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On enhanced cooperation

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Abstract

We analyze the issues relative to the formation of sub-unions in a federation, called *enhanced cooperation agreements* in the European Union. When centralization is not politically feasible, an agreement among a subset of countries may allow such countries to exploit benefits from coordination that would otherwise be lost. Other countries in the federation may object to the sub-union because it changes the status quo; if cooperation at the federal level becomes convenient in the future, the change in the status quo may adversely affect the countries which remained initially outside the sub-union. We show that as long as the countries can commit to coordinate on a policy which takes into account the utility of the excluded countries, sub-union formation may be optimal. The relative advantage of a sub-union towards immediate centralization increases when transfers are costly. On the other hand, if commitment is not possible then the excluded countries may be penalized. We use the results to discuss the newly introduced rules for enhanced cooperation agreements in the European Union.

JEL classification: H1; H7
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1. Introduction

In a federation, most policy issues are either decided at the central level or are decentralized and left to the member states. There is however a possible alternative: only a subset of states may decide to coordinate their policies on a particular issue, while the remaining states continue to decide autonomously. In the European Union, for instance, these sub-unions have been recently

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institutionalized under the name of 'Enhanced Cooperation Agreements', or ECAs (Treaty of Nice, 2002). On theoretical grounds, these agreements raise at least two questions. What are the trade-offs involved for a federation in allowing sub-unions to be formed? And, how should federal institutions be organized to deal effectively with sub-unions?

In a static framework, the answers are relatively straightforward. Subunions should be allowed if they do not damage the other members of the federation, or if the resulting negative externalities can be compensated for. They should be prohibited otherwise. The governance of such agreements also seems to be straightforward. When there are no negative externalities, the members of the sub-union should be allowed to choose the policies they prefer, with no interference from the other members of the federation. Otherwise, policies and compensations for externalities should be decided jointly by all countries in the federation.

Things become more problematic if we move to a (more realistic) dynamic and stochastic framework. Political conveniences change over time in ways that cannot be precisely predicted ex ante. As a consequence, even if a sub-union does not damage the other members of the federation today, it might do so *in the future*. For example, the countries outside the subunion may contemplate joining it in the future, say because cooperation on that particular issue turns out to be convenient ex post. Then, even if there are no negative externalities from the sub-union at the present or in the future, the fact that a sub-union has already been established in the past may change the status quo to the advantage of the first-comers. In this case, cooperation may occur at worse terms for the late-comers than it would do if the sub-union had been prohibited to start with.

This suggests that one important trade-off in sub-unions' formation is between the increased welfare for the countries joining immediately the sub-union and the expected losses for the remaining countries in future periods. It also suggests that the optimal governance structure for the sub-unions is far from trivial. For example, it might make sense to allow countries that initially decide to opt out the sub-union to retain some decision power on the sub-union itself. Rules about who can join the sub-union in the future, and at what conditions, also appear to be crucial.

These theoretical considerations play a role in many real world cases. For example, in international trade agreements, this dynamic trade-off appears in deciding whether preferential agreements across countries should be considered as 'stumbling blocks' or 'building blocks' for multilateral agreements (see e.g. Levy (1997) and Aghion et al. (2004)). The most salient example however is the European Union (EU). After the enlargement, the heterogeneity among EU members has become so large that it is difficult to find common policies beneficial to all countries. Yet, there are still clearly many fields where further integration could benefit at least some subsets of EU members, and might in the future benefit all of them if these cooperative agreements turn out to be successful. Traditionally, the EU has coped with these conflicting needs in an ad hoc way, looking for intergovernmental agreements which allowed some of the members to go on with further integration, while others could 'opt out', at least temporarily. The European Monetary Union and the Shengen treaty are the best known examples of this strategy. In many cases, however, this strategy failed to work entirely. The growing dissatisfaction with this state of affairs led the EU members to agree on the introduction of well defined procedures to allow subsets of members to form sub-unions (i.e. ECAs), conditioning this possibility to the satisfaction of a number of detailed political constraints.[1]

[1] The rules for forming ECAs in the EU were introduced in the Treaty of Amsterdam (1997). The Treaty of Nice (ratified in 2003) removed the veto power which the former treaty left to each country, thus making the implementation of ECAs much easier. At the present, to form an ECA at least 8 EU members must be involved and the ECA must be approved by a qualified majority in the Council of Ministers. Furthermore, the European Commission assesses the compatibility of the proposed ECA with the other institutions governing the Union.

The debate over the role of ECAs in the EU is still open. Baldwin et al. (2001), for instance, argue that "ECAs could become the main engine of future European integration", a point which has certainly been reinforced by the recent failure to ratify the European Constitution and its new decision rules for the EU. But other observers do not share this optimistic view. Some contend that ECAs fall way short of what the EU really needs to become an efficient policy making body. Symmetrically, others see ECAs as a hidden way to overcome the unanimity requirement for the adoption of the most important policies in the EU and fear the formation of a two-speed Europe. However, to our knowledge, no formal analysis has been offered to support either claim or to discuss the optimality of the specific provisions introduced in the Treaties for the creation of sub-unions.[2]

In this paper, we make a first step in this direction. For the reasons previously pointed out, we think that in order to cast light on this debate an explicit dynamic and stochastic framework is required. We develop such a framework on the basis of a very simple model. The task of the analysis is to sharpen our intuition and not to address any specific policy issue. However, to add concreteness to the discussion, we choose an example where ECAs are likely to become important in the future EU, the harmonization of accounting rules for corporations.[3]

In our model, there are two periods and three countries. Two countries have initial accounting standards that are closer than that of the third, so that these two countries are natural candidates to form a sub-union in the first period. In each period, each country can invest either at home or partly in the other countries. Harmonization of standards is beneficial because it reduces the costs of investing abroad. However, the benefits of the investment are uncertain in the first period, so that it is not clear whether or not the countries should pay for the cost of harmonization.

In this setting we take a mechanism design perspective, and ask whether harmonization of the standards between the two closer countries (i.e. an ECA) should be allowed in the first period, and under which governance rules for the federation. We deliberately avoid modelling sub-unions formation as the result of an explicit dynamic bargaining game across countries. The reason is that there is no generally accepted approach to the problem of coalition formation, and the results tend heavily to depend on the specific (and always somewhat arbitrary) extensive form of the bargaining game.[4] Our approach is to investigate the optimality properties of ECAs under different hypotheses on the constraints that a benevolent planner may face. We then show that our basic insights are robust to many different reasonable bargaining assumptions. In the context of the EU, our approach has also a nice institutional interpretation, as the European Commission plays this planning role, being the only EU body that has the right to propose (to the Council and the Parliament) legislation on harmonization policy.

[2] Formal analyses of the functioning of European institutions are surprisingly scarce, and usually focused on voting procedures. See for instance Widgrén (2001) on Enhanced Cooperation and Noury et al. (2003) on the European Parliament. See also Inman and Rubinfield (1998), Wrede (2002), Perotti (2001), Stehn (2002) and Tabellini (2002) for more general discussions on the allocation of economic competencies between the EU and the member states.

[3] Differences in legal and accounting rules are well known to represent one of the main obstacles for an efficient allocation of capital in Europe, see the Ruding Report (1992) and the recent survey by Bond et al. (2000). Years of discussions and several European Commission proposals for across-the-board harmonization have not been successful. The difference in current practices across European countries is simply too large, and the overall benefits of harmonization are difficult to assess at the present. However, for historical reasons, differences in accounting standards are lower for subsets of the EU countries than they are for the Union as a whole. It is then possible that the adoption of common standards in this area could become one of the first examples of enhanced cooperation in the future EU.

[4] Burbidge et al. (1997) make the following observation in a similar context: 'Any extensive form one writes down as a description of the protocol of dynamic negotiation is bound to be somewhat arbitrary; and as is well known, equilibria in dynamic games are often extremely sensitive to the precise protocols.'

We start analyzing the benchmark case of a benevolent planner who can freely choose harmonization policies and lump sum transfers for all countries involved. We show that in this case there is indeed a set of parameters such that ECA dominates all other possible alternatives. Quite intuitively, ECA is better than centralization if the variance of the standards inside the sub-union is sufficiently smaller than the variance in the federation at large. Furthermore, we show that at the optimal enhanced cooperation policy, the country outside the sub-union is not worse-off. This is so because harmonization in the second period, if it happens, still occurs at the same (efficient) level as it does under decentralization.

Next, we consider what happens when we introduce political imperfections. In many real world federations compensating transfers have to be financed through distortionary taxation, and commitment to future policies is difficult. We consider first the case in which lump sum transfers across countries are not available, but countries can still commit to harmonize in the second period at the efficient standard. We show that in this case the set of parameters such that ECA is optimal unambiguously increases with respect to centralization. Under centralization a single standard is imposed over heterogenous countries, and this makes it more likely that some countries will need compensatory transfers. If transfers are costly, this decreases the social welfare generated by centralization. Countries are more homogeneous in a sub-union, which leads to lower transfers. Thus, the social loss caused by distortionary transfers tends to be smaller under enhanced cooperation.

Results are reversed if we assume that countries can use lump sum transfers but cannot commit in the first period to harmonize at the efficient standard in the second period. In this case, even if the standard is chosen efficiently in the second period, the countries forming a sub-union have an incentive to manipulate the standard to their advantage in the first period. This implies that if the third country joins in the second period, it is worse off with respect to decentralization. In this case, enhanced cooperation may be worse for welfare than straight centralization or decentralization.

These results have important implications for the present debate in the EU and in other international unions. They suggest that ECAs can indeed be a valid alternative to immediate centralization, and that this alternative improves if the federation finds it increasingly more costly to compensate the countries that are penalized by immediate centralization. But for these benefits to materialize, it is necessary to design institutions which prevent the countries forming a sub-union from using their first mover advantage against the excluded countries. On positive grounds, this may explain why the present arrangements in the EU allow excluded countries to retain some decision power on the ECAs policies (via the European Commission and the European Parliament) or even why countries who have opted out from EMU in the past still have a say on the Euro group's fiscal policy (through the Ecofin). On normative grounds, one may however wonder if this is enough. For example, the basic effect of present Treaty of Nice rules on ECAs is that now a subset of countries can form a sub-union without the consensus of the excluded countries. We prove that this is an effective way to increase the probability that an immediate centralized solution (and not an ECA) will be accepted by all members.

This paper is related to many other pieces of literature. In an informal analysis, Dewatripont et al. (1995) were the first to note the potential advantages of ECAs (which they call 'flexible integration') for the EU. They stress the advantages of experimentation and learning associated with ECAs, an issue we do not consider here. Formal analyses of ECA's are instead rare. Harstad (2005) studies minimum thresholds for flexible integration as a potential efficient mechanism to solve free-riding problems when partial integration offers positive externalities to outside countries, but his analysis is static. Alesina et al. (2001a,b, 2003) focus on a time inconsistency problem associated with union formation, and exploit the median voter's theorem to prove that unions will

tend to be smaller and more centralized than it would be optimal (see also Roberts (1999)). They propose a number of institutional solutions, including enhanced cooperation mechanisms. Levy (1997) discusses a similar issue, but in a different context. He shows that bilateral trade agreements may undermine political support for multilateral ones, by rising the reservation utility of the median voters in the two countries, a result extended by Aghion et al. (2004) to more general bargaining structures and political constraints. More generally, there is a huge literature, motivated by international trade, which study coalitions and sub-coalitions formation in the context of specific dynamic bargaining structures (e.g. Seidmann and Winter (1998), Burbidge et al. (1997), Bloch (1992)), but results are difficult to generalize. Somewhat more related to the present work is the stream of research originated by Fernandez and Rodrick (1991) on switching majorities in a dynamic and uncertain framework (see Gerard Roland (2000), chapter 2, for an extensive coverage of this literature and several extensions to political reforms). However, there is no application of this idea to the issue of harmonization and sub-unions.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 analyzes the benchmark case in which the countries are able to commit and lump-sum transfers are available. Section 4 analyzes how the results are modified when transfers are costly and when the countries are unable to commit to future policies. It also shows that the rules introduced by the Treaty of Nice are likely to lead to more centralization. Section 5 concludes the paper. All the proofs are collected in the Appendix.

2. The model

There are two periods and three countries belonging to a federation.[5] Each country is characterized by a different accounting standard for corporations. The set of all possible standards is given by the interval [0,1] and θ_i is the historically determined standard of country i. We assume $\theta_1 = 0, \theta_2 \in \left(0, \frac{1}{2}\right)$ and $\theta_3 = 1$, so that the standards of countries 1 and 2 are closer than that of country 3. Standards can be changed, but this is costly, as new laws have to be drafted and approved, professionals (accountants, lawyers, tax officials etc.) need to be trained anew, mistakes generated in the transition period have to be corrected and so on. For simplicity we assume that the cost of adopting a new standard is quadratic in the distance of the new standard from the historical one[6], i.e. if country i adopts the new standard x at time 1 pays the cost $(x-\theta_i)^2$.

Harmonization of standards is beneficial because it facilitates capital movements. Each country has one unit $k_i = 1$ of capital available for investment at the beginning of each period and can invest it in any of the three countries, using a technology displaying decreasing returns to scale. Let $\mathbf{x} = (x_1, x_2, x_3)$ be the triplet of standards chosen by the three countries at the beginning of period 1. If country i invests an amount k_{ij} in country j at time 1 then the expected return is

$$f_{ij}(k_{ij}, \gamma, \mathbf{x}) = \gamma k_{ij}^{\alpha} - cI_{[k_{ij}>0, x_i \neq x_j]},$$

where γ is a random variable whose value is unknown at time 1, $\alpha \in (0,1)$ and c is a fixed cost which is paid when capital is invested in a country with a different standard (I is the indicator function, taking value 1 when $k_{ij} > 0$ and $x_i \neq x_j$ and zero otherwise). For simplicity, we assume that c

[5] In our setting, this is taken to imply that the three countries already cooperate on some other policy dimension (e.g. the common market), and that this agreement is so important for them that they are willing to surrender their sovereignty on other dimensions as well, accepting to form ECAs only inside the rules established by the federation at large.

[6] The quadratic cost formulation allows us to greatly simplify the analysis, but the main qualitative results of the paper would survive to more general convex cost functions.

is very large, so that no country wishes to invest in another country having a different standard.[7] The variable γ captures the uncertainty about the returns from harmonization. When γ is low, investing capital brings small benefits, which in turn implies that the costs of harmonization may not be worth paying. Notice that in our formulation the same shock affects domestic and foreign investment, so that γ is actually a shock to capital productivity. However, this assumption is completely inessential for the analysis, and it is only made in order to save notation; nothing substantial would change if we assumed instead that only the returns from investing abroad were uncertain.[8]

When γ is high, harmonization may become profitable. For simplicity, we assume that γ can only take two values, 0 with probability $1-p$, and 1 with probability p. We also assume that the productivity of the capital invested by country i in country j is independent of the capital invested by other countries. This assumption is also not essential, and the analysis can be easily generalized to account for externalities.

If $x_1=x_2=x_3$, standards pose no barrier to the movement of capital. In this case, given our assumptions on technology, each country invests 1/3 of the capital available in each country. When only two standards are identical, each of the two countries with identical standards invests 1/2 of the capital in each of the two countries, while the third country only invests at home. Finally, when the three standards are all different, each country only invests at home.

The countries have to trade off the cost of changing the historically given standards with the new investment opportunities that harmonization of standards may yield. At period 1 the value of the new investment opportunities is uncertain, as it depends on the realization of the parameter γ. At period 2, the uncertainty is resolved and the value of the new investment opportunities is known for sure. More precisely, we assume the following time-line for our model.

Period 1

At period 1 the countries adopt a triplet of policies $\mathbf{x}=(x_1,x_2,x_3)$. There are three possibilities. The three countries may adopt a common standard, two countries may decide a common standard while the other decides to have a different standard, or each country may have a different standard. Once the decision on the vector $\mathbf{x}$ has been taken, each country decides how to invest its capital among the different countries. The expected utility for country i at time 1 is then

$$u_{1i}(\mathbf{x},\theta_i) = -(x_i-\theta_i)^2 + \max_{(k_{i1},k_{i2},k_{i3})\in\Delta} E\left[\sum_{j=1}^{3} f_{ij}(k_{ij},\boldsymbol{\gamma},\mathbf{x})\right]$$

where expectation is taken over the value of γ and

$$\Delta = \left\{(k_{i1},k_{i2},k_{i3}) | k_{ij}\geq 0, j=1,2,3 \text{ and } \sum_{j=1}^{3} k_{ij}=1\right\}.$$

[7] This assumption is of course extreme and it is made just to sharpen our analysis. In a more general model, investment costs may be a continuous decreasing function of the difference in the accounting standards of the countries. In this case, cooperation across countries need not coincide with full harmonization of the standards.

[8] A completely equivalent formulation would have $\gamma_D=1$ always for the domestic investment, and γ_F (for foreign) stochastic, taking values 0 or 1. When $\gamma_F=1$ the analysis of the second period is exactly the same as in the paper. When $\gamma_F=0$, the only thing that changes in the second period is the reservation utility, which is 1 (the value of the domestic investment) rather than 0. Looking at the problem from an ex ante perspective, $\gamma_D=1$ and γ_F stochastic generally imply that the countries will be more reluctant to harmonize, since the value of the domestic investment is higher. However, all the results below would still hold.

Period 2

At the end of period 1 the value of γ is observed. At this point, a new vector $\mathbf{x}'$ is chosen, according to the rules of the federation. The countries have a new endowment of one unit of capital, and the capital is invested. The utility of country i in the second period is

$$u_{2i}(\mathbf{x}, \mathbf{x}', \theta_i, \boldsymbol{\gamma}) = -(x_i' - g(\theta_i, x_i))^2 + \max_{(k_{i1}, k_{i2}, k_{i3}) \in \Delta} \sum_{j=1}^{3} f_{ij}(k_{ij}, \boldsymbol{\gamma}, \mathbf{x}')$$

where g is a function which takes into account the modification of the bliss point as a consequence of the choice of the standard in the previous period.

We allow for changes in the bliss point over time when new standards are adopted. The bliss point can move only partially towards the new standard because of adjustment costs. As an example of these adjustment costs, one may think to the accountants or the tax officials who are yet not trained or fully accustomed to the new rules and would therefore welcome a partial return to the old rules.

The two extreme cases are $g(\theta_i, x_i) = \theta_i$ (preferences do not change with the adoption of the new standard) and $g(\theta_i, x_i) = x_i$ (the country fully adapts in period 2 to the new standard adopted at period 1). For simplicity we adopt the linear specification

$$g(\theta_i, x_i) = \beta x_i + (1-\beta)\theta_i$$

with $\beta \in [0,1]$. Note that in our formulation what changes over time is the ideal point, not the decision. Suppose for example that country i selects policy x_i at period 1, and maintain the same policy at period 2. Country i will then pay an adjustment cost $(x_i - \theta_i)^2$ in the first period, and an adjustment cost $(x_i - g(x_i, \theta_i))^2$ in the second period. This also implies that if two countries select the same policy $x_i = x_j = x$ at period 1 and maintain this choice at period 2, they will still be coordinated. However, their ideal points will be different (as long as $\beta < 1$), so that if they were to decide to quit coordinating on that issue, they would choose different policies (see below).

Finally note that the decision at period 2 is taken *after* having observed the value of γ. A low realization of γ implies that the gains from cooperation are not as high as expected, and in that case the best thing to do for each country is to choose a standard that reflects the new ideal point, i.e. $x_i' = g(x_i, \theta_i)$. On the other hand, a high realization of γ tilts the balance in favor of more integration. Importantly, this may imply that a country that decided not to integrate in period 1 might now be willing to harmonize its standard. The main issue becomes what should be done in this case, that is how the new policy $\mathbf{x}'$ should be selected.

3. Efficient solution

We begin by computing the decision rule that maximizes the sum of the three countries' utilities. This can be interpreted as the case in which the decisions are taken by a benevolent planner under unanimity rules, and costless transfers can be used to compensate the countries who sustain higher costs from harmonization.

3.1. The second period problem

We start analyzing the optimal decision once the value of γ is known. If the realization is 0 then it is always optimal to decentralize the decision. In this case, each country will select as a new standard $x_i' = g(x_i, \theta_i)$.

If the realization is 1, then further harmonization may be optimal. Define

$$V_2(\mathbf{x}', \mathbf{x}, \theta) = \sum_{i=1}^{3} u_{2i}(\mathbf{x}, \mathbf{x}', \theta_i, \gamma = 1).$$

When a single standard x' is adopted, the sum of the total payoffs in the three countries is:

$$V_2(\mathbf{x}', \mathbf{x}, \theta) = \sum_{i=1}^{3} \left(-(x' - g(x_i, \theta_i))^2 + 3^{1-\alpha} \right).$$

The efficient solution is then to minimize the total cost $\sum_{i=1}^{3}(x' - g(x_i, \theta_i))^2$ with respect to x'. If we define

$$\bar{x} = \frac{\sum_{i=1}^{3} x_i}{3} \quad \text{and} \quad \bar{\theta} = \frac{\sum_{i=1}^{3} \theta_i}{3}, \tag{1}$$

then the solution is

$$x' = \frac{\sum_{i=1}^{3} g(x_i, \theta_i)}{3} = \beta \bar{x} + (1-\beta)\bar{\theta},$$

yielding a total payoff of

$$V_2^c(\mathbf{x}, \theta) = \max_{x' \in \mathbf{X}^c} V_2(\mathbf{x}', \mathbf{x}, \theta) = 3^{2-\alpha} - \sum_{i=1}^{3} \left(\frac{\sum_{j=1}^{3} g(x_j, \theta_j)}{3} - g(x_i, \theta_i) \right)^2,$$

where

$$\mathbf{X}^c = \{(x_1, x_2, x_3) | x_1 = x_2 = x_3\}$$

is the set of centralization policies.

When countries a and b only adopt a common policy[9] in period 2 (the 'enhanced cooperation' solution), then the optimal policy is

$$x' = \frac{g(x_a, \theta_a) + g(x_b, \theta_b)}{2},$$

yielding a total payoff for the federation of

$$V_2^{ec}(\mathbf{x}, \theta) = \max_{x' \in \mathbf{X}^{ec}_{\{a,b\}}} V_2(\mathbf{x}', \mathbf{x}, \theta) = 2^{2-\alpha} - \sum_{i \in \{a,b\}} \left(\frac{\sum_{j \in \{a,b\}} g(x_j, \theta_j)}{2} - g(x_i, \theta_i) \right)^2 + 1$$

where

$$\mathbf{X}^{ec}_{\{a,b\}} = \{(x_1, x_2, x_3) | x_a = x_b\}$$

is the set of policies compatible with enhanced cooperation between countries a and b (notice that the third country pays no adjustment cost and gets a return of 1 for investing the capital at home).

[9] In principle, the two countries with the closest standards at period 2 may be different from the two countries with the closest standards at period 1 (that is, countries 1 and 2), since at period 1 the standards change as a consequence of the choice of the vector (x_1, x_2, x_3).

Finally, when standards are different each country selects the standard $g_i(x_i,\theta_i)$ and only invests domestically; the total payoff is then

$$V_2^d(\mathbf{x},\theta) = 3.$$

Which of the three policies is optimal depends on the value of α and on the two triplets (x_1,x_2,x_3) and $(\theta_1,\theta_2,\theta_3)$. There is however a natural monotonicity. Lower values of α make it more convenient to split capital across countries, and therefore tend to favor harmonization. This monotonicity property is made precise in the next proposition.

Proposition 1. *Consider the second period problem when $\gamma=1$. For every given value of the triplets (x_1,x_2,x_3) and $(\theta_1,\theta_2,\theta_3)$, there are values α_1 and α_2, with $0<\alpha_1\leq\alpha_2<1$ such that full harmonization is optimal for $\alpha\in[0,\alpha_1]$, enhanced cooperation between the two closest countries is optimal for $\alpha\in(\alpha_1,\alpha_2)$ and decentralization is optimal for $\alpha\in[\alpha_2,1]$.*

The proposition is quite intuitive. When α is small, it pays a lot to split capital across countries. Thus, full harmonization is optimal. When α is close to 1 the technology is close to constant returns to scale, and the advantage of splitting capital is small. In this case it is better to avoid paying the adjustment costs, and decentralization is optimal. In intermediate cases, enhanced cooperation may be preferred. Notice that the case $\alpha_1=\alpha_2$ cannot in general be excluded; in this case enhanced cooperation is never optimal in period 2.

In the following we will focus on the case in which it is always optimal to harmonize the standards when $\gamma=1$, as this is the only interesting situation in our context (see below). It is therefore useful to investigate further the interval $[0,\alpha_1]$. Suppose first $\beta=0$. In this case, it can be easily shown that $\alpha_2>\alpha_1$, so that there are always values of α for which enhanced cooperation is strictly better that centralization and decentralization. Furthermore, maintaining $\theta_1=0$ and $\theta_3=1$, and letting θ_2 vary, α_1 is strictly increasing in θ_2. The values of α_1 are also pretty large: at $\theta_2=0$, $\alpha_1=0.71$, and at $\theta_2=1/2$, $\alpha_1=0.83$.

When $\beta>0$, the results depend on the choices of (x_1,x_2,x_3) in the first period. However, whenever the first period choices do not reverse the order of the ideal points among countries, and more specifically when

$$\frac{g(x_1,\theta_1)+g(x_1,\theta_2)}{2}<g(x_3,\theta_3) \tag{2}$$

it is again the case that α_1 is increasing in θ_2.

Intuitively, a higher value of θ_2 makes the distribution of the θ's more symmetric (it is perfectly symmetric when $\theta_2=1/2$), and this reduces the cost of centralization. Thus, if we consider the function,

$$V_2^c(\alpha) = 3^{2-\alpha} - \sum_{i=1}^{3}\left(\frac{\sum_{j=1}^{3} g(x_j,\theta_j)}{3} - g(x_i,\theta_i)\right)^2,$$

this function shifts upward when θ_2 increases (or, more generally, when the distribution of the θ's becomes more symmetric). On the other hand, increasing θ_2 makes the cost of enhanced cooperation higher, since the distance $|\theta_2-\theta_1|$ is larger. Thus, if we define the function

$$V_2^{ec}(\alpha) = 2^{2-\alpha} - \sum_{i\in\{a,b\}}\left(\frac{\sum_{j\in\{a,b\}} g(x_j,\theta_j)}{2} - g(x_i,\theta_i)\right)^2 + 1,$$

this function shifts downward when θ_2 increases (provided condition (2) is satisfied). Finally, observe that the utility of decentralization, V_2^d, does not depend on α. The value α_1 is then determined by the equation

$$V_2^c(\alpha) = \max\{V_2^{\text{ec}}(\alpha), V_2^d\}.$$

The functions on both sides are decreasing in α, and at the solution point the LHS crosses the RHS from above. Since an increase in θ_2 shifts the LHS upwards and the RHS downwards, it follows that α_1 increases with θ_2.[10]

3.2. The ex ante problem

We now turn to the ex ante problem. As anticipated, in order to focus on the dynamic trade-offs of partial integration, we assume that α is sufficiently small, so that full harmonization is always optimal in the second period when $\gamma=1$. The problem the planner faces is therefore how to position the standards of the different countries in period 1, taking into account the possibility that with probability p full harmonization will occur in period 2.

Remark. In our context, $\alpha \leq \alpha_1$ is the only interesting case. If the second-period optimal policy involves decentralization when $\gamma=1$, no harmonization ever occurs and the optimal choice for the three countries is simply to stick to their original standards in period 1. If enhanced cooperation becomes optimal in the second period, then it can be shown that harmonization occurs for countries 1 and 2. In this case country 3 never moves from the original standard, and the planner's problem simply reduces to decide whether to adopt a common standard immediately for countries 1 and 2 or wait until the second period. The solution trivially depends on p; if p is large then the two countries immediately harmonize their standard, while if p is small they wait one period and harmonize the standards only if $\gamma=1$. In both cases, harmonization always occurs at the cost-minimizing standard $(\theta_1+\theta_2)/2$. Notice however that in the second case, as long as $\beta>0$, countries 1 and 2 will nevertheless move their standards a little bit closer in period 1, in anticipation of the possible harmonization in period 2. This is so because with a convex cost function, it is always optimal to spread the cost of adopting a common standard over the two periods, and $\beta>0$ makes it possible to move partially in period 1. The main point however is that in this case the third country does not move from its original standard in any period, and therefore there is no potential trade-off between the utility of the sub-union and that of the third country.

By the analysis of the previous section, we know that in the second period the planner will choose full harmonization at $\left(\sum_{i=1}^{3} g(x,\theta_i)\right)/3$ when $\gamma=1$. There are then three cases to consider ex ante.

[10] A similar reasoning shows that α_2 is decreasing in θ_2, so that the interval $[\alpha_1,\alpha_2]$ for which enhanced cooperation is optimal in the second period shrinks as θ_2 increases.

When a common standard x for the three countries is imposed at time zero, so that $\mathbf{x}=(x,x,x)$, the total expected welfare is

$$V^c(x,x,x)=\sum_{i=1}^{3}u_{1i}(\mathbf{x},\theta_i)+pV_2^c(x,\theta)=p3^{2-\alpha}-\sum_{i=1}^{3}(x-\theta_i)^2 + p\left[3^{2-\alpha}-\sum_{i=1}^{3}\left(\frac{\sum_{i=1}^{3}g(x,\theta_i)}{3}-g(x,\theta_i)\right)^2\right].$$

If a common standard x_1 is only imposed for countries 1 and 2, while country 3 selects x_3, then total expected welfare is

$$V^{\mathrm{ec}}(x_1,x_2,x_3)=p(2^{2-\alpha}+1)-\sum_{i=1}^{2}(x_1-\theta_i)^2-(x_3-\theta_3)^2 + p3^{2-\alpha}-p\sum_{i=1}^{2}(\bar{g}-g(x_1,\theta_i))^2-p(\bar{g}-g(x_3,\theta_3))^2,$$

where $\bar{g}=\left(\left(\sum_{j=1}^{2}g(x_1,\theta_j)\right)+g(x_3,\theta_3)\right)/3$. At last, when in period 1 the countries adopt a triplet (x_1,x_2,x_3) such that the three numbers are all different, expected utility is

$$V^d(x_1,x_2,x_3)=p3-\sum_{i=1}^{3}(x_i-\theta_i)^2+p\left[3^{2-\alpha}-\sum_{i=1}^{3}\left(\frac{\sum_{j=1}^{3}g(x_j,\theta_j)}{3}-g(x_i,\theta_i)\right)^2\right].$$

We now solve for the optimal policy in the different cases. As a matter of notation, let

$$V_*^k(p,\beta)=\max_{\mathbf{x}\in\mathbf{X}^k}\quad V^k(\mathbf{x})$$

where $k\in\{d,\mathrm{ec},c\}$ refers to the policy adopted in the first period and $\mathbf{X}^k$ is the set of feasible choices given policy k (for example, if $k=c$ then only triplets $\mathbf{x}=(x,x,x)$ are feasible; when $k=\mathrm{ec}$, we assume that the ECA is formed between country 1 and 2). In the following, when needed to simplify the formulas, we use the notations $\bar{\theta}$, $\bar{x}$ (defined in Eq. (1)) and $\sigma_\theta^2=\frac{1}{3}(\sum_{i=1}^{3}(\theta_i-\bar{\theta})^2)$. Also, we will write $U_{*i}^k(p,\beta)$ to denote the expected utility achieved over two periods by country i when regime k is chosen and the optimal triplet $\mathbf{x}\in\mathbf{X}^k$ is chosen (so that $V_*^k(p,\beta)=\sum_{i=1}^{3}U_{*i}^k(p,\beta)$).

Consider first the case of decentralization. The first order conditions can be written as

$$p\beta(\beta(\bar{x}-x_i)+(1-\beta)(\bar{\theta}-\theta_i)\Big)=x_i-\theta_i$$

for $i=1,2,3$. Summing up the three FOCs we obtain $\sum_{j=1}^{3}x_j=3\bar{\theta}$, so that in the second period the optimal point is $\bar{\theta}$. Substituting, we get

$$x_i^d=\theta_i+\frac{p\beta}{1+p\beta^2}(\bar{\theta}-\theta_i). \tag{3}$$

The optimal choice under decentralization is a weighted average of the current standard θ_i and the standard to be adopted in case of harmonization. Although no harmonization occurs in the current period, when $\beta>0$ it is convenient to move the standard towards $\bar{\theta}$ in anticipation of the possible harmonization in the future period. The extent of the movement today depends on the

probability of harmonization tomorrow (i.e. p) and on how effective is that move in changing the ideal point (i.e. how large is β). Formally, the weight $p\beta/(1+p\beta^2)$ increases in p and β, reaching a maximum of 1/2 when $p=\beta=1$, that is when harmonization occurs with probability 1 and there is immediate adaptation to the new standard. In that case, the cost of harmonization is sustained with probability 1, and countries move half-way in the first period to the optimal standard to be set in the following period.

For future reference, it is worth noting that country i would be willing to choose voluntarily the point x_i^d if it were assured that the standard $\bar{\theta}$ would be chosen in case of centralization in the second period. In other words, in order to implement the decentralized allocation, a benevolent planner does not have to intervene directly in the choice of standard of each country. Rather, the outcome could be implemented simply by making a commitment to having centralization at $\bar{\theta}$ whenever $\gamma=1$, and then letting the countries choose their standards independently.

The expected welfare under decentralization is

$$V_*^d(p,\beta) = 3(1+3^{1-\alpha})p - 3\frac{p}{1+p\beta^2}\sigma_\theta^2.$$

Consider now the case of enhanced cooperation. The first order conditions with respect to x_1 and x_3 yield

$$(\theta_1+\theta_2) - \frac{\beta p(1-\beta)}{3}(\theta_1+\theta_2-2\theta_3) + \frac{2\beta^2 p}{3}x_3 = \left(2+\frac{2\beta^2 p}{3}\right)x_1,$$

$$\theta_3 + \beta^2 p\frac{2}{3}x_1 + \frac{\beta(1-\beta)p}{3}(\theta_1+\theta_2-2\theta_3) = \left(1+\frac{2\beta^2 p}{3}\right)x_3.$$

Solving the two equations we obtain

$$x_1^{ec} = \frac{\theta_1+\theta_2}{2} + \frac{p\beta}{1+p\beta^2}\left(\bar{\theta} - \frac{\theta_1+\theta_2}{2}\right) \tag{4}$$

$$x_3^{ec} = \theta_3 + \frac{p\beta}{1+p\beta^2}(\bar{\theta}-\theta_3) \tag{5}$$

Notice that $(2x_1+x_3)/3=\bar{\theta}$, so that if countries harmonize in the second period, they do so again at $\bar{\theta}$.[11]

The solution under enhanced cooperation is similar to the one we obtained under decentralization and can be explained along the same lines. Under enhanced cooperation the countries behave as in the decentralized solution, but with countries 1 and 2 'aggregated' together in a single

[11] The result depends on the use of a quadratic cost function. With more general cost functions, there is no guarantee that the efficient solution in the second period would be the same under the three different rules. But, as long as the cost function is convex, the same trade-offs among policies would remain.

country with an ideal point equal to their mid point, $(\theta_1+\theta_2)/2$. To see this just note that

$$x_1^{ec} = \frac{x_2^d + x_2^d}{2} \quad x_3^{ec} = x_3^d$$

and from Eq. (3), x_1^{ec} is the standard which would be chosen under decentralization by a country with original standard $(\theta_1+\theta_2)/2$. The intuition is as follows. Under enhanced cooperation, the planner must solve two problems at once. First, it must choose a common standard for the two countries joining the sub-union. Second, it must optimally adjust this standard in anticipation of the (possible) harmonization of the second period. Since harmonization in the second period, if it materializes, occurs at $\overline{\theta}$, the optimal solution is to adopt the decentralized solution for the sub-union as a whole, and then split the extra costs for harmonization between the two countries, choosing the mid point between their (optimal) decentralized solutions.

Thus, at the enhanced cooperation solution, country 1 always moves to the right and moves more than it would do under decentralization. On the contrary, country 2 moves less than under decentralization, and it may move either to the right or to the left of its initial standard. Indeed, it can be easily checked that $x_1^{ec} > \theta_2$ when $\theta_2 < \frac{2p\beta}{p\beta+3p\beta^2+3}$, and vice-versa. When θ_2 is small, both countries are far away from $\overline{\theta}$, so that they will have to move a lot if centralization occurs in the second period. Therefore, it is optimal for them to move to a common point closer to $\overline{\theta}$, to the right of θ_2. On the other hand, when θ_2 is large it is already very close to $\overline{\theta}$ (it is exactly equal to $\overline{\theta}$ if $\theta_2 = \frac{1}{2}$), while θ_1 is far away from $\overline{\theta}$. Therefore, it is more efficient to reduce the cost of country 1 than the cost of country 2, which is going to be small anyway. The optimal solution is then for country 2 to move a little bit to the left in order to allow country 1 to reduce its adjustment cost.

Finally, we can exploit further the fact that x_1^{ec} is equal to the decentralized solution for a country with standard $(\theta_1+\theta_2)/2$, to write total utility under enhanced cooperation as

$$V_*^{ec}(p,\beta) = p(2^{2-\alpha}+1+3^{2-\alpha}) - 3\frac{p}{1+p\beta^2}\sigma_\theta^2 - \frac{(\theta_2-\theta_1)}{2}Z(p,\beta),$$

where

$$Z(p,\beta) \equiv 1 + p(1-\beta)^2 - \frac{p}{1+p\beta^2}.$$

The total expected cost under enhanced cooperation is thus equal to the cost under decentralization, plus an extra term which measures the additional costs imposed on countries 1 and 2 from partial harmonization. Since $Z(p,\beta)$ is strictly positive for any value of p and β, these extra costs are increasing in the distance $\theta_2-\theta_1$. Notice that

$$\frac{dZ}{dp} = -\frac{(1+(\beta^2 p+1)(1-\beta))}{(1+p\beta^2)^2}(p\beta^2+1p\beta)\beta < 0$$

and

$$\frac{d^2Z}{d^2p} = \frac{2\beta^2}{(1+p\beta^2)^3} > 0$$

so that Z is a decreasing and convex function of p.

For future reference, it is also useful to compute the utility that each country enjoys under enhanced cooperation. For country 3, as $x_3^{ec}=x_3^d$, welfare is exactly the same under enhanced cooperation and under decentralization. The utility of country i, with $i=1, 2$, is obtained by substituting for x_1^{ec}. This gives:

$$U_{*i}^{ec} = p(2^{1-\alpha}+3^{1-\alpha})-\frac{p}{1+p\beta^2}(\theta_i-\bar{\theta})^2-\frac{(\theta_2-\theta_1)^2}{4}Z(p,\beta).$$

Note, as argued above, that the cost paid by the country joining the subunion is equal to the one paid under decentralization plus half the extra cost needed to harmonize the standards of the two countries at period 1. This result will be useful below.

Finally, it is immediate to see that in the case in which harmonization occurs immediately then the optimal standard is $x^c=\bar{\theta}$. The expected welfare under immediate harmonization can then be written as

$$V_*^c(p,\beta) = p2\times 3^{2-\alpha}-3(1+p(1-\beta)^2)\sigma_\theta^2.$$

3.3. A comparison

We can now compare the welfare of the federation under the three different regimes. Some computations yield[12]

$$V_*^{ec}-V_*^d = p(2^{2-\alpha}-2)-\frac{(\theta_2-\theta_1)^2}{2}Z(p,\beta) \tag{6}$$

$$V_*^c-V_*^{ec} = p(3^{2-\alpha}-2^{2-\alpha}-1)-\frac{3}{2}(\theta_3-\bar{\theta})^2Z(p,\beta) \tag{7}$$

$$V_*^c-V_*^d = p(3^{2-\alpha}-3)-3Z(p,\beta)\sigma_\theta^2 \tag{8}$$

Expected benefits are always higher under centralization than under decentralization, but so are the costs. Enhanced cooperation is an intermediate case, which allows reaping some of the advantages of harmonization at lower costs than centralization. The advantage of enhanced cooperation versus centralization increases when the distance $\theta_3-\bar{\theta}$ increases. Signing the effect of changes in β is more difficult, since $Z(p,\beta)$ is not monotone in β. However, we can prove the following result.

Proposition 2. *There exist two values p^* and p^{**}, with $0<p^*\leq p^{**}<1$ such that when $p\in[0,p^*]$ decentralization at period 1 is optimal, when $p\in[p^*,p^{**}]$ enhanced cooperation is optimal, and when $p\in[p^{**},1]$ centralization is optimal.*

Intuitively, centralization always dominates decentralization when p is close to 1, so that it is very likely that harmonization will be successful. On the other hand, decentralization always dominates centralization when p is close to 0, as it is very likely that harmonization would not bring about trade benefits. For intermediate values of p, enhanced cooperation may be the efficient

[12] We simplify the notation by ignoring the dependence of V_*^k on (p,β).

solution of a social welfare maximization problem. Notice that the optimal policy in this case entails some change in the standard of the excluded country in the first period as well.

Proposition 2 only establishes that $p^* \leq p^{**}$. If $p^* = p^{**}$ then enhanced cooperation is never optimal, and the optimal policy switches from decentralization to centralization as p increases. Whether or not the set (p^*, p^{**}) is empty depends on the parameters of the problem. Intuitively, as we have already shown for the second period solution, the main factor which affects the optimality of the enhanced cooperation solution is the distance between θ_2 and θ_1. When θ_1 and θ_2 are close, the cost of setting an identical standard for countries 1 and 2 in the first period is small and it might therefore be worth paying it to have the (potential) additional benefits of partial harmonization. On the other hand, if $\theta_2 = \frac{\theta_1 + \theta_3}{2}$ (country 2 is equally distant from the other two countries) then the costs of partial harmonization are very high and enhanced cooperation is less likely to be optimal. Building on this intuition, we now prove:

Proposition 3. *If $\theta_2 = \theta_1$ then $p^* = 0$ and $p^{**} > 0$. When θ_2 increases, p^* increases and p^{**} decreases.*

Since all the functions are continuous, the proposition implies that when θ_2 is sufficiently close to θ_1 the interval (p^*, p^{**}) is non-empty. The interval shrinks as θ_2 increases. When θ_2 increases the value of σ_θ^2 decreases, reaching a minimum at the point $\theta_2 = \frac{\theta_1+\theta_3}{2}$. Since both V_*^c and V_*^d depend negatively on σ_θ^2, they increase. This is intuitive, as a lower σ_θ^2 implies that it is less costly to centralize in the second period. This effect is also present in the case of enhanced cooperation, but there is now a countervailing effect. When θ_2 increases, the distance between θ_2 and θ_1 increases and this increases the cost of harmonizing the standard for countries 1 and 2 in the first period. When θ_2 is close to θ_1 the effect relative to σ_θ^2 prevails, so that V_*^{ec} increases. However, as θ_2 gets closer to $\frac{\theta_1+\theta_3}{2}$ the second effect prevails, and V_*^{ec} actually decreases. At any rate, the presence of the second effect implies that in general V_*^{ec} grows more slowly than V_*^d and V_*^c, therefore reducing the set of values of the parameters in which enhanced cooperation is optimal.[13]

4. Political constraints

So far we have derived conditions under which enhanced cooperation dominates the alternatives in the benchmark situation in which lump sum transfers can be used, decisions are taken by a benevolent planner under the unanimity rule, and countries can commit to the efficient solution in the second period. This is of course a very poor description of policy making in any real-world federation. The question then arises if the case for enhanced cooperation becomes more or less robust under more realistic scenarios.

In this section we focus on two key issues. We first discuss how our results change when transfers are costly but countries can still somehow commit to an efficient solution in the second period. We then reverse these assumptions, considering the case in which lump-sum transfers can be used, but the countries are no longer able to commit to future policies. Finally, we use our results to discuss the recently introduced rules for ECAs (in the Treaty of Nice) on EU's future evolution, a federation where neither lump sum transfers nor committing technology seem to be available.

[13] This does not imply that when $\theta_2 = \frac{\theta_1+\theta_3}{2}$ enhanced cooperation is never optimal. For instance, for $\alpha=\beta=0$ and $\theta_2=1/2$, enhanced cooperation is optimal for $3/32 > p > 2/32$. The reason is that under enhanced cooperation costs are always lower than under centralization. Hence, even if the benefits from harmonization are high, it might be worth moving from decentralization to enhanced cooperation, rather than to centralization directly, as p increases.

For simplicity, in this section we will always assume that centralization is so desirable, when γ is equal to 1 in the second period, that a proposal of harmonization at any standard is unanimously approved by all countries (this corresponds to assuming that α is sufficiently small). This will avoid the complication of having to consider second period transfers into the analysis. However, we maintain that it may be necessary to use compensatory transfers or other policy distortions to convince the countries to centralize before γ is known.

4.1. Costly transfers

Suppose first that compensating transfers across countries cannot be made or can be made only at a welfare cost, say because funds have to be collected through distortionary taxation.[14] Suppose however that in the first period countries can still write a binding contingent contract, committing to harmonize at some given standard in the second period whenever $\gamma=1$. We start assuming that this committed standard is $\bar{\theta}$, to make comparisons with the previous sections easier; we show below that the precise standard committed upon is not important for our results. What is important is that the commitment assumption implies that the formation of a sub-union in the first period cannot affect the choice of the standard in the second period, and therefore cannot reduce the welfare of the excluded country.

To analyze this case, we start assuming the following decision process (and we later discuss how the results can be extended to other reasonable procedures):

1. At period 1, all countries agree to harmonize standards at $\bar{\theta}$ in period 2 if $\gamma=1$. Furthermore, a benevolent planner makes a proposal about the current period, possibly together with a set of transfers. If the planner proposes enhanced cooperation or centralization and the proposal is unanimously accepted then the prescribed policies and the proposed transfers are enacted. Otherwise, no transfer takes place and the countries are free to select the standard they desire in the current period.
2. At period 2 harmonization at $\bar{\theta}$ occurs if $\gamma=1$; if $\gamma=0$ then each country autonomously selects its standard. There are no transfers in this period.

We assume that binding contracts among the countries can be established only through the benevolent planner. Thus, no sub-coalitions of countries can be effectively formed at period 1 once the proposal by the planner is rejected.[15] Under this procedure, each country has a reservation utility at least equal to what it can obtain under the decentralization policy:

$$U_{*i}^{d} = p(1+3^{1-\alpha}) - \frac{p}{1+p\beta^{2}}(\theta_i - \bar{\theta})^2.$$

This is so because, as we have shown above, if no harmonization occurs at period 1, but it is known that in the second period harmonization will occur at $\bar{\theta}$, the best choice for each country coincides with the decentralized option. This implies that when deciding which policy to

[14] In the European Union intergovernmental compensating transfers are used very little, suggesting a very high cost for transferring funds. When a country is hurt by some policy decision, it is often compensated by distorting other pieces of legislation or through sectorial or regional grants which, in principle, should be used for different objectives. See Tabellini (2002) and Sapir (2003) on this point.

[15] This is indeed the current procedure inside the EU. An ECA needs to be approved first by the European Commission before reaching the Council, and no independent agreement among member countries on the matters covered by the Treaty is allowed outside this procedure.

implement, the planner has now to take into account these individual rationality constraints. If any of the constraints is violated at the optimal solution described in the previous section, then the planner will have to take measures to accommodate the country not receiving enough utility. This can be done either through costly transfers or by distorting the standards proposed in the first period away from the efficient level. In any case, the social value of a policy is reduced when compensatory measures need to be taken to support that policy.

To see the effect of these individual rationality constraints, note first that whenever the values of the parameters are such that the sum of the utilities under enhanced cooperation is greater than the sum of the utilities under decentralization (that is, $V_*^{\mathrm{ec}} \geq V_*^d$) then each country obtains a utility at least equal to U_{*i}^d.

Proposition 4. *If $V_*^{ec} \geq V_*^d$ then $U_{*i}^{ec} \geq U_{*i}^d$ for each i; furthermore, it is always the case that $V_{*3}^{ec} = V_{*3}^d$.*

The implication of the proposition is that a policy of enhanced cooperation can *always* be implemented without transfers, provided that the countries are able to commit to harmonization at $\overline{\theta}$ in the second period. Therefore, the fact that transfers are costly and the individual rationality constraints have to be satisfied has no impact on the social welfare which can be attained under enhanced cooperation. A decentralization policy also does not require transfers.

This leads to the conclusion that the only policy that is potentially penalized under costly transfers is centralization. In turn, this implies that when transfers are costly the set of parameters such that enhanced cooperation is superior to centralization (weakly) expands.

The fact that the enhanced cooperation policy does not require transfers does not hold generally. It depends on our specific assumptions on the cost function and on the number of countries. But it would still be true that as long as the countries can commit to harmonize at the efficient level in the second period, under an ECA, the excluded countries would not need any compensating transfers. Furthermore, as long as the variance of the standards inside the sub-union is smaller than that of the federation at large, it would also be true that the extra costs needed to support enhanced cooperation would be strictly lower than those needed to support centralization. Hence, the basic insight that the presence of costly transfers increases the efficiency of enhanced cooperation with respect to centralization is likely to hold more generally.

This result is robust even to different procedures and different standards committed upon for the second period. Suppose for instance that the planner can only allow an ECA to be formed, but cannot set a precise value for x_1^{ec}. Rather, that value is selected by countries 1 and 2 through negotiation, and if they fail to reach an agreement, then they settle on the decentralized solution. The specific results depend on the details of the bargaining game between countries 1 and 2, but notice that as long as the three countries have committed to centralize at $\overline{\theta}$ in the second period, $V_*^{\mathrm{ec}} > V_*^d$ implies that countries 1 and 2 can certainly find values of the standard in the first period such that their expected utility is strictly higher under enhanced cooperation than under decentralization. With costly transfers, this standard may be different from the value x_1^{ec} given by Eq. (4). However, as long as the negotiation procedure allows the two countries to pick points on the Pareto frontier,[16] enhanced cooperation will be certainly chosen over decentralization whenever $V_*^{\mathrm{ec}} > V_*^d$.

Furthermore, the proposition would remain true even if the countries committed to centralize in the second period at some $\overline{x} \neq \overline{\theta}$. In this case, let us redefine $U_{*i}^d(\overline{x})$ and $U_{*i}^{\mathrm{ec}}(\overline{x})$ as the utilities

[16] For example, this is what would happen if we modeled the enhanced cooperation agreement between country 1 and 2 as a cooperative game and used the Nash bargaining solution as equilibrium concept.

achieved by country i under decentralization and enhanced cooperation, respectively. It would remain true that $U^d_{*3}(\bar{x})=U^{ec}_{*3}(\bar{x})$, as commitment protects country 3 from the distortion of future standards that the ECA may induce. On the other hand, it remains true that whenever countries 1 and 2 choose x_1^{ec} in order to maximize the sum of their utilities, they effectively behave as a country of type $\frac{\theta_1+\theta_2}{2}$, so that they end up splitting equally the surplus created by the ECA with respect to decentralization. This in turn implies that the ECA can be implemented without transfers. Finally notice, as we argued above, that this conclusion remains true even if the two countries choose x_1^{ec} through some alternative negotiation process, as long as this negotiation allows them to select outcomes which are Pareto superior to decentralization.

4.2. No commitment

Consider now the opposite case where costless transfers can be enforced but the three countries can no longer commit at period 1 to the standard to harmonize in the next period. Indeed, in many relevant cases, there may simply be no way to enforce this kind of commitment in a federation, as the countries may find it optimal ex post to agree on a different policy. This generates a standard time inconsistency problem, since the countries may now try to use their choice of the standard in the current period to influence the decision in the subsequent period.

We study this problem by assuming the following simple set up. Suppose that the standards of the three countries have not been harmonized at period one. Then, at period 2, if $\gamma=1$ the planner proposes harmonization at the efficient point

$$x^c=\frac{\sum_{i=1}^3 g(x_i,\theta_i)}{3}=\beta\frac{\sum_{i=1}^3 x_i}{3}+(1-\beta)\bar{\theta},$$

where x_i is the standard adopted by country i at period 1. This is the choice which maximizes the sum of the utilities at time 2, and it will be accepted unanimously since we have assumed that when $\gamma=1$, each country is strictly better off under centralization.[17] Notice that this also implies that no transfer needs ever to be paid in this period. Thus, if centralization does not occur at period 1, the countries know that centralization will occur at $\sum_{i=1}^3 g(x_i,\theta_i)/3$ with probability p in period 2.

Suppose now that decentralization prevails at period one, so that the three countries are free to choose their own standard. In this case, no transfer needs to be paid in this period. If each country is left free to move its standard, it must then realize that by moving its own standard at period 1 it is also going to affect the harmonized standard which will be enforced with probability p at period 2, since $\sum_{i=1}^3 g(x_i,\theta_i)/3$ depends on x_i (whenever $\beta>0$). With no commitment, and no possibility of writing binding contracts between the countries, the result is a Nash equilibrium in the choices of the standards in the first period. The next proposition describes this equilibrium.

Proposition 5. *If decentralization prevails in the first period then, in the unique Nash equilibrium, the choice of country i is*

$$x_i^{NEd}=\theta_i+\frac{\frac{2}{3}p\beta}{1+\frac{2}{3}p\beta^2}(\bar{\theta}-\theta_i).$$

[17] The important point in this sub-section is that the standard x^c chosen in the second period is a function of the x_i's chosen in the first period. Again, even if x^c were chosen through some different bargaining procedure, as long as x^c is sensitive to the x_i's, the kind of distortions we analyze here will be present.

Notice that when the standards x_i^{NEd} are chosen at period 1, harmonization of the standards at period 2, when it happens, occurs again at $\bar{\theta}$. Comparing the first period choices in the Nash equilibrium with what should occur under a commitment to $\bar{\theta}$ in case of harmonization, it is immediate to see that $|x_i^d - x_i^{NEd}| > 0$. This implies that, while the choice at the second period is unchanged, in a Nash equilibrium each country moves less in the first period than under commitment. The intuition is simple. In choosing its standard in period 1 under decentralization and no commitment, each country has to trade-off two effects. On one hand, by moving away from its historical standard it reduces the expected costs of harmonization to be paid in period 2. On the other hand, by keeping its choice in period 1 closer to its historical standard, it forces the planner in period 2 to choose an harmonization policy which is closer to its preferred point. In equilibrium the countries end up exactly offsetting each other and harmonization still occurs at $\bar{\theta}$. However, as a result of these contrasting incentives, each country moves less than it would be optimal to minimize its total expected costs. The conclusion is that the lack of commitment decreases the social value of a decentralization policy.

On the contrary, it is immediate to see that, as long as the countries can enforce costless transfers, centralization is not affected by lack of commitment. If the countries accept to harmonize the standards at $\bar{\theta}$ at period one, then the same standard will be optimal subsequently (when $\gamma = 1$).

Consider finally the case of enhanced cooperation. Since lump sum transfers are available, the two countries in the sub-union will choose the standard which minimizes the sum of their costs; any other choice is Pareto dominated by a policy in which costs are minimized and transfers are appropriately chosen to make everybody better off. From the previous analysis we know that this standard will be determined as if the cost function of the sub-union were given by $2\left(x_1 - \frac{\theta_1+\theta_2}{2}\right)^2$. However, in setting up this standard, the two countries must also realize that their choice in the first period is going to affect the choice of the planner in the second period. In this case, we have the following equilibrium.

Proposition 6. *There is a unique Nash equilibrium in the positioning game between the sub-union of countries 1 and 2 on one side and country 3 on the other side. The values x_1^{NEec} and x_3^{NEec} are:*

$$x_1^{NEec} = \frac{\theta_1 + \theta_2}{2} + \left(\frac{3p\beta}{9 + 5p\beta^2}\right)\left(\bar{\theta} - \frac{\theta_1 + \theta_2}{2}\right)$$

$$x_3^{NEec} = \theta_3 + \frac{6p\beta}{(9 + 5p\beta^2)}(\bar{\theta} - \theta_3).$$

One important conclusion that derives from Proposition 6 is that

$$\frac{2x_1^{NEec} + x_3^{NEec}}{3} = \bar{\theta} + \left(\frac{p\beta}{9 + 5p\beta^2}\right)(\bar{\theta} - \theta_3) < \bar{\theta},$$

so that in the second period the standard chosen in the case of harmonization turns out to be strictly lower than the efficient standard $\bar{\theta}$. The reason lies in the asymmetry existing between the sub-union and the third country in terms of their influence on the final standard. When the sub-union moves the current standard by Δx, the final standard moves by $\frac{2}{3}\beta\Delta x$, while a movement of

Δx by the third country moves the final standard only by $\frac{1}{3}\beta\Delta x$. Also notice that:

$$\frac{3p\beta}{9+5p\beta^2} < \frac{\frac{2}{3}p\beta}{1+\frac{2}{3}p\beta^2} < \frac{6p\beta}{(9+5p\beta^2)}$$

so that the countries in the sub-union move their standards less, and the third country more, than in the decentralized Nash equilibrium.

These results allow us to reach two important conclusions. First, since centralization is unaffected by lack of commitment but social welfare is reduced under the other two policies, the case for enhanced cooperation becomes unambiguously weaker when commitment is impossible. Second, lacking commitment, the third country is made worse off by an ECA and, if given the possibility, it would always veto the formation of an ECA unless compensatory monetary transfers are paid. Indeed, Proposition 6 immediately implies the following corollary.

Corollary 1. Suppose that the countries cannot commit to choosing a standard in period 2, and that in period 2 the standard is chosen efficiently. Then country 3 prefers decentralization in the first period to an ECA between countries 1 and 2.

4.3. Enhanced cooperation and the treaty of Nice

As a last exercise, we can attempt to use our previous results to gain some insights on the impact of the rules for the formation of ECAs in the European Union, as recently introduced in the Treaty of Nice. A stylized representation of those rules in our context could go as follows:

1. A (qualified) majority of Member States can agree to form an ECA on selected issues. The approval of countries not belonging to the ECA is no longer necessary, but all countries have the right to enter into the agreement if they so desire.
2. ECA's policies can be changed only by unanimous agreement of all the countries belonging to the ECA.

We will call No Veto–No Exclusion (NV–NE) the rule under which countries not belonging to the ECA cannot block its formation but have the right to enter if they so desire. The Treaty does not contemplate any mechanism for monetary compensations in relation to the formation of ECAs. Furthermore, no mechanism for committing to future changes of the current policies seems to be in place.[18] Therefore, the actual mechanism set up in the Treaty of Nice can be characterized as one in which the NV–NE rule applies, no monetary compensations are used, and no commitment is possible.

Again, a detailed analysis of the mechanisms for forming sub-unions inside the EU would require a specific modelling of the procedures and the goals of all the actors involved, a task which goes beyond the scope of this paper. But we can at least observe the following. Our previous analysis has shown that lack of commitment tends to favor centralization, while lack of monetary transfers tends to penalize it. Those conclusions were obtained under the assumption that an individual rationality constraint had to be satisfied for each country. The actual rules in the

[18] All EU countries may participate to the discussion about the policy to be selected in an ECA, but only the countries joining the ECA have the right to vote on this policy, according to the EU rules prevailing for the subject where the ECA is formed. For further details, see again Baldwin et al. (2001) and Berglof et al. (2003).

European Union allow for the formation of ECAs even if the excluded countries do not agree. The main difference with the previous analysis is therefore that the individual rationality constraint for the latter countries need not be satisfied.

Corollary 1 shows that, when there is no commitment, the formation of an enhanced cooperation damages the interests of the excluded country. The conclusion was obtained under the assumption that in the second period a socially optimal standard (that is, $(\sum g(x_i,\theta_i))/3$) would be chosen. The rules contained in the Treaty of Nice reinforce this effect, since the standard in the second period can only be changed by unanimity. This essentially implies that, once a standard is set by an ECA in the first period, it cannot be changed in the second period. Basically, a country remaining out of the ECA in the first period faces a 'take it or leave it' offer in the second period: Integration can only be achieved at the terms established by the countries belonging to the ECA in the first period.

There is of course no reason to expect the outcome under such rules to be efficient. The interesting question however is whether they tend to induce more or less centralization. We now argue that the NV–NE rule should tend to make centralization a more likely outcome. The basic reason is that the third country may prefer to join immediately the ECA (thus yielding immediate centralization), and so have a say in the choice of the standard, rather than wait until the second period and be forced (with some probability) to accept the standard chosen by the other two countries.

To make this argument more precise, suppose that our planner, in this case the European Commission, always proposes to harmonize at $\bar{\theta}$ if centralization occurs in the first period and at

$$x^c = \frac{\sum_{i=1}^{3} g(x_i,\theta_i)}{3} = \beta\frac{\sum_{i=1}^{3} x_i}{3} + (1-\beta)\bar{\theta}$$

if $\gamma=1$ in the second period.[19] Notice that these would have been the only two possibilities before the approval of the Treaty of Nice, with unanimity required for centralization in both periods.[20] With no transfers in the first period, centralization then occurs in the first period only if country 3, which is the one more likely to be hurt by harmonization, agrees to immediate centralization. In keeping with our previous notation, let $U^c_{*3}(\bar{\theta})$ be the expected utility of country 3 in this case. If instead country 3 chooses decentralization in the first period, by Proposition 5, its expected utility is

$$U_3^{\mathrm{NE}d} = p(1+3^{1-\alpha}) - \left(\frac{(4p\beta^2+9)p}{(2p\beta^2+3)^2}\right)(\theta_3-\bar{\theta})^2.$$

Then, in the pre-Treaty of Nice case, centralization in the first period only occurs if $U^c_{*3}(\bar{\theta}) \geq U_3^{\mathrm{NE}d}$. Following the approval of the Treaty of Nice, countries 1 and 2 are now free to form an ECA in the first period if they wish to do so; suppose this is the case (our previous analysis suggests that for θ_2 sufficiently close to θ_1, country 1 and 2 would certainly be better off by forming a sub-union in the first period rather than adopting the decentralization policy). Again, which standard 1 and 2 would choose in the first period if they form an ECA depends on the specific

[19] Of course, lacking transfers, $\bar{\theta}$ may not be what the planner would propose in the first period. But notice that our analysis below would still hold for any proposed centralization policy, provided that the third country is the one more penalized by this policy in the first period.

[20] In truth the Amsterdam Treaty already contemplated the possibility of ECA's, but unanimity by all EU members, and not only by a majority, was required for the ECA to be approved.

assumptions on their negotiation process. But, for the sake of simplicity, suppose that the two countries forming the ECA just maximize the sum of their expected utilities over the two periods, thus choosing the standard

$$\bar{x}^{\mathrm{ec}} = \frac{\theta_1 + \theta_2}{2}, \tag{9}$$

Country 3 then knows that if it does not accept immediate centralization at $\bar{\theta}$, it will have to harmonize at $\bar{x}^{\mathrm{ec}}$ in the second period with probability p. The expected utility of country 3 when the ECA is formed is therefore obtained by solving

$$U_3^{\mathrm{NVec}} = \max_x -(x-\theta_3)^2 + p(1 + 3^{1-\alpha} - (\beta x + (1-\beta)\theta_3 - \bar{x}^{\mathrm{ec}})^2).$$

The solution is

$$x_3^{\mathrm{NVec}} = \theta_3 - \frac{p\beta}{1+p\beta^2}(\theta_3 - \bar{x}^{\mathrm{ec}}),$$

giving to country 3, an expected utility equal to

$$U_3^{\mathrm{NVec}} = p(1 + 3^{1-\alpha}) - \left(\frac{p}{p\beta^2+1}\right)(\theta_3 - \bar{x}^{\mathrm{ec}})^2.$$

Under the NV–NE rules of the Treaty of Nice, country 3 will then be willing to accept immediate centralization if $U_{*3}^{c}(\bar{\theta}) \geq U_3^{\mathrm{NEec}}$. Comparing this condition with the previous one, it is then clear that country 3 will be prepared to accept more often centralization in the first period under the new Treaty of Nice rules if $U_3^{\mathrm{NE}d} > U_3^{\mathrm{NEec}}$, that is if country 3 is made worse off by the ECA. Substituting, this occurs if

$$\left(\frac{p}{p\beta^2+1}\right)(\theta_3 - \bar{x}^{\mathrm{ec}})^2 > \left(\frac{(4p\beta^2+9)p}{(2p\beta^2+3)^2}\right)(\theta_3 - \bar{\theta})^2, \tag{10}$$

and it can be checked that this condition is always satisfied whenever $\bar{x}^{\mathrm{ec}}$ is given by Eq. (9). More in general, condition (10) will be satisfied whenever the bargaining between countries 1 and 2 leads to a value $\bar{x}^{\mathrm{ec}}$ which is not too close to $\bar{\theta}$.

The conclusion is that the set of parameters such that centralization occurs is likely to be larger under the NV–NE rule than under a rule which requires unanimity in the first period. In other words, the introduction of the rules to form ECA's in the EU may be in reality just a device to bypass the objections to further centralization by some countries.

Is this good or bad for social welfare? This depends on whether one believes that the rules existing before the introduction of ECA were biased against centralization or not. Many observers would agree that, under unanimity, lack of transfers and lack of commitment may make it difficult to reach decisions in the EU. This might tend to bias the decisions excessively towards the status quo, which in many cases means decentralization. The introduction of rules allowing for ECAs even without the consent of excluded countries may then be a partial remedy.

On the other hand, it should be noted that when centralization occurs under NV–NE but it would not have occurred under unanimity, it is likely that the social value of the centralization

decision is lower.[21] When centralization is very beneficial then it will be unanimously approved, and when it is very damaging for the outside countries it will be rejected anyway. It is only in intermediate cases that centralization is rejected under unanimity but it is implemented under NV–NE.

5. Conclusions

In a dynamic model a basic trade-off in allowing sub-unions to be formed is between the increased welfare for the countries joining immediately the sub-union and the expected losses for the other countries in future periods, as a consequence of the possible change in the status quo. Hence, the introduction of enhanced cooperation mechanisms is certainly Pareto improving as long as the excluded countries can be guaranteed against, or compensated for, this change in the status quo. There is a role for enhanced cooperation even in the benchmark case of costless transfers and unanimity rules, as there may be cases where the lower costs for supporting harmonization in a sub-union (due to the lower variance of the standards in the sub-union than in the federation) may dominate the extra expected benefits from immediate centralization. This role is further enhanced when compensating transfers become impossible or very costly to enforce, as enhanced cooperation requires smaller transfers than immediate centralization.

These beneficial effects of enhanced cooperation however hinge on the fact that the countries joining the sub-union can commit not to change the status quo in the future or to compensate the excluded countries for this change. If they cannot, then enhanced cooperation may be harmful for the excluded countries and for the welfare of the federation at large.

Our results offer some important insights on the functioning of federations such as the European Union. First, they may help to explain why the introduction of ECAs is sometimes opposed by excluded countries even when there are no obvious negative externalities at play. Maybe those countries fear future exploitation rather than current negative externalities. Second, in terms of the governance rules for the federation, our analysis strongly suggests that, absent commitment power, countries which decide to opt out of the sub-union should however be involved in the decision process of the sub-union. This may explain some otherwise puzzling characteristics of the existing European institutions (such as for instance the presence of no-Euro countries in the Ecofin). Finally, we have shown that when ECAs can be formed without the consent of excluded countries (as is the case in the Treaty of Nice), centralization becomes more likely.

The analysis can be extended in several directions. First, we assumed that after the first period uncertainty is resolved, and the countries automatically learn whether it is optimal or not to harmonize a given policy. In reality, forming an ECA might be the only way to find out if centralization on a given function is beneficial. Sub-unions might then be thought of as offering a public good to all members of the Union and issues of free-riding and protection of the investment, through admission policies to the subunion, would arise naturally. Second, there is a natural complementarity between different policies which we have completely overlooked here. For example, centralization of foreign policy would tend to make it more beneficial the centralization of defence policy. This suggests that there may be an optimal timing for enforcing ECAs on different issues (see Roland (2000) for an approach to reforms in transition economies along similar lines). We believe that an analysis of these issues would provide interesting avenues for further research.

[21] We thank a referee for pointing this out.

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Appendix A

Proof of Proposition 1. Let $V_2^c(\alpha)$ and $V_2^{ec}(\alpha)$ be the values of V_2^c and V_2^{ec} as a function of α. We want to prove that the two curves cross exactly once on the interval [0,1]. To see that the two curves cross at least once, observe that the functions are continuous and that $V_2^c(0) > V_2^{ec}(0)$, $V_2c(1) < V_2^{ec}(1)$. To see that they can cross at most once, observe that the difference $(V_2^c(\alpha) - V_2^{ec}(\alpha))$ is strictly decreasing for all values of $\alpha \in [0,1]$. Let us call α^* the point at which $V_2^c(\alpha^*) = V_2^{ec}(\alpha^*)$.

Now notice that the payoff under decentralization, $V_2^d = 3$, is independent of α. Furthermore, both $V_2^c(\alpha)$ and $V_2^{ec}(\alpha)$ are decreasing functions and $V_2^d < V_2^c(0)$, $V_2^d > V_2^{ec}(1)$. Let α_1 be the unique solution to $V_2^c(\alpha) = \max\{V_2^d, V_2^{ec}(\alpha)\}$. Then centralization is optimal in the interval $[0,\alpha_1]$. If $\alpha_1 < \alpha^*$ then decentralization is optimal over the interval $[\alpha_1,1]$. If $\alpha_1 = \alpha^*$ then there is a unique value $\alpha_2 \geq \alpha^*$ such that $V^{ec}(\alpha_2) = 3$. Clearly, enhanced cooperation is optimal on (α_1,α_2) and decentralization is optimal on $[\alpha_2,1]$. □

Proof of Proposition 2. Let $V_*^k(p), k = c, ec, d$ be the value of V_*^k as a function of p. We start observing that at $p = 0$ we have $V_*^d(0) > V_*^{ec}(0) > V_*^c(0)$, while at $p = 1$ we have $V_*^d(1) < V_*^{ec}(1) < V_*^c(1)$. Furthermore, using the expressions (6)–(8) and the fact that Z is decreasing and convex in p we can conclude that each pair of curves crosses only once. Call $\hat{p} \in (0,1)$ the value such that $V_*^c(p) = V_*^d(p)$, $\tilde{p} \in (0,1)$ the value such that $V_*^c(p) = V_*^{ec}(p)$ and, finally, call $\bar{p} \in (0,1)$ the value such that $V_*^{ec}(p) = V_*^d(p)$. At this point we define $p^* = \min\{\hat{p},\bar{p}\}$ and $p^{**} = \max\{\hat{p},\tilde{p}\}$ and we are done. □

Proof of Proposition 3. If $\theta_2 = \theta_1$ then by inspection $V_*^{ec}(0,\beta) = V_*^d(0,\beta)$, which implies $p^* = 0$ and $V_*^{ec}(p,\beta) > V_*^d(p,\beta)$ whenever $p > 0$ (in fact, when $\theta_2 = \theta_1$ we have $x_1^d = x_2^d = x_1^{ec}$; decentralization and enhanced cooperation prescribe the same policies).

To prove the second part, observe that $\frac{\partial \sigma_\theta^2}{\partial \theta_2} = -\frac{2}{3}(\bar{\theta} - \theta_2)$, so that:

$$\frac{dV_*^c}{d\theta_2} = 2(1 + p(1-\beta)^2)(\bar{\theta} - \theta_2)$$

$$\frac{dV_*^d}{d\theta_2} = 2\frac{p}{1 + p\beta^2}(\bar{\theta} - \theta_2)$$

Furthermore, using the envelope theorem and rearranging we have:

$$\frac{dV_*^{ec}}{d\theta_2} = 2(1 - p\beta(1-\beta))(x_1 - \theta_2) + 2p(1-\beta)(\bar{\theta} - \theta_2),$$

where the first term is negative and the second is positive. We now show:

$$\frac{dV_*^c}{d\theta_2} > \frac{dV_*^{ec}}{d\theta_2} \qquad \frac{dV_*^d}{d\theta_2} > \frac{dV_*^{ec}}{d\theta_2},$$

This will be enough to reach our conclusion. To see this, remember that for a given θ_2 the value $\bar{p}=p^*(\theta_2)$ is defined by the equality

$$V_*^d(\bar{p},\theta_2) = V_*^{ec}(\bar{p},\theta_2).$$

If we now keep $\bar{p}$ fixed and we increase θ_2 by a small amount $\Delta\theta_2$ we have:

$$V_*^d(\bar{p},\theta_2+\Delta\theta_2) > V_*^{ec}(\bar{p},\theta_2+\Delta\theta_2).$$

Therefore, the value $\bar{\bar{p}} = p^*(\theta_2+\Delta\theta_2)$ at which

$$V_*^d(\bar{\bar{p}},\theta_2+\Delta\theta_2) = V_*^{ec}(\bar{\bar{p}},\theta_2+\Delta\theta_2)$$

must satisfy $\bar{\bar{p}} > \bar{p}$. An analogous reasoning holds for the value p^{**}.

The only thing left to do is to check the inequalities. We have:

$$\frac{dV_*^c}{d\theta_2} - \frac{dV_*^{ec}}{d\theta_2} = 2(1-p\beta(1-\beta))(\bar{\theta}-x_1) > 0,$$

since $x_1 < \bar{\theta}$. We also have:

$$\frac{dV_*^d}{d\theta_2} - \frac{dV_*^{ec}}{d\theta_2} = 2p\beta\left(\beta\frac{1-p\beta(1-\beta)}{1+\beta^2 p}\right)(\bar{\theta}-\theta_2) - 2(1-p\beta(1-\beta))(x_1-\theta_2)$$

which is strictly positive since $x_1 < \theta_2$ and $\bar{\theta} > \theta_2$. □

Proof of Proposition 4. It is immediate to see that the utility of country 3 is the same under decentralization and under enhanced cooperation. Therefore, the condition $V_*^{ec} > V_*^d$ is equivalent to:

$$U_{*_1}^{ec} + U_{*_2}^{ec} \geq U_{*_1}^d + U_{*_2}^d$$

When the policy given by Eq. (4) is selected we have

$$U_{*_i}^{ec} - U_{*_i}^d = p(2^{1-\alpha}-1) - \frac{1}{4}(\theta_1-\theta_2)^2 Z(p,\beta)$$

for $i=1,2$. Therefore $U_{*1}^{ec} - U_{*1}^d = U_{*2}^{ec} - U_{*2}^d$ and we conclude that under that value $U_{*i}^{ec} > U_{*i}^d$ for $i=1,2$. □

Proof of Proposition 5. Country i chooses x_i in the first period to solve:

$$\min_{x_i} \quad (x_i-\theta_i)^2 + p\left(\beta x_i + (1+\beta)\theta_i - \left(\beta\left(\frac{x_i}{3} + \sum_{j\neq 1}\frac{x_j}{3}\right) + (1-\beta)\bar{\theta}\right)\right)^2$$

The first order condition (which is also sufficient) for country i is:

$$2(x_i-\theta_i) + 2p\left(\frac{2}{3}\beta x_i + (1-\beta)\theta_i - \left(\beta\sum_{j\neq i}\frac{x_j}{3} + (1-\beta)\bar{\theta}\right)\right)\frac{2}{3}\beta = 0$$

The system of three equations has the unique solution:

$$x_i^{\mathrm{NE}} = \theta_i + \frac{\frac{2}{3}p\beta}{1+\frac{2}{3}p\beta^2}(\bar{\theta}-\theta_i). \tag{11}$$

□

Proof of Proposition 6. Countries 1 and 2 choose x_1 in the first period to solve:

$$\min_{x_1}(x_1-\theta_{12})^2 + p\left(\beta x_1 + (1-\beta)\theta_{12} - \beta\left(\frac{2x_1+x_3}{3}\right) - (1-\beta)\bar{\theta}\right)^2$$

where $\theta_{12}=(\theta_1+\theta_2)/2$. The first order condition is:

$$(x_1-\theta_{12}) + p\left(\beta x_1 + (1-\beta)\theta_{12} - \left(\beta\left(\frac{2x_1}{3}+\frac{x_3}{3}\right) + (1-\beta)\bar{\theta}\right)\right)\frac{1}{3}\beta = 0$$

while the condition for x_3 is

$$(x_3-\theta_3) + p\left(\beta x_3 + (1-\beta)\theta_3 - \left(\beta\left(\frac{2x_1}{3}+\frac{x_3}{3}\right) + (1-\beta)\bar{\theta}\right)\right)\frac{2}{3}\beta = 0$$

Solving for the two equations we obtain:

$$x_1^{\mathrm{NEec}} = \theta_{12} + \left(\frac{3\beta p}{9+5p\beta^2}\right)(\bar{\theta}-\theta_{12}) \tag{12}$$

$$x_3^{\mathrm{NEec}} = \theta_3 + \frac{6p\beta}{(9+5p\beta^2)}(\bar{\theta}-\theta_3) = \theta_3 - \frac{12p\beta}{(9+5p\beta^2)}(\bar{\theta}-\theta_{12}). \tag{13}$$

□

Proof of Corollary 1. Let $U_3^{\mathrm{NE}d}$ be the expected utility of country 3 when there is no commitment and there is decentralization in the first period. Since Proposition 5 implies that, under decentralization, the standard chosen in the second period under centralization is $\bar{\theta}$, the expected utility of country 3 is

$$U_3^{\mathrm{NE}d} = -(x_3^{\mathrm{NE}}-\theta_3)^2 + p(1+3^{1-\alpha} - (\beta x_3^{\mathrm{NE}} + (1-\beta)\theta_3 - \bar{\theta})^2)$$

where x_3^{NE} is given by Eq. (11). Substituting we obtain

$$U_3^{NEd} = p(1+3^{1-\alpha}) - \left(\frac{(4p\beta^2+9)p}{(2p\beta^2+3)^2}\right)(\theta_3-\bar{\theta})^2 \tag{14}$$

Now let U_3^{NEec} be the expected utility of country 3 when there is no commitment and countries 1 and 2 form and ECA in the first period. Proposition 6 implies that, under enhanced cooperation, the standard chosen in the second period will be

$$\beta\frac{2x_1^{NEec}+x_3^{NEec}}{3} + (1-\beta)\bar{\theta} = \bar{\theta} - \frac{p\beta^2}{9+5p\beta^2}(\theta_3-\bar{\theta}),$$

since x_1^{NEec} and x_3^{NEec} are given by Eqs. (12) and (13), respectively. The expected utility of country 3 is

$$U_3^{NEec} = -(x_3^{NEec}-\theta_3)^2 + p\left(1+3^{1-\alpha} - \left(\beta x_3 + (1-\beta)\theta_3 - \left(\beta\frac{2x_1+x_3}{3} + (1-\beta)\bar{\theta}\right)\right)^2\right)$$

and using Eqs. (12) and (13) we obtain

$$U_3^{NEec} = p(1+3^{1-\alpha}) - \left(9p\frac{(4p\beta^2+9)}{(5p\beta^2+9)^2}\right)(\bar{\theta}-\theta_3)^2.$$

Thus the condition

$$U_3^{NEd} > U_3^{NEec}$$

is equivalent to

$$\left(9p\frac{(4p\beta^2+9)}{(5p\beta^2+9)^2}\right) - \left(\frac{(4p\beta^2+9)p}{(2p\beta^2+3)^2}\right) > 0$$

or

$$\frac{(4p\beta^2+9)(11p\beta^2+18)p^2\beta^2}{(5p\beta^2+9)^2(2p\beta^2+3)^2} > 0$$

which is obviously satisfied. □

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