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ABSTRACT

Fiscal Union Consensus Design under the Risk of Autarky*

Inspired by the current debate over the future of the monetary union in Europe, this paper provides a simple model for the determination of the conditions of survival of the common good, which requires the creation of an effective fiscal union. We highlight the importance of institutional design and varying decision weights for the enlargement of the space for consensus. Our model deepens the discussion of economic risk and political risk in fiscal federalism, and highlights the related roles of country heterogeneity and institutional design in enlarging the scope for cross country fiscal agreements.

JEL Classification: D70, D78, E62, F15 and H77
Keywords: autarky, consensus, fiscal union, heterogeneous countries, uncertainty and voting weights

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1 Introduction

"(...) extraordinary events could occur that would force joint co-ordination of fiscal policies. Then the Greek crisis arrived" (Romano Prodi, Former President of the European Commission, May 2010);

"If you want to create a federal organisation, you must be ready to have a certain amount of redistribution within it. (...) But strong and weaker states both have their responsibility" (Wolfgang Schäuble, Germany's Federal Minister of Finance, May 2010);

"There are just two outcomes for the eurozone, according to some investors: break-up or greater fiscal integration. As monetary union stands at a crossroads in its gravest crisis since it was launched 11 years ago, the first option is deemed unthinkable. So attention is now turning to the second. At a meeting of European finance ministers this week, it was agreed that improved co-ordination of national budgets and stricter monitoring of high-debt countries are essential for the single currencys survival. Many see that as a symbolic first step to greater fiscal union " (David Oakley, May 2010).

The European Union is the longest lived institutional agreement between heterogeneous countries. Until recently it was also seen as the most successful. The current crisis, as countries bound by a common currency face large shocks, suggests the importance of the missing next step: a common fiscal policy may be essential to sustain the benefits of a common currency. However, different countries seem to favour different policy options: while some countries are inclined towards a common fiscal policy accompanied by transfers towards ailing countries, other countries ponder abandoning the currency union altogether and revert to autarky. Motivated by the current debate in Europe, this paper provides a theoretical model aiming to identify some important determinants of the probability of obtaining the necessary consensus for a fiscal union, and aiming to highlight in particular the role of heterogeneity in income per capita and population size, both in terms of positive analysis of country preferences and in terms of normative analysis of the type of reallocations of

decision power that would make a fiscal union consensus feasible.

We start with a set of M countries heterogeneous in income per capita and in population size, subject to different income shocks, who have agreed to provide a public good. At some later stage, the volatility of income shocks increases, so that country preferences regarding participation in the union change.[1] We focus on the interesting scenario where, after the increase in uncertainty, there is no consensus in favour of adding the fiscal union dimension. Instead, some countries would rather revert to autarky and altogether abandon the common good. In fact, we show that some countries may favour deepening the union and adding a fiscal dimension but, if that is not possible, would rather revert to autarky.[2] Furthermore, we show how the addition of institutional design and the change of decision weights can, under some conditions, re-establish consensus on the desirability of a fiscal union, relying also on the tradition of constitutional design exemplified by Buchanan and Tullock (1967) and Curtis (1972).

Our work shares some similarities with Casella (1992b), in that we also study the feasible distribution of power compatible with the formation of a union by countries heterogeneous in size. She shows that the possibility to abandon the union, combined with the strategic interactions among the member countries, must set boundaries on the feasible distribution of powers. In our model the countries with higher weight in the union must be those that are proner to make fiscal transfers after the realization of significant shocks, and this introduction of an explicit relationship between an existing monetary union and the possibility of a fiscal dimension generates opposite results: while in the absence of fiscal policy insurance the feasibility of a currency union may require violating proportionality of power in favor of smaller countries, the opposite is true in our setting.

We enlarge the scope of the existing discussion on fiscal federalism in the literature in

[1] de Grauwe (2011) documents a substantial increase in the standard deviation of the yearly relative unit labor costs in the Eurozone, from a level of around 6 in 2000 to a level over 10 in 2010. We can interpret this as evidence of a shift in volatility to which the economies in the monetary union are subject.

[2] See Persson et al. (1997) for a discussion of different preferences over deepening of European policy-making in diverse policy areas. See Casella (1992a, 2001), Alesina and Spolaore (1997), and Bolton and Roland (1997) for different formalizations of the main issues at stake, and Ruta (2005) for a survey.

two directions. First, our set-up allows for heterogeneous countries - or jurisdictions – both in terms of size and in terms of income per capita. Both relative size and relative income are central to the choice over a common fiscal policy and the proportional representation rights. To our surprise, the economics literature has thus far relied almost universally on jurisdictions of equal size or equal income per capita, emphasizing rather the co-movement of output fluctuations.[3] Interestingly, the relevance of heterogeneity in relative incomes and population sizes was evident to the founding fathers, in the debate leading to the drafting of the US federal constitution. As Alexander Hamilton puts it in 1787: "Let Virginia be contrasted with North Carolina, Pennsylvania with Connecticut, or Maryland with New Jersey, and we shall be convinced that the respective abilities of those States, in relation to revenue, bear little or no analogy to their comparative stock in lands or to their comparative population."

The second shortcoming of the literature on fiscal federalism is the absence of an explicit discussion of the relation between voting arrangements on the one hand and the decision between embarking on a joint fiscal policy and abandoning the common good on the other.[4] As put forward by de Grauwe (2010), "it can be said that the government debt crisis in the eurozone is the result of a failure of economic governance". In line with this, Persson et al. (1997) suggest that a transfer of fiscal responsabilities to the European Union without "appropriate political institutions" would be a divisive move and would create a "political barrier" between countries that feel "in" or "out" as to the major decisions. In other words, there would naturally be calls for a revision of the political weights of the different countries involved. Such a debate was also present in the drafting of the US constitution. In the

[3] A careful analysis of the debate on Turkish accession to the European Union, reveals how the two salient economic issues are Turkey's relative size and income per capita. In sharp contrast, the accession of small countries such as Malta or Cyprus, or the relatively rich Scandinavian countries, were non-issues.

[4] The voting weights in collective decision making are always a central part of treaties (see e.g. the Nice Treaty, the Lisbon Treaty, etc. See Felsenthal and Machover (2001) and references therein). The issue of the weights ascribed to countries of differing size and economic conditions is however never explicitly related to the implications of such weights for important *deepening* steps like that of fiscal unification. In contrast, one can find work on voting weights reallocations for the prospect of *widening* of the Union, see e.g. Sutter (2000) and Barsan-Pipu and Tache (2009).

Federalist papers, James Madison highlights the importance of finding appropriate political weights for small and large states, which are neither equal weights nor simple proportional weights. As Madison puts it in 1788: "To the difficulties already mentioned may be added the interfering *pretensions of the larger and smaller States*. We cannot err in supposing that the former would contend for a participation in the government, fully proportioned to their superior wealth and importance; and that the latter would not be less tenacious of the equality at present enjoyed by them. We may well suppose that neither side would entirely yield to the other, and consequently that the struggle could be terminated only by compromise. It is extremely probable, also, that *after the ratio of representation had been adjusted*, this very *compromise* must have produced a fresh struggle between the same parties, to give such a turn to the organization of the government, and to the distribution of its powers, as would increase the importance of the branches, in forming which they had respectively obtained the greatest share of influence."[5]

The pioneering work of Gordon (1983) presented a now classic argument highlighting the insurance benefits of a common fiscal policy.[6] The ensuing literature concentrated on the possible negative co-movement of output across jurisdictions, as it created incentives to share a fiscal policy.[7] Acquiring access to a more stable tax base became the lynchpin of

[5] Madison (1788) goes on to amaze that " (...) the convention should have been forced into some deviations from that artificial structure and regular symmetry which an abstract view of the subject might lead an ingenious theorist to bestow on a Constitution planned in his closet or in his imagination? The real wonder is that so many difficulties should have been surmounted, and surmounted with a unanimity almost as unprecedented as it must have been unexpected". In today's words, the emergence of unanimity once the appropriate "ratios of representation" have been agreed to.

[6] Shiller (1993) presented an empirical study of risk hedging possibilities across countries. Fidrmuc (2004) studied the effects of shocks correlation and persistence on the optimality of fiscal unions. Celentani, Conde-Ruiz and Desmet (2004) show how a set of decentralized fiscal entities ("autarky" in our terminology) leads to inefficient risk sharing even if countries have access to a sequentially complete financial structure of assets. These authors point out that the creation of a fiscal union can recover the efficiency of risk sharing. Thus, they argue, a fiscal union plays an important role and is necessary even if countries have access to complete markets. This issue has recently arisen in the current discussion of the benefits of the European Union issuing Euro bonds.

[7] See for instance, Bolton and Roland (1997) and Alesina and Spolaore (1997) for pure interregional redistributive models where the threat of secession by the rich imposes a binding constraint on federal fiscal policy. See also Persson and Tabellini (1996a) for an investigation of the trade-off between risk sharing and redistribution when jurisdictions are asymmetric as far as aggregate risk parameters are concerned. In a companion paper, Person and Tabellini (1996b), the authors have focused on the trade-off between interregional risk sharing and the presence of moral hazard in local government behaviour.

the discussion on fiscal unions. Alesina and Perotti (1998) have labelled such an incentive "economic risk", but have then raised the possibility that a reduction in the volatility of the tax base, which decreases economic risk, might be associated with higher volatility of the tax rate for a given allocation of decision power. The latter might actually raise what the authors call "political risk", discouraging the establishment of a common fiscal policy. The mechanism is simple: faced with non-synchronous fluctuations in output over time, countries or regions decrease economic risk by sharing budgetary decisions and stabilizing the tax base; however, the non-synchronous shocks may lead the larger country – which holds decision power - to respond to a negative shock by imposing a higher tax rate on the union. In sum, in fiscal unions with heterogeneous jurisdictions, economic insurance and political risk may be part of the same bundle. Relative to the traditional literature, the model in Alesina and Perotti (1998) reduces the range of parameters for which a fiscal union is desired. Even with shocks that are negatively and perfectly correlated, the country with less decision power may want to avoid the fiscal union.

Our model examines how the allocation of voting power across jurisdictions interacts with heterogeneity in population size and in income per capita to determine the likelihood of unanimous adhesion to a fiscal union. We incorporate economic and political fundamentals and show that there are allocations of voting rights that enlarge the set of parameters for which fiscal unions are formed. In a sense, we enlarge the parameter set so that Gordon (1983) and Alesina and Perotti (1998) can be seen as particular cases of a broader discussion.

Section 2 presents the model set-up. Section 3 examines country preferences for each of three possible alternatives: the status quo with provision of a joint public good, a system with an additional fiscal union, and autarky. Section 4 characterizes the bargaining space. Section 5 simulates how proportional proposal rights enlarge the feasibility set and may support a common fiscal policy, for different parameter sets as far as the correlation among shocks and asymmetries between countries. Section 6 concludes.

2 Model

2.1 Country incomes, sizes and shocks

Let us consider a set of M countries - or, more generally, jurisdictions- with fixed frontiers. Countries may differ in terms of population size and average income. We denote country i's pre-tax income per capita by $Y_i \in R_+$. Assume, for simplicity, that all individuals in country i have the same income, excluding therefore the standard issues related to internal redistribution.[8] Country i's population is denoted by $N_i \in R_+$. Total population is therefore $N = \sum_{i=1}^{M} N_i$. The relative population size of country i in the union is $n_i = N_i/N$ with $n_i \neq 0$. Migration issues among countries are absent here.

We consider two dates, date 0 and date 1. At date 1, all countries are subject to idiosyncratic random productivity shocks that change their income levels. For each country i, the random productivity shock ε_i follows a discrete distribution[9] and can take two possible values, $\bar{\varepsilon}_i \in [0, 1)$ and $-\bar{\varepsilon}_i$.[10] Shocks are interpreted as medium-term shocks to productivity. Country i's after shock income per capita is denoted by $X_i = Y_i(1 + \varepsilon_i)$. The triplet shock-income-size $(\varepsilon_i, Y_i, N_i) \in \{\bar{\varepsilon}_i, -\bar{\varepsilon}_i\} \times R_+ \times R_+$ characterizes country i's type.

Let $\varepsilon = (\varepsilon_1, ..., \varepsilon_M)$ denote a vector of shocks for this economy. For any pair of countries (i, j) with shocks $(\varepsilon_i, \varepsilon_j)$, there are four possible realizations $(\bar{\varepsilon}_i, \bar{\varepsilon}_j)$, $(-\bar{\varepsilon}_i, -\bar{\varepsilon}_j)$, $(\bar{\varepsilon}_i, -\bar{\varepsilon}_j)$ and $(-\bar{\varepsilon}_i, \bar{\varepsilon}_j)$. We assume that, for any pair of countries, asymmetric shocks, $(\bar{\varepsilon}_i, -\bar{\varepsilon}_j)$ and $(-\bar{\varepsilon}_i, \bar{\varepsilon}_j)$, occur with the same probability, denoted as $q^a_{ij} \equiv \Pr(\bar{\varepsilon}_i, -\bar{\varepsilon}_j) = \Pr(-\bar{\varepsilon}_i, \bar{\varepsilon}_j)$. Likewise for symmetric shocks, $(\bar{\varepsilon}_i, \bar{\varepsilon}_j)$ and $(-\bar{\varepsilon}_i, -\bar{\varepsilon}_j)$, which occur with probability $q^s_{ij} \equiv$

[8] As pointed out in the Introduction, the purpose of the current study is to analyze the "country incentives" to add a fiscal union dimension to an existing set of international institutions, whereas the "class incentives" in countries with heterogeneous internal income levels have been studied, e.g. by Casella (2001), Person and Tabellini (1996a,b), Barberà and Jackson (2006) and Morelli et al (2011) and references therein. There is basically a feasibility trade-off: when allowing for internal heterogeneous incomes it is difficult to allow for asymmetric population sizes and country incomes in the analysis of strategic institutional choice. In this paper the elimination of internal heterogeneities allows us to introduce the relevant heterogeneities across countries.

[9] Similar results and figures are obtained when using a continuous distribution, such as the multivariate normal. However, in the latter case, closed form solutions cannot be obtained.

[10] We require after shock income to be non-negative and so take the lower bound of ε_i to be -1. By simmetry we take the upper bound of ε_i to be 1.

$\Pr(\bar{\varepsilon}_i, \bar{\varepsilon}_j) = \Pr(-\bar{\varepsilon}_i, -\bar{\varepsilon}_j)$. Clearly, we must have that $q_{ij}^a + q_{ij}^s = 1/2$. Consider $\Pr(\varepsilon)$, one of the possible M-dimension distributions that is consistent with the two-dimensional distributions proposed for all pairs.[11] We denote by $\mathbf{C}$ the space of symmetric matrices $[\rho_{ij}]_{M\times M}$ of pair-wise correlation coefficients with generic element ρ_{ij}.

We assume that only one private good exists, whose price is normalized to one. All disposable income is thus spent on the consumption of this good.

2.2 Regimes

At date 0, the status quo has all countries benefiting from being part of a common agreement where they share the benefits of a public good - such as a common currency-, but deciding fiscal policies at the country level. In Section 3 below we characterize the parameter region where all countries indeed choose the status quo. The public good - for instance, a common currency- is associated with a scalar $g > 1$ that affects country income. The absence of the public good corresponds to $g = 1$. We start from a status-quo where the public good is present - such as the common currency in the European Union - and then work out the conditions under which the public good is kept or abandoned.

The utility of the representative agent is logarithmic and increases in the consumption of the private good X_i and public good g.

$$V_i^{SQ} = \ln(gX_i) \tag{1}$$

In this functional form (1), the public good re-scales after-shock income, thus amplifying income fluctuations.[12] We denote by σ_i^g the standard deviation of shocks in the presence of public good g, with $\sigma_i^g < 1$.

[11] Notice that there are many M-dimensional distributions consistent with a single set of two-dimensional distributions. See Stoyanov (1996, p. 53) for examples showing that pairwise independence does not imply joint independence.

[12] Think of southern European countries which suffer a productivity shock and, given their membership of a common currency area, have no possibility of using devaluation to smooth the shock.

At time 0, there is a change in fundamentals so that one or more σ_i change and some countries want to revise the common regime. There are three options to choose from. Either all countries agree to remain in the status quo (the benchmark case); or all countries agree to add a common fiscal policy dimension; or they revert to autarky, the situation where countries do not share the benefits of the public good nor adopt a common fiscal policy. The three alternative institutional structures that need to be compared are:

(A) Reversion to autarky (A), which means abandoning the benefits of the public good, say the common currency. The absence of such public good determines a lower variance of after-shock disposable incomes. In the common currency interpretation, this lower shock variance is due to the (unmodeled) possibilities of local adjustments determined by independent monetary policy instruments. The notation for the standard deviation of shocks in this case is σ_i^A (so $\sigma_i^A < \sigma_i^g < 1$). The country i representative agent's utility of consumption in autarky is given by

$$V_i^A = \ln X_i \tag{2}$$

(SQ) Remaining in the "status quo" (SQ), characterized by the same functional form as (1), with a shock standard deviation σ_i^g, with $\sigma_i^A < \sigma_i^g < 1$.

(U) Adding a fiscal union to the status quo (common currency). In this case countries will jointly decide the tax rate of a linear tax system immediately after the unanimous decision to form the fiscal union, so that taxation acts as a form of insurance before the realization of shocks at date 1. Given that the public good benefit is present in both the fiscal union and the status quo alternatives, we assume that the shock standard deviations in both regimes are the same, i.e., $\sigma_i^U = \sigma_i^g$.

For the fiscal union to be formed, all countries must agree. On the other hand, a change from SQ to A can be done by each country independently, and this presumably should affect

the value of g for the remaining countries. Since we start from a situation where the M countries were voluntarily members of the common currency area or monetary union (see next section), we consistently exclude the possibility of individual deviations to autarky at time 0. One way to maintain symmetry between the potential reforms is to assume that the M original countries are all *necessary* for the (monetary) union to work, so that an individual deviation would directly imply the immediate collapse of the common currency and reversion to state A with $g = 1$.[13]

Let $y = \sum_{i=1}^{M} n_i Y_i$ denote the average income per capita in the fiscal union, before shocks are realized. Let $x = \sum_{i=1}^{M} n_i X_i$ denote the pre-tax, after-shock average income of the fiscal union. The utility of an individual in country i in the fiscal union is

$$V_i^U(T) = \ln g \left((1-T)X_i + (T - \frac{1}{2}T^2)x \right) \tag{3}$$

where T denotes the tax rate that is chosen in the union. The term $(1-T)X_i$ is the after-tax income after the shock is realized and the common tax is imposed. The term $(T - \frac{1}{2}T^2)x$ corresponds to the amount received after tax rebates, which depends on the average income x in the fiscal union, as well as on the deadweight loss $(-\frac{1}{2}T^2)$ generated by the tax system.[14]

2.3 Preferred tax rate in the fiscal union

To determine the benefit of the alternative U, we first need to compute the preferred tax rate of each country in the fiscal union. Let us take the first order condition of $V_i^U(T)$ with respect to T. Country i's preferred tax rate is given by

$$T_i(\varepsilon) = \begin{cases} 1 - \frac{X_i}{x} & \text{if } X_i < x \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

[13] This corresponds for example to the pure collective action case analyzed in Maggi and Morelli (2006).

[14] The quadratic deadweight loss prevents the poor individual from imposing a tax rate that fully expropriates the rich. This is a standard assumption in the literature.

The lower the country i's after shock income relative to the average income, the higher its preferred tax rate in the fiscal union. Observe that the term X_i/x makes the preferred tax rate for a given country to depend on the income and population of all other countries in the union. Figure 2.1 plots the preferred tax rate T_i for a generic country i in a two-country fiscal union composed by countries i and j. T_i is a function of both the relative income Y_i/Y_j and relative country size N_i/N_j. In this graph the shocks are assumed to be $(\varepsilon_i, \varepsilon_j) = (-0.2, 0.2)$. Axes Y_i/Y_j and N_i/N_j are measured in a logarithmic scale.[15]

[Figure 2.1 about here]

Lemma 2.1: *Country i's desired tax rate is (weakly) decreasing in its relative size and income.*

Proof: See the Appendix.

2.4 Reversals

A *state* $\omega = (C, (Y_i, N_i)_{i=1,...,M})$ is a vector of shock correlations and country incomes and sizes. The state space is denoted by $\mathbf{\Omega} = \mathbf{C} \times \mathbb{R}_+^M \times \mathbb{R}_+^M$. We say that, given $\omega \in \mathbf{\Omega}$, there is *possibility of reversal* for a country i if there exists a vector of shocks $\varepsilon = (\varepsilon_i)_{i=1}^M$ such that $Y_i > y$ and $X_i < x$. In other words, a pre-shock "rich country" becomes a "poor country" after the shock, when compared to the average income.[16] A high probability of no reversal can be due either to the small size of the shocks, given the differences in pre-shock incomes, or to a high correlation coefficient among country shocks.

Figure 2.2 portrays the income per capita for a selection of countries - Belgium, Germany, France, Italy, Netherlands, Ireland, U.K.- , and the period 1970 to 2009. We also

[15] A log scale makes the distance between two points b/a and a/b equal. For example, the distance between point 1/2 (where country i has half income than country j) and 2/1 (where country i has double income than country j) is the same since $log(2/1) = -log(1/2)$. Observe that point 0 in the Y_i/Y_j axis represents the case where both countries have the same income.

[16] In the basic two country case, this just means that the countries switch positions in terms of relative income.

report average EU income per capita, which was naturally affected by several EU enlargements. Each accession can be interpreted as as a shock to the union, changing EU average income and size. The curve EU-GDP is adjusted to these accessions. Accessions may lead to reversals. We can observe that reversals between pairs of countries with similar incomes are very frequent (see Belgium, France, Germany, Netherlands, U.K. and Denmark). However, reversals with respect to the EU income average are less frequent: they occur in Belgium (1973, 1977, 1979), Germany (1974), Finland (1995), Ireland (1997), and Italy (2007). de Grauwe (2010) documents how country relative unit labor costs, an indicator of competitiveness, suffer frequent reversals in a ten year period leading to up to 2010. If we take these as indicators of future income per capita, this evidence is supportive of our view that there is a great scope for income reversals in the medium run.

[Insert Figure 2.2 about here]

2.5 Date 0 expected utilities

At date 0 countries face the uncertainty of shock realizations at date 1. This is particularly important for the fiscal union regime, since we assume that the decision of joining the fiscal union occurs at date 0, *before* shocks are realized. Thus, countries' utilities must be written in expectation. We find that:

Lemma 2.2: *Country i's expected utility in SQ is*

$$E[V_i^{SQ}(\varepsilon_i)] = \ln g + \ln Y_i + \frac{1}{2}\ln(1-\sigma_i^2) \tag{5}$$

Proof: See the Appendix.

Lemma 2.3: *Country i's expected utility in A is*

$$E[V_i^{A}(\varepsilon_i)] = \ln Y_i + \frac{1}{2}\ln(1-(\sigma_i^A)^2) \tag{6}$$

Proof of Lemma 2.3: Similar procedure to Proof of Lemma 2.2. Notice that the function (5) is now, by assumption, evaluated at σ_i^A (a constant). ■

By substituting the desired tax rate (4) into country i's utility in the fiscal union regime (3), we find the country i's expected utility in the fiscal union, for the cases when country i decides and country j decides the tax rate, which are, respectively,

$$E[V_i^U(T_i(\varepsilon))] = \sum_{\varepsilon \in \{\bar{\varepsilon}_i, -\bar{\varepsilon}_i\}^M} \Pr(\varepsilon) \left(\ln g \left(\frac{2X_i + x^2 - X_i^2}{2x} \right) \right) \tag{7}$$

$$E[V_i^U(T_j(\varepsilon))] = \sum_{\varepsilon \in \{\bar{\varepsilon}_i, -\bar{\varepsilon}_i\}^M} \Pr(\varepsilon) \left(\ln g \left(\frac{2X_iX_j + x^2 - X_j^2}{2x} \right) \right) \tag{8}$$

By altering relative income and relative country size, we illustrate how functions (7) and (8) change, for given (6). Figures 2.3 and 2.4 consider the case with two countries, i and j, using the probabilities for the realization of shocks to derive the relevant moments. It can be shown that $E(\varepsilon_i) = 0$, $\sigma_i = \bar{\varepsilon}_i$ and $\rho_{ij} = 1 - 4q_{ij}^A$ (see Lemma A.1 in the Appendix). In Figures 2.3 and 2.4 we take $\sigma_i^A = \sigma_j^A = 0.6$, $\sigma_i^g = \sigma_j^g = 0.815$, $\rho = -0.5$ and $g = 1.4$.

[Figures 2.3 and 2.4 about here]

Figure 2.3 depicts (7), (8) and (6) as a function of relative incomes, for equal country sizes.[17] We observe that, when country i decides on the tax rate, its expected utility $E[V_i^U(T_i(\varepsilon))]$ is always above its expected utility in autarky, $E[V_i^A(\varepsilon_i)]$. As Y_i/Y_j increases, the benefit from deciding on the tax rate, $E[V_i^U(T_i(\varepsilon))] - E[V_i^A(\varepsilon_i)]$, decreases and converges to a positive constant value ($E[V_i^U(T_i(\varepsilon))]$, which converges to $E[V_i^{SQ}(\varepsilon_i)]$, which is above $E[V_i^A(\varepsilon_i)]$). In this figure we can also see that, as we move to the left in the x-axis and country i becomes poorer, $E[V_i^U(T_j(\varepsilon))]$ converges to $E[V_i^A(\varepsilon_i)]$. Roughly speaking, the fact that j is deciding the tax rate becomes irrelevant as i becomes very poor. Consequently, the expected utility of country i approaches that of autarky.

[17] Notice that the graphs take into account that the tax rate is that chosen by the country which has decision power.

Figure 2.4 shows how $E[V_i^U(T_i(\varepsilon))]$ and $E[V_i^U(T_j(\varepsilon))]$ change as countries' relative sizes N_i/N_j change, for equal country incomes. In this graph we can observe how $E[V_i^U(T_i(\varepsilon))]$ is decreasing in N_i/N_j and above $E[V_i^A(\varepsilon_i)]$. When country i is substantially smaller than country j, the tax base of the union is almost entirely composed of country j's income. In that case, country i chooses to charge a high tax, raising its expected utility well above that of autarky. As country i relative size increases, its income becomes a larger fraction of the tax base of the union, and country i chooses a low tax rate. As a consequence, the expected utility of country i in the union approaches its autarky level.

In Figure 2.4 we also verify that the curve $E[V_i^U(T_j(\varepsilon))]$ is always below $E[V_i^A(\varepsilon_i)]$, as expected given that, in the latter case, i is not deciding. $E[V_i^U(T_j(\varepsilon))]$ decreases from $n_i = 0$ (and i is very small), to $n_i = 1/2$. This is due to the initial effect of a higher tax rate T_j (as x is increasing when n_i increases and $X_i > X_j$). For $n_i > 1/2$ the curve starts to smoothly increase, given that the tax base increases ($x \to X_i$), converging to some horizontal asymptote (as $T_j \to 1 - X_j/X_i$ when $n_i \to \infty$).

2.6 Proportional compromise

We assume that the formation of the fiscal union requires unanimity. Once the union is formed, the tax rate is chosen according to a proportional compromise. In a *collective decision policy* by *proportional compromise* what matters is the "*weight*" p_i that each country i has in such a system. A proportional compromise can correspond then to the weighted average of the preferred tax rates of the various countries. Equivalently, one could interpret a weight as the probability with which a country is assigned decision power on the tax rate. Formally, we prefer this second interpretation. The weights must obviously satisfy $p_i \in [0, 1]$ for all i, and $\sum_{i=1}^{M} p_i = 1$. In the instances where country i does not decide, which occurs with probability $1 - p_i$, the other $M - 1$ countries will decide given some weights, which we denote by $(p'_{ij})_{j \neq i}$, such that $\sum_{j \neq i} p'_{ij} = 1$.[18] Observe that $p_j = (1 - p_i)p'_{ij}$. We

[18] Here, p'_{ij} denotes the weight with which country j chooses the tax rate when country i does not choose it.

thus have that $p_i + (1 - p_i)(\sum_{j \neq i} p'_{ij}) = 1$. For a given system $(p_1, ..., p_M)$ of proportional weights, expected utility in a fiscal union under such weights system is given by

$$E[V_i^U(\varepsilon)] = p_i E[V_i^U(T_i(\varepsilon))] + \sum_{j \neq i} p_j E[V_i^U(T_j(\varepsilon))] \tag{9}$$

3 Choice over regimes: status quo, fiscal union or autarky

Let us consider a situation at date 0 when, after some initial period where all countries agreed to share a public good such as a common currency, these countries experience an episode of higher uncertainty in their shocks, that is, σ_i^g jumps for some i.[19] At this point, countries face the choice between abandoning the status quo and reverting to autarky, or adding the fiscal policy dimension to the union with "appropriate" distribution of voting weights. Below we give a numerical example that illustrates this message. We now characterize in a formal way the possible regimes.

Let us define at date 0, for each country i, three thresholds: $\hat{\sigma}_i$, denoting the volatility of shocks that makes country i indifferent between the status quo and the fiscal union; $\tilde{\sigma}_i$, at which country i is indifferent between status quo and autarky; and $\bar{\sigma}$, which makes country i indifferent between fiscal union and autarky.[20] Since countries are heterogenous they may have different thresholds for σ_i. Figure 3.1 illustrates the three thresholds for a country i in a two country economy. For simplicity, we assume same income and size for both countries. We compute the function $E[V_i^U(\varepsilon)]$, for each country, assuming the same voting weights, that is, $p_i = p_j = 1/2$.

[Figure 3.1 about here]

[19] We can think of the recent crisis in the European Union as resulting from a rise in uncertainty revealed by the large asymmetric and negative shocks experienced by several countries within Euro.

[20] Respectively, the thresholds can be formally defined as $\hat{\sigma}_i = \{\sigma_i : E[V_i^{SQ}] = E[V_i^U(T(\varepsilon))]\}$, $\tilde{\sigma}_i = \{\sigma_i : E[V_i^{SQ}] = E[V_i^A]\}$ and $\bar{\sigma}_i = \{\sigma_i : E[V_i^U(T(\varepsilon)] = E[V_i^A]\}$. Furthermore, we can obtain the following closed solution for $\tilde{\sigma}_i$, by making $E[V_i^{SQ}] = E[V_i^A]$ (using expressions (6) and (5)): $\tilde{\sigma}_i = \sqrt{1 - (1 - (\sigma_i^A)^2)/g^2}$.

We want $\hat{\sigma}_i$, $\tilde{\sigma}_i$ and $\bar{\sigma}_i$ to be uniquely defined. The expected utility in autarky is given by (6), which is a horizontal straight line for all σ_i. On the other hand, country i's expected utility in status quo, given by (5), is decreasing and concave in σ_i (see Lemma A.2 in the Appendix). These two facts guarantee that $\tilde{\sigma}_i$, at which country i is indifferent between status quo and autarky, is uniquely defined. In order to have $\hat{\sigma}_i$ and $\bar{\sigma}_i$ also uniquely defined, we need the single crossing property to hold between, respectively, functions (9) and (5), and (9) and (6). This occurs when $\frac{dE[V_i^U(\varepsilon)]}{d\sigma_i} < 0$ and $\frac{d^2E[V_i^{SQ}(\varepsilon_i)]}{d(\sigma_i)^2} < \frac{d^2E[V_i^U(\varepsilon)]}{d(\sigma_i)^2} < 0$, for all $\sigma_i \in [0, 1)$.

Proposition 3.1: *For a set of realizations* $(\varepsilon_i, Y_i, N_i)_{i\in\mathbf{I}}$, $\hat{\sigma}_i$, $\tilde{\sigma}_i$ *and* $\bar{\sigma}_i$ *exist and can be represented as in Figure 3.1 so that, for each country* i *subject to shocks* σ_i*:*

a) *the thresholds* $\hat{\sigma}_i$, $\tilde{\sigma}_i$ *and* $\bar{\sigma}_i$ *can be ordered so that* $\hat{\sigma}_i < \tilde{\sigma}_i < \bar{\sigma}_i$.

b) *if* $\sigma_i < \hat{\sigma}_i$, *the status quo is preferred to the fiscal union, which in turn is preferred to autarky. Formally,* $E[V_i^{SQ}(\varepsilon_i)] > E[V_i^U(\varepsilon)] > E[V_i^A(\varepsilon_i)]$.

c) *if* $\hat{\sigma}_i < \sigma_i < \tilde{\sigma}_i$, *the fiscal union is preferred to the status quo, which in turn is preferred to autarky. Formally,* $E[V_i^U(\varepsilon)] > E[V_i^{SQ}(\varepsilon_i)] > E[V_i^A(\varepsilon_i)]$.

d) *if* $\tilde{\sigma}_i < \sigma_i < \bar{\sigma}_i$, *the fiscal union is preferred to autarky, which in turn is preferred to the status quo. Formally,* $E[V_i^U(\varepsilon)] > E[V_i^A(\varepsilon_i)] > E[V_i^{SQ}(\varepsilon_i)]$.

e) *if* $\bar{\sigma}_i < \sigma_i < 1$, *autarky is preferred to the fiscal union, which in turn is preferred to the status quo. Formally,* $E[V_i^A(\varepsilon_i)] > E[V_i^U(\varepsilon)] > E[V_i^{SQ}(\varepsilon_i)]$.

Recall that our analysis relies on two assumptions. On the one hand, for the fiscal union to form, unanimity is required. On the other, if one country decides to go into autarky, the common good can no longer be provided.

As pointed out above, initially all countries agree to share a public good, that is, $\sigma_i^g < \hat{\sigma}_i$ for all i. We then consider a change in some of the σ_i^g that makes at least one of the countries have $\sigma_i^g > \hat{\sigma}_i$. Now, given $(\varepsilon_i, Y_i, N_i)$ and the new σ_i^g, for all i, we can characterize four different relevant regions as far as the distribution of country preferences over regimes is concerned.

Region 1 All countries have $\sigma_i^g < \tilde{\sigma}_i$ and there is at least one country i with $\sigma_i^g \in (\hat{\sigma}^i, \tilde{\sigma}^i)$ and a country k with $\sigma_i^g < \hat{\sigma}^i$. In this case, at least one country prefers a fiscal union, but there is no unanimity in support of that move. Since all countries prefer status quo to autarky, the regime remains in status quo. Notice that, if sufficient countries are in region $\sigma_i^g \in (\hat{\sigma}^i, \tilde{\sigma}^i)$, where they prefer fiscal union to the status quo, it may be in their interest to compensate countries with $\sigma_i^g < \hat{\sigma}^i$ through economic and political incentives, and make them approve the creation of the fiscal union.

Region 2 All countries have $\sigma_i^g \in (\ \hat{\sigma}_i,\ \bar{\sigma}_i)$. In this case the fiscal union is formed since there is unanimity. Notice that even if all countries have $\sigma_i^g \in (\ \tilde{\sigma}_i,\ \bar{\sigma}_i)$, so that all prefer autarky to the status quo, they unanimously prefer the fiscal union.

Region 3 There is at least one country i with $\sigma_i^g < \hat{\sigma}_i$ and another country k with $\sigma_k^g \in (\tilde{\sigma}_k,$ $\bar{\sigma}_k)$. If this happens, country i prefers to remain in status quo, country k while prefering to move to the fiscal union, will revert to autarky since no unanimity is attained. Similarly to region 1 above, if enough countries have $\sigma_i^g \in (\hat{\sigma}^i, \bar{\sigma}^i)$, they could use economic and political incentives to convince countries with $\sigma_i^g < \hat{\sigma}^i$ to vote in favor of the fiscal union.

Region 4 Finally, there is at least one country with $\sigma_i^g > \bar{\sigma}^i$, prefering autarky to both status quo and fiscal union. Again, by a similar argument as above, if there are sufficiently many countries with $\sigma_i^g \in (\hat{\sigma}^i, \bar{\sigma}^i)$, they can compensate countries with $\sigma_i^g > \bar{\sigma}^i$ (and eventually those countries with $\sigma_i^g < \hat{\sigma}_i$), through economic and political incentives, and make them prefer the creation of the fiscal union.

In regions 3 and 4 an interesting tradeoff arises. Countries in favor of a fiscal union may want to use economic and political incentives to induce countries that prefer autarky to vote in favor of fiscal union. Given our assumptions, this is a case where they either are able to move to fiscal union or to revert to autarky.

Let us illustrate this trade-off with a simple numerical example with three countries, C1, C2 and C3. For simplicity we assume that all countries have the same volatility, σ^g, but individual thresholds are different. These are $\hat{\sigma}_1 = 0.6$, $\hat{\sigma}_2 = 0.35$, $\hat{\sigma}_3 = 0.1$, $\tilde{\sigma}_1 = 0.8$, $\tilde{\sigma}_2 = 0.7$ and $\tilde{\sigma}_3 = 0.45$. Now, consider the situations before and after bad news arrive and volatility σ^g increases. Table 3.1 portrays the two moments.[21]

Before	$U \succ SQ$	$SQ \succ A$
C1	NO	YES
C2	NO	YES
C3	NO	YES

After	$U \succ SQ$	$SQ \succ A$
C1	NO	YES
C2	YES	YES
C3	YES	NO

Table 3.1

Before the news, $\sigma^g = 0.05$ and the three countries prefer status quo to both fiscal union and autarky. After the news, with $\sigma^g = 0.5$, the situation changes. Now, country C3 prefers fiscal union to the status quo, but if the former regime is not unanimously supported, country C3 reverts to autarky, and makes status quo collapse. Notice that countries C2 and C3 may be able to convince country C1 to accept the fiscal union, through economic or political incentives. The nature of the institutional design that provides the political incentives to bring C1 to support the fiscal union is the subject of the next section.

4 Institutional design: the bargaining space

As shown in section 3 there are instances (named regions 3 and 4) where an interesting trade-off arises between moving unanimously to fiscal union or reverting to autarky. Institutional design comes into the scene at this point. As mentioned in subsection 2.6, an important mechanism is the adoption of proposal weights, whereby in the fiscal union countries decide the joint tax rate with specific probabilities. These probabilities, $(p_i, (p'_{ij})_{j \neq i})_{i=1}^{M}$,

[21] In these tables, $a \succ b$ denotes alternative a is preferred to alternative b.

must be such that, for all countries, the expected utility in the fiscal union is at least equal to the expected utility in autarky. By choosing the appropiate proposal weights, countries can provide the right incentives to convince other countries to adhere to the fiscal union. We proceed to characterize the bargaining space in which a fiscal union is chosen by unanimity.

Let p_{ij} be the maximum value of p_i, for given $(p'_{ij})_{j\neq i}$, such that country j is at least as well off in the union as in autarky. Then,

$$\bar{p}_{ij} \in \arg\max p_{ij} \quad \text{such that}$$
$$p_{ij}E[V_j^U(T_i(\varepsilon))] + (1-p_{ij})\sum_{s\neq i} p'_{is}E[V_j^U(T_s(\varepsilon))] \geq E[V_j^A] \tag{10}$$

Let us now define by $\bar{p}_i$ the minimum of $\bar{p}_{ij}$, for all $j \neq i$. $\bar{p}_i$ is the maximum value of the proportional proposal right that the union can assign to country i, given $(p'_{ij})_{j\neq i}$, compatible with *all* countries $j \neq i$ being at least as well off in the fiscal union as in autarky. $\bar{p}_i$ equals $\min_j \bar{p}_{ij}$, and is the value of $\bar{p}_{ij}$ associated with the country j that faces the highest shadow value attached to restriction (10).[22] We find that $\bar{p}_i(\omega)$, given $(p'_{ij})_{j\neq i}$, is given by

$$\bar{p}_i(\omega, (p'_{ij})_{j\neq i}) = \min_j \left\{ \frac{E[V_j^A] - \sum_{s\neq i} p'_{is}E[V_j^U(T_s(\varepsilon))]}{E[V_j^U(T_i(\varepsilon))] - \sum_{s\neq i} p'_{is}E[V_j^U(T_s(\varepsilon))]} \right\} \tag{11}$$

We denote by $\underline{p}_i$ the minimum probability with which country i decides, given the vector $(p'_{ij})_{j\neq i}$, that is compatible with the same country i being at least as well off in the union as in autarky. Formally,

$$\underline{p}_i \in \arg\min p_i \text{ such that}$$
$$p_iE[V_i^U(T_i(\varepsilon))] + (1-p_i)\sum_{s\neq i} p'_{is}E[V_i^U(T_s(\varepsilon))] \geq E[V_i^A] \tag{12}$$

[22] Thus, it might be that, at the resulting $\bar{p}_i$, some countries find their constraint (10) not binding.

Using equality in (12), we find that

$$\underline{p}_i(\omega, (p'_{ij})_{j\neq i}) = \frac{E[V_i^A] - \sum_{s\neq i} p'_{is} E[V_i^U(T_s(\varepsilon))]}{E[V_i^U(T_i(\varepsilon))] - \sum_{s\neq i} p'_{is} E[V_i^U(T_s(\varepsilon))]} \tag{13}$$

Also, observe that

Remark 4.1: *If* $\bar{p}_i(\omega, (p'_{ij})_{j\neq i}) - \underline{p}_i(\omega, (p'_{ij})_{j\neq i}) > 0$ *occurs for one country* i*, then all countries agree to form the union, at realization* ω*.*

We denote by $\mathbf{P}_i(\omega, (p'_{ij})_{j\neq i})$ the space of all vectors $(p_i(\omega), (p'_{ij})_{j\neq i})$ such that $p_i \in [\underline{p}_i, \bar{p}_i] \neq \emptyset$. Then, for a given realization ω, the space $\mathbf{P} = \cup_i \mathbf{P}_i$ is non-empty if $\mathbf{P}_i \neq 0$ for at least one country i. Since, in that case, (10) for all j, and (12) are both satisfied (so $\mathbf{P}$ is non-empty), then the union is ex-ante Pareto improving, in the usual sense. On the contrary, if $\mathbf{P}$ is empty, there is no set of assigned proportional proposal rights that satisfy the incentive compatibility constraint for every country.

5 Simulations

With our model we can explore how to set-up voting mechanisms that preserve the benefits of a common good while limiting the political risk of entering a fiscal union with countries with different income and size. We incorporate institutions into the picture, in the form of proportional representation rights. Thus, we bring an element of political insurance where the literature has so far concentrated on economic risk (insurance) alone. Institutional design is at the core of economic unions: it creates new institutions and voting rules that sustain the agreement and preserve the benefits of common economic policies (in our case the public good).

5.1 Correlation of shocks and voting weights

Our analysis extends both Gordon (1983) and Alesina and Perotti (1998) to the whole range of possible ρ and p_i. Gordon (1983) focuses on the classical one-dimensional analysis of the role of negative correlation across shocks. He showed that when $\rho < 0$ a fiscal union is a way to provide economic insurance. The more negative the value of ρ, the higher the benefits of common insurance.[23] Alesina and Perotti (1998) extend Gordon's framework by letting one country, which they assume marginally larger than the other, to always decide on the fiscal instrument.

Figures 4.1 and 4.2 illustrate how the bargaining space between two countries i and j changes when the correlation between country'shocks change. We consider two different scenarios: $N_i = N_j$ and $Y_i = (1/2)Y_j$ (Figure 4.1) and $N_i = N_j$ and $Y_i = Y_j$ (Figure 4.2). In both cases we assume $g = 1.4$. In both figures, the bargaining space is increasing the lower is the correlation coefficient. The bargaining space starts being positive at some $\rho \in [0, 1]$ ($\rho = 0.3$ in Figure 4.1 with heterogeneous incomes, and $\rho = 0.7$ in Figure 4.2 with homogeneous countries). At $\rho = -1$ the fiscal union is sustainable when $p_i \in [0.67, 0.75]$ for Figure 4.1, while for Figure 4.2 the fiscal union is sustainable when $p_i \in [0.45, 0.55]$.

[**Figures 4.1 and 4.2 about here**]

These pictures illustrate the argument in Alesina and Perotti (1998) that "political risk" may overwhelm "economic risk", reversing the result in Gordon (1982), that the more negative correlation between shocks favors the formation of the fiscal union. In our paper, the lower is the correlation between shocks, the larger is the bargaining space. However, we have non-empty bargaining space even with $\rho > 0$.

In the context of Alesina and Perotti (1998), where always the same country decided on the common tax rate ($p_i = 1$), the fiscal union might not be possible due to the implicit

[23] In the same vein of Bolton and Roland (1997) political economy model of integration, Fidrmuc (2004) considers the impact of region-specific shocks in a dynamic setting, and shows that negatively correlated temporary shocks allow greatest gains from inter-regional risk sharing.

political risk, even when $\rho = -1$. However, in contrast to Alesina and Perotti (1998), where institutional design was absent, we see how reassigning voting weights for different shocks correlation scenarios is necessary for the two countries to accept to join the union.

In other words, what these pictures bring to our analysis is that a sensible redistribution of voting powers that decreases the likelihood of country i deciding guarantees ex-ante unanimity in favor of the union. Thus, the addition of the institutional dimension countered the "political risk effect" in Alesina and Perotti (1998).

5.2 Income and size asymmetries and voting weights

Previous results in the literature have focused on the correlation coefficient between country shocks to analyze the benefits of forming a union, *for equal countries' ex-ante income and population.* Here, instead, we start with countries different in income and size, and characterize the bargaining space for different possible parameterizations. We pose the following question: given the unanimous voting rule, what are the income and size parameters that make a fiscal union possible?

Figure 4.3 shows how the bargaining space changes when relative incomes and population sizes change. We assume $\rho = -0.5$. The three dimensional graph shows that the less heterogeneous the countries, the larger the scope for agreement. The reasoning is as follows: when countries become dissimilar in income, the country with higher income demands higher weight in the union. This in turn decreases the bargaining space. On the other hand, when countries become dissimilar in size, the country with a larger population may be discouraged from imposing heavy taxes on its richer partners in the union, as it would be imposing deadweight losses on its own, large population. In terms of $\bar{p}_i$ and $\underline{p}_i$, we have that both variables decrease the higher is the relative size of country j in the union. This is because, the higher the size of j, the lower the $\bar{p}_i$ that country j requires to be in the union. Also, the higher N_j, the lower the $\underline{p}_i$ that i requires to be in the union, since a larger j is easier to self-discipline when deciding the tax rate. Coelho and Tavares (2011)

present strong empirical evidence showing that neighboring countries that are more similar in size and in income per capita are indeed much more prone to embark on international economic agreements, in the fiscal, trade, and monetary dimensions.

[**Figure 4.3 about here**]

6 Conclusions

Our set-up relates to the classic literature on fiscal federalism, but substantially enlarges the parameter set under scrutiny, as we introduce countries that are heterogeneous in income per capita and in population size, and explicitly discuss the relevance of the allocation of decision rights. We show that, in addition to the issues of economic risk and, more recently, political risk, the sustainability of a fiscal union is substantially improved when political weights are brought to the fore. We show how the correlation of income shocks, relative population size and relative income interact with decision rights and characterize the feasibility set.

There are some unexplored interesting issues associated to our framework that would be of interest for future research. For example, how to characterize the efficient voting weights once the fiscal union (with the common good) has formed. To this end, Barberá and Jackson (2006) analysis offers a good guidance on how to proceed even in the presence of heterogeneity within countries. Given our results on the bargaining space for consensus design, the choice of which weights to pick when the space is non-empty could also be influenced, beside efficiency, by dynamic stability or equity, and such interactions of desiderata would all need to be considered.

7 Apendix

Proof of Lemma 2.1: Lemma 1 immediately follows if we rewrite country j's preferred tax rate when $X_j < x$ as follows

$$T_i(\varepsilon) = \frac{(1-n_i)((1+\varepsilon_j) - (Y_i/Y_j)(1+\varepsilon_i))}{1+\varepsilon_j + n_i((Y_i/Y_j)(1+\varepsilon_i) - (1+\varepsilon_j))} \text{ if } X_i < x \qquad \blacksquare$$

Proof of Lemma 2.2: First, notice that the expected value is $E(\varepsilon_i) = \bar{\varepsilon}_i \Pr(\bar{\varepsilon}_i) + (-\bar{\varepsilon}_i)\Pr(-\bar{\varepsilon}_i) = \bar{\varepsilon}_i(1/2) + (-\bar{\varepsilon}_i)(1/2) = 0$. The variance is $Var(\varepsilon_i) = E(\varepsilon_i^2) - E(\varepsilon_i)^2 = \frac{1}{2}\bar{\varepsilon}_i^2 + \frac{1}{2}(-\bar{\varepsilon}_i)^2 = \bar{\varepsilon}_i^2$, so $\sigma_i = \bar{\varepsilon}_i$. Now, since $\sigma_i = \bar{\varepsilon}_i$ and $\Pr(\varepsilon_i = \bar{\varepsilon}_i) = \Pr(\varepsilon_i = -\bar{\varepsilon}_i) = 1/2$, we have that $E[V_i^{SQ}(\varepsilon_i)] = \frac{1}{2}\ln(Y_i(1+\sigma_i)) + \frac{1}{2}\ln(Y_i(1-\sigma_i))$, which can be rewritten as $E[V_i^{SQ}(\varepsilon_i)] = \ln(Y_i) + \frac{1}{2}\ln(1-\sigma_i^2)$. $\blacksquare$

Lemma A.1: $E(\varepsilon_i) = 0$, $\sigma_i = \bar{\varepsilon}_i$ and $\rho_{ij} = 1 - 4q_{ij}^A$.

Proof of Lemma A.1: In the proof of Lemma 2.2 above we show that $E(\varepsilon_i) = 0$ and $\sigma_i = \bar{\varepsilon}_i$. Consider now shocks to two countries, whose covariance is given by $Cov(\varepsilon_i, \varepsilon_j) = E(\varepsilon_i\varepsilon_j) - E(\varepsilon_i)E(\varepsilon_j) = E(\varepsilon_i\varepsilon_j) = q_{ij}^A[\bar{\varepsilon}_i(-\bar{\varepsilon}_j) + (-\bar{\varepsilon}_i)\bar{\varepsilon}_j] + \frac{1}{2-q_{ij}^A}[\bar{\varepsilon}_i\bar{\varepsilon}_j + (-\bar{\varepsilon}_i)(-\bar{\varepsilon}_j)] = \bar{\varepsilon}_i\bar{\varepsilon}_j(1 - 4q_{ij}^A)$. From the above it follows that the correlation is $\rho_{ij} = \frac{Cov(\varepsilon_i,\varepsilon_j)}{\sqrt{Var(\varepsilon_i)Var(\varepsilon_j)}} = 1 - 4q_{ij}^A$. Alternatively, given a correlation parameter $\rho_{ij} \in [-1, 1]$, we have $q_{ij}^A = \frac{1-\rho_{ij}}{4}$. $\blacksquare$

Lemma A.2: *Country i's expected utility in status quo, given by (5), is decreasing and concave in σ_i.*

Proof of Lemma A.2: Since $\sigma_i = \bar{\varepsilon}_i \in (0, 1)$, we have $dE[V_i^{SQ}(\varepsilon_i)]/d\sigma_i = -\frac{\sigma_i}{1-\sigma_i^2} < 0$ and $d^2E[V_i^{SQ}(\varepsilon_i)]/d(\sigma_i)^2 = -\frac{1+\sigma_i^2}{(1-\sigma_i^2)^2} < 0$. $\blacksquare$

Proof of Proposition 3.1: All items immediately follow using the intermediate value theorem, making use of the single crossing property, which guarantees that the three thresholds are uniquely defined. In particular, to find each threshold, we need to find two values for σ_i, for which the difference between the two functional forms that determine it takes different signs. For example, for $\tilde{\sigma}_i$, take $\sigma_i = \sigma_i^A < 1$, so $E^\rho[V_i^{SQ}(\varepsilon_i)] - E[V_i^A(\varepsilon_i)] > 0$, and

$\sigma_i = 1 - \delta$, with $\delta > 0$ sufficiently small, for which $E^{\rho}[V_i^{SQ}(\varepsilon_i)] - E[V_i^{A}(\varepsilon_i)] < 0$. Recall that $E[V_i^{A}(\varepsilon_i)]$ is constant in σ_i (see (6), and that $E^{\rho}[V_i^{SQ}] \to -\infty$ as $\delta \to 0$ (see (5). The other two thresholds can be found using the same procedure. ■

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8 Figures

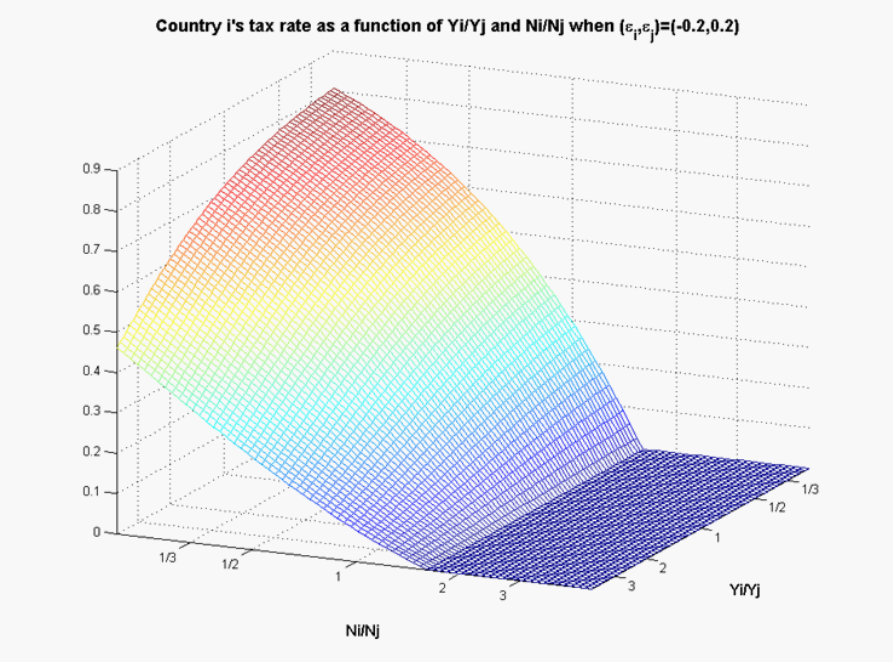


Figure 2.1

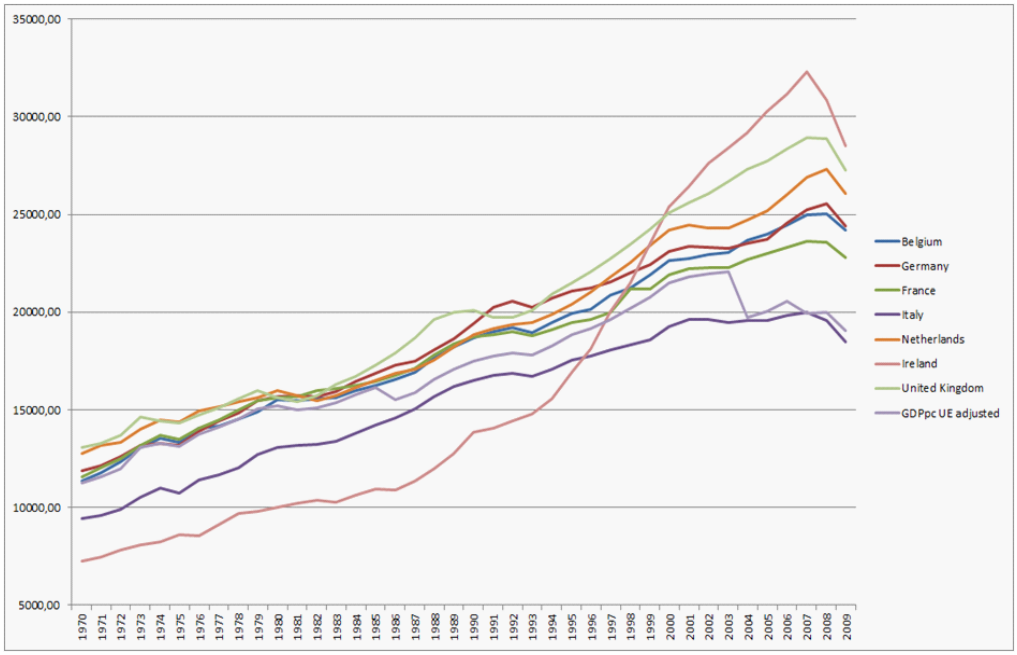


Figure 2.2: EU countries selection (Belgium, Germany, France, Italy, Netherlands, Ireland, U.K., and EU GDP adjusted) from 1970 to 2009.

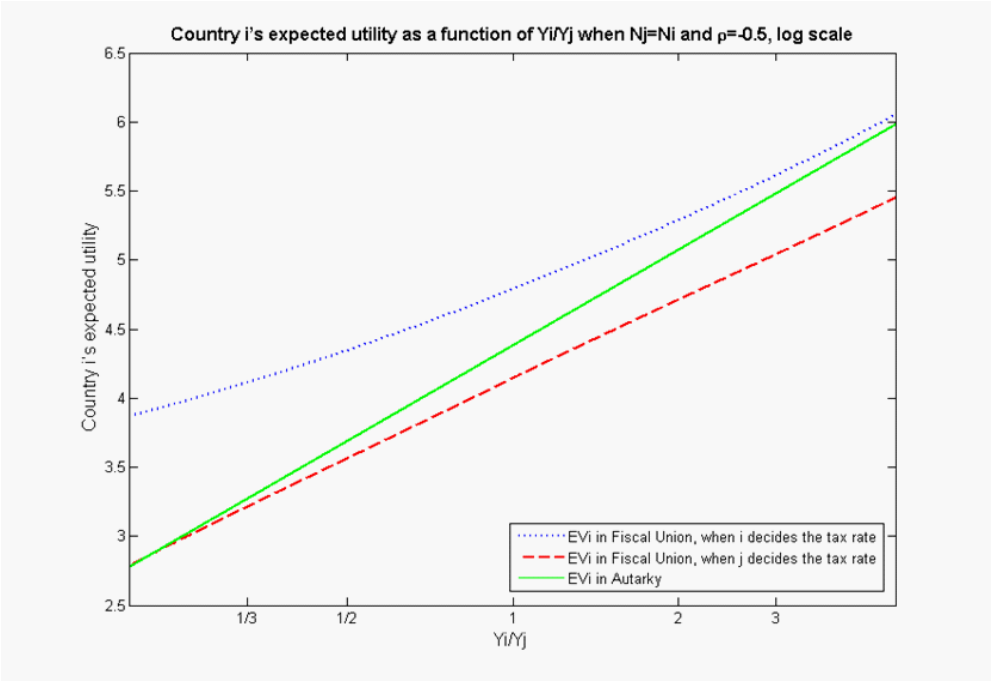
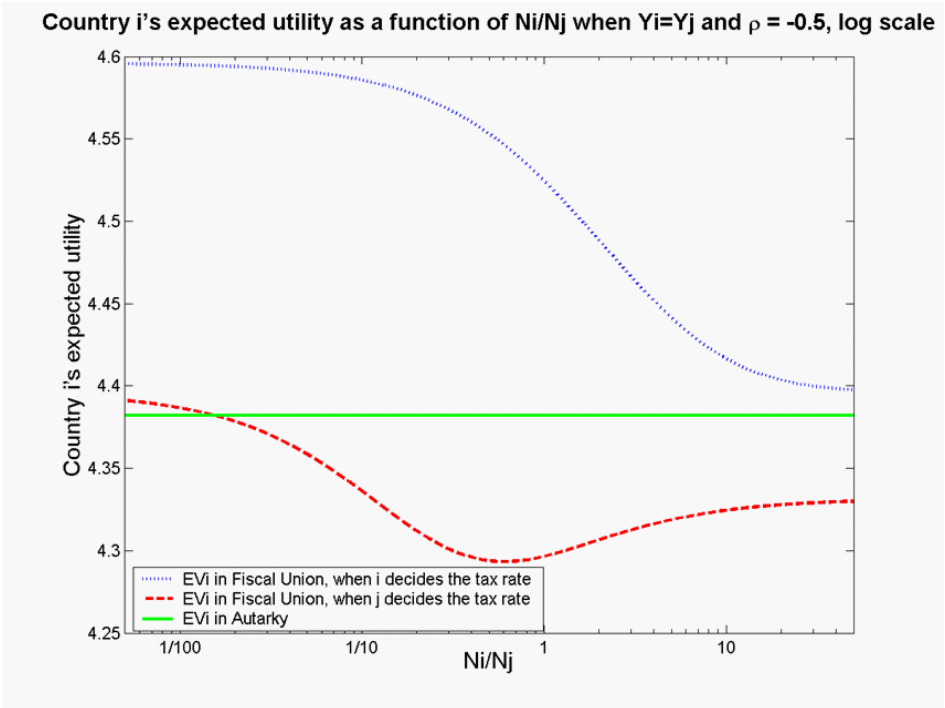


Figure 2.3



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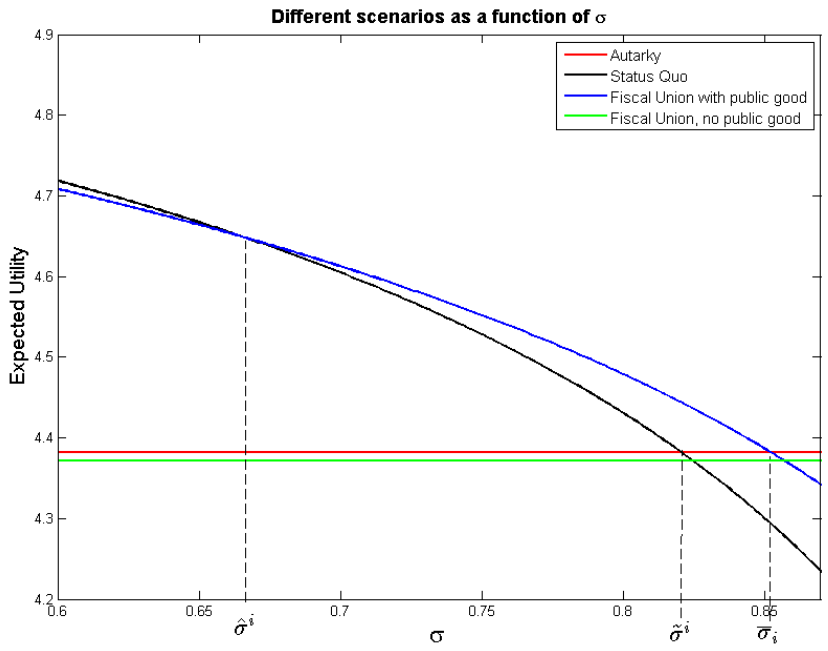

Figure 3.1

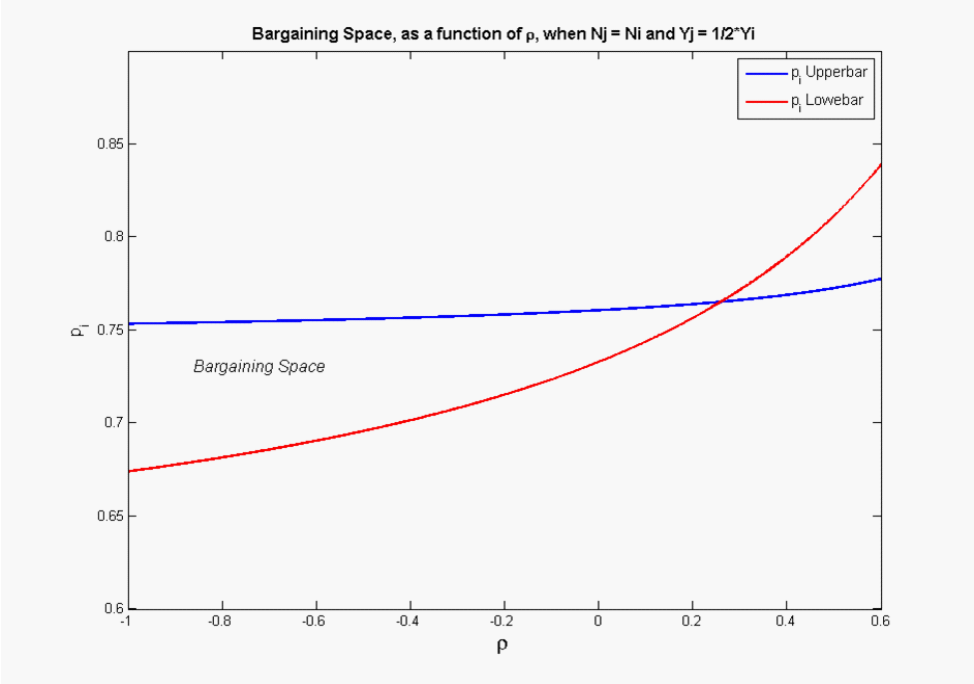

Figure 4.1

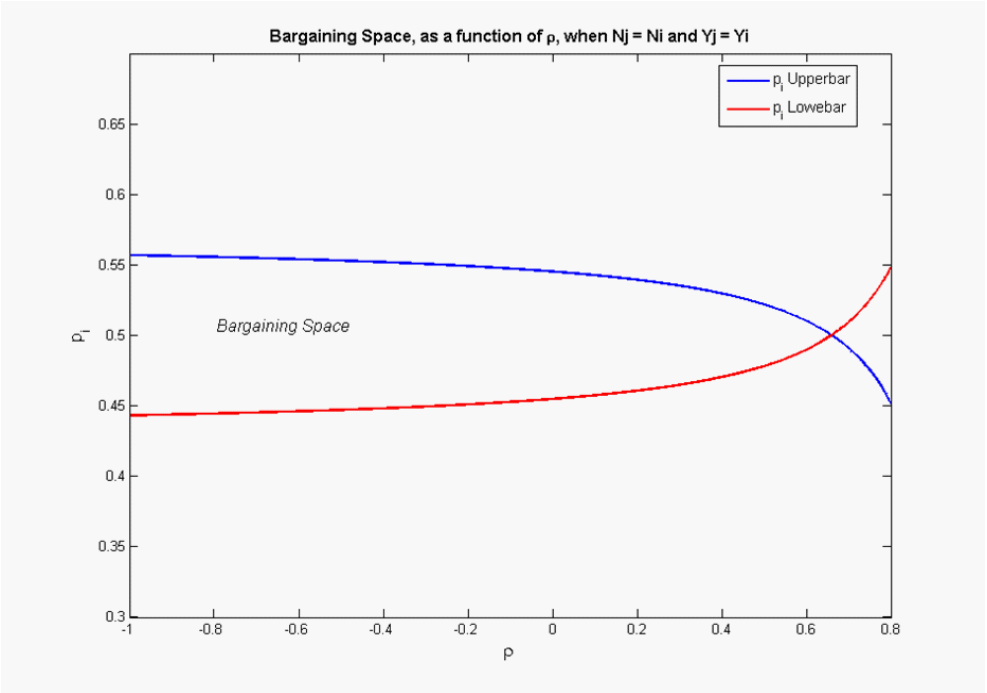

Figure 4.2

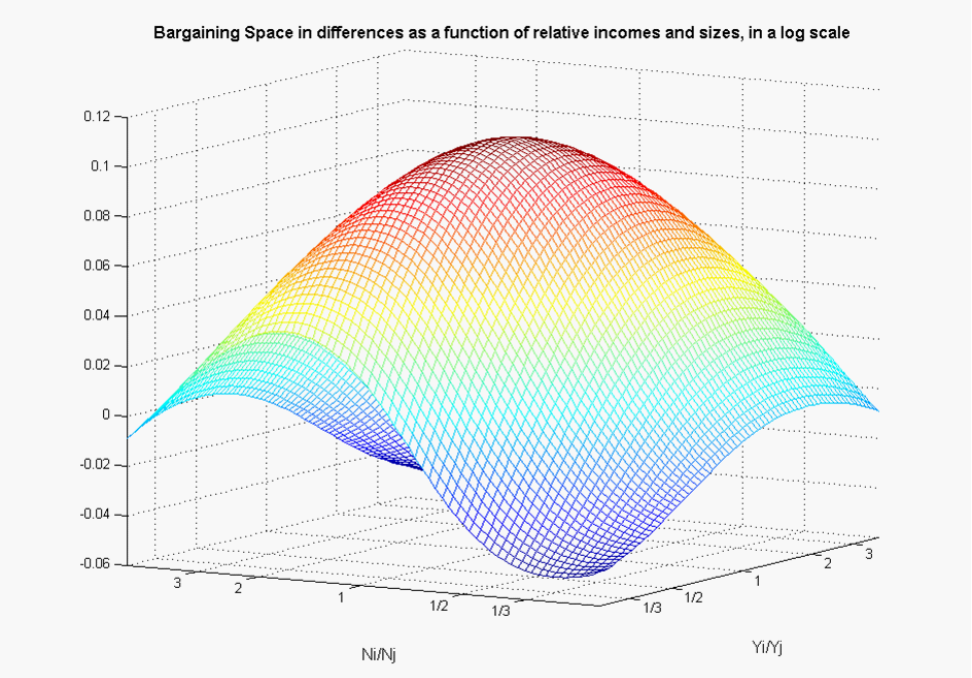

Figure 4.3