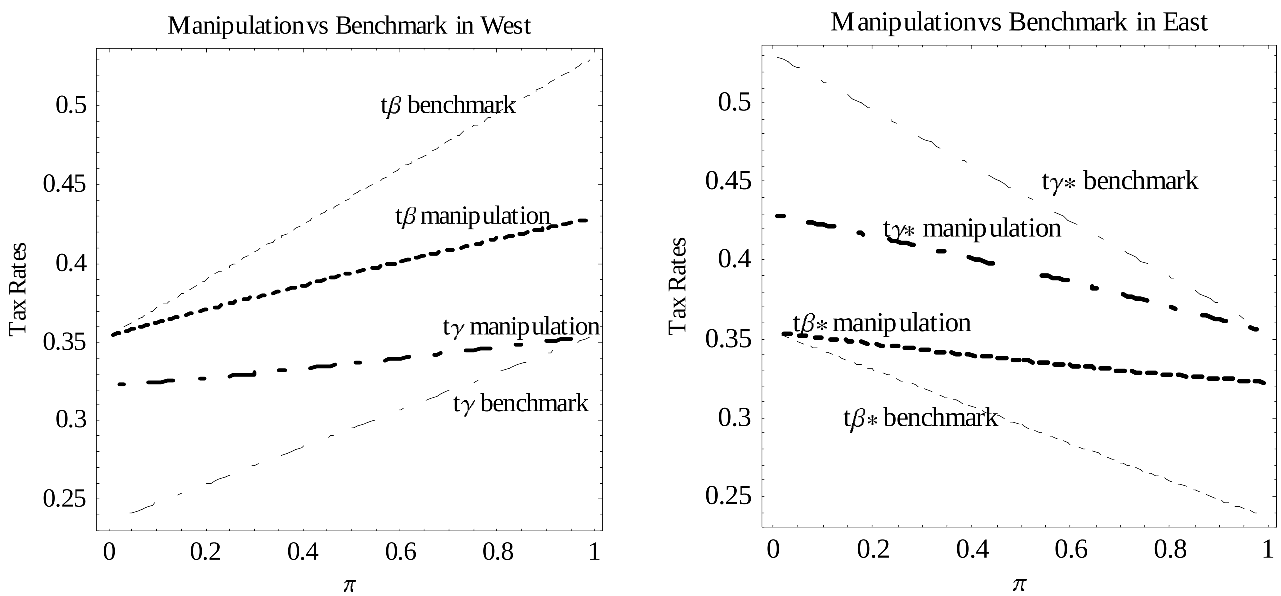

Figure 2: Tax rates in West and East.

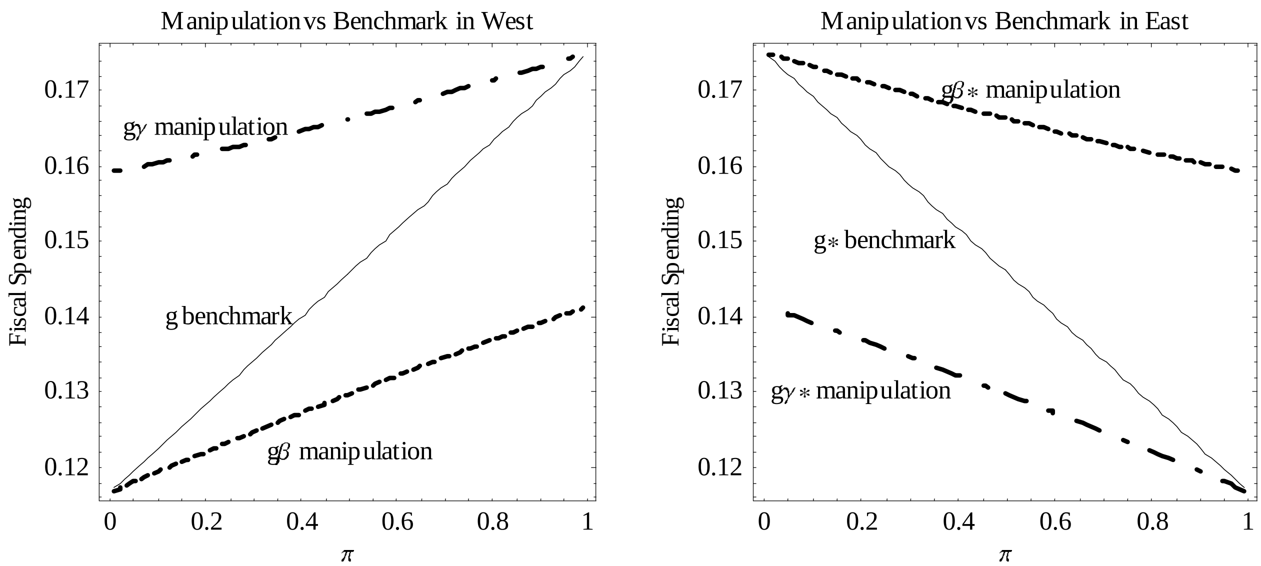

Figure 3: Fiscal spending in West and East.

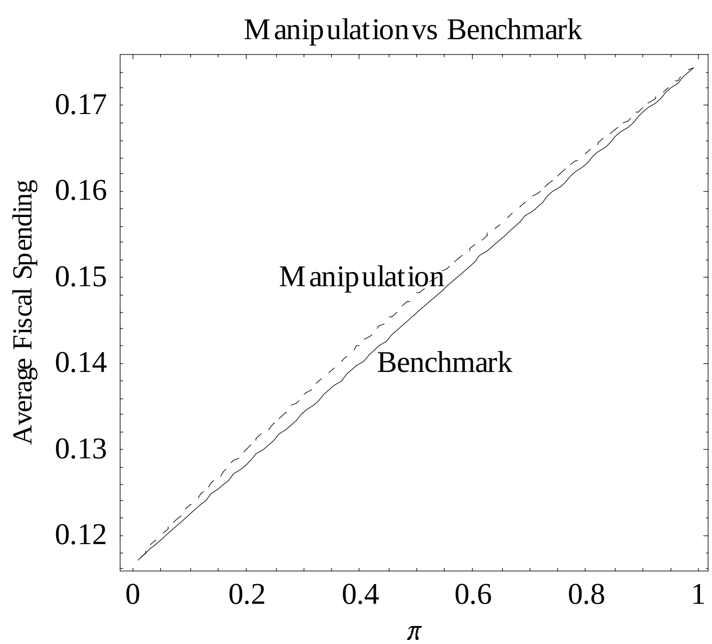

Figure 4: Expected fiscal spending in West.

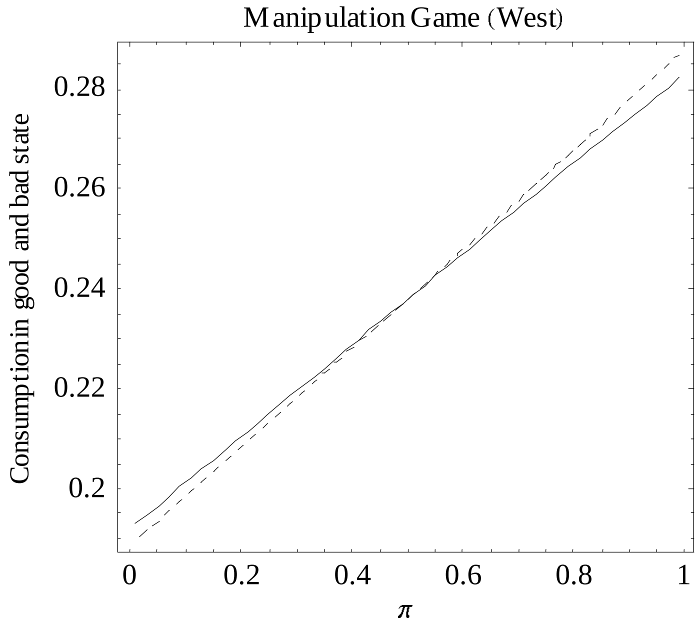

Figure 5: Consumption in good and bad state in the West.

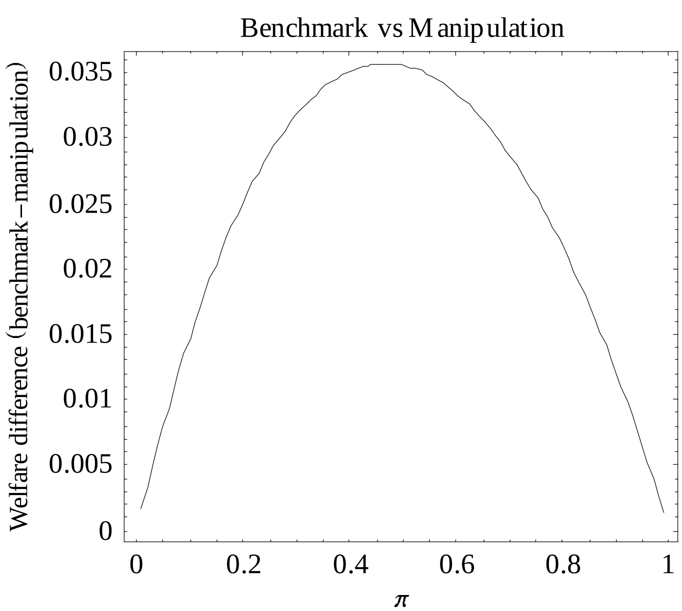

Figure 6: Difference between benchmark and manipulation game expected equilibrium utility for the median type Western resident

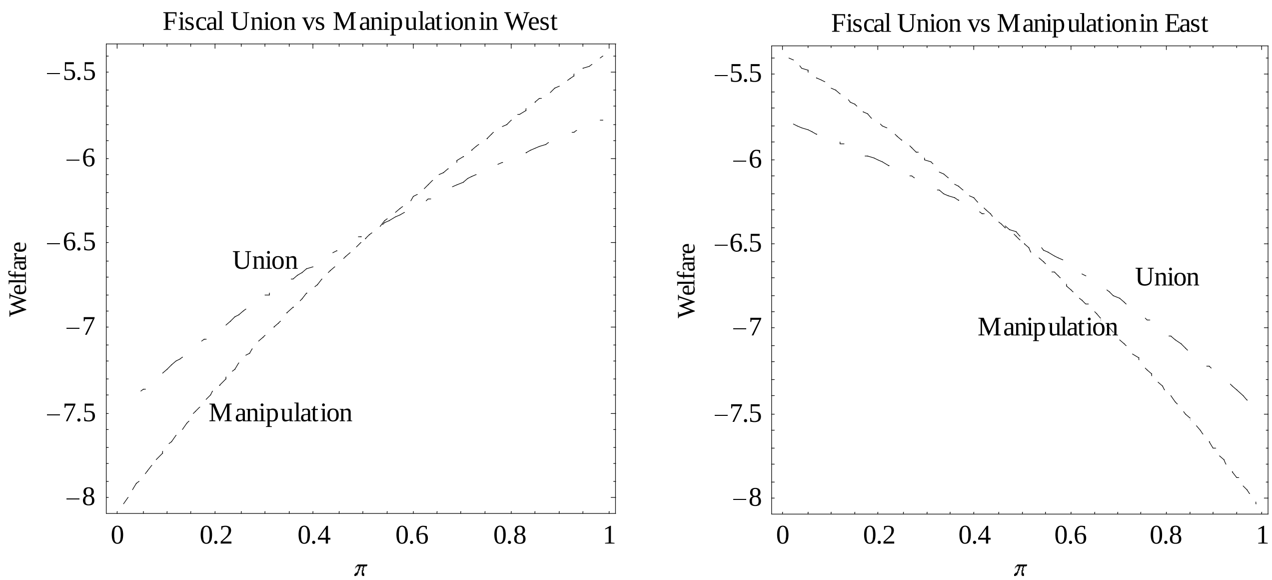

Figure 7: Expected welfare in West and East in fiscal union and in decentralized case.