Harmonization and Side Payments in Political Cooperation

By Bård Harstad*

For two districts or countries that try to internalize externalities, I analyze a bargaining game under private information. I derive conditions for when it is efficient with uniform policies across regions—with and without side payments—and when it is efficient to prohibit side payments in the negotiations. While policy differentiation and side payments allow the policy to better reflect local conditions, they create conflicts between the regions and, thus, delay. The results also describe when political centralization outperforms decentralized cooperation, and they provide a theoretical foundation for the controversial “uniformity assumption” traditionally used by the fiscal federalism literature. (JEL C78, D72, D82, H77)

Consider the classical situation with regional public goods: due to externalities, regions A and B each contributes too little. Thus, the regions would like to negotiate an agreement where they must both contribute more. The regions may be heterogeneous, but local preferences are local knowledge. In this simple context, I ask two simple questions: Can the regions benefit by constraining themselves to agreements with complete harmonization of policies? When will side payments improve the agreement? The answers turn out to explain puzzling aspects of federal unions and solve controversies in the associated literature.

Take, for a start, the case without side payments. The regions disagree on how the policy should be differentiated, since each wants the other to contribute more. The region with the highest value of the public good is most eager to settle the agreement and is, in equilibrium, forced to contribute the most. Such differentiation is typically efficient. But to obtain a better deal, each region would like to signal reluctance to participate in the agreement, and reluctance can be signaled by delay. If, instead, policies must be uniform across regions, there is no desire to signal bargaining power by delay, since both regions will have to contribute by the same amount in any case. Thus, uniformity is good when the cost of strategic delay is larger than the value of differentiation. This turns out to be the case when the externality is large, while the heterogeneity and the value of the agreement are small.

When side payments and differentiation are both possible, the situation is quite different. First, one region can pay the other for contributing more. This generates gains from trade. Second, the desired “direction of trade” depends on the regions’ values of the public good, so that a region reveals its type by its proposal. This makes delay less necessary as a signaling device. For both reasons, policy differentiation is always beneficial when side payments are involved. To further reduce strategic delay, however, it might be even better to prohibit both side payments and differentiation.

By contrasting these two cases, the effect of side payments is isolated. As already noticed, side payments allow both gains from trade and a method for the regions of signaling their types, so that delay is less necessary as a signaling device. As a third effect, however, a reluctant region may force the other region to pay side transfers in addition to contributing more. The conflict of interest is larger with side payments, and the incentive to signal reluctance may increase. In fact, when the “gains from

* Managerial Economics and Decision Sciences, Kellogg School of Management, Northwestern University, Evanston, IL 60208 (e-mail: harstad@northwestern.edu). Building on my dissertation, the paper improved substantially under the guidance of Torsten Persson. I am also grateful for the help of Philippe Aghion, Alberto Alesina, David Austen-Smith, Patrick Bolton, Daniel Diermeier, Oliver Hart, Bob Staiger, Lucy White, four anonymous referees, and several seminar audiences. Thanks to Christina Lönnblad for editorial assistance, and Jan Wallander’s and Tom Hedelius’ Research Foundation and the Norwegian Research Council for financial support.
trade” are small, side payments are detrimental to efficiency.

The results justify why side payments do not always take place. In federal unions, side payments can be implemented by taxes differing across regions, but, typically, federal tax rates are uniform, and explicit transfers between districts are unusual. Linkages between trade and environmental agreements, for example, are also rare. This is puzzling to many scholars, since “linking issues together in ‘package deals’ can open the door to agreements by ensuring that there are prizes for everybody,” suggesting that “side payments are needed to reach the best result.”

In some cases, the possibility of side payments depends on the institutions. The European Council, comprising the European prime ministers and heads of states, typically negotiates large package deals, including transfers. The Council of Ministers, however, has less discretion over alternative political issues, and side payments are difficult. The desirability of side payments may thus dictate the optimal allocation of control between the chambers.

Political harmonization is another characteristic of federal policies and international agreements. In the European Union (EU), uniformity is recognized as “the classic Community method.” Article 94, Treaty of the European Community, calls for an “approximation of laws, regulations or administrative provisions,” which has led to an explosion of directives calling for uniform policies for, e.g., the environment (John McCormick 2001). Since such uniformity cannot reflect local conditions, it is often criticized. Although Alberto Alesina, Ignazio Angeloni, and Federico Etro (2005, 602) admit that harmonization is “a typical way in which the EU implements policies,” they argue that such “rigid” unions are inferior to “flexible” ones, which allow for policy differentiation. This paper, by contrast, points out the advantages of harmonization and describes when this is beneficial.

The paper makes two contributions to the literature on fiscal federalism (surveyed by Wallace Oates, 1999). Traditionally, this literature compares decentralization and centralization assuming that (i) centralization implies uniformity; (ii) under decentralization, local governments do not cooperate. The “uniformity assumption” (i) is heavily criticized for lacking theoretical foundations, although Paul Seabright (1996, 63) admits that “centralized political systems do tend to implement policies that are regionally more uniform than decentralized ones. An important question is why.” Addressing the question, this paper finds a rationale for harmonization, but also shows that this requires a precommitment. Since regions in a federal union are better able to make such commitments (e.g., by writing a constitution), the paper explains why (and when) policies are more uniform within than across federal unions.

Assumption (ii) is also controversial, and ought to be relaxed. After all, local governments often have both incentives and discretion to negotiate whenever externalities exist, with no commitment to uniformity, although this may

---

1 The quotes are borrowed from Neill Nugent (2003, 357) and Herman Cesar and Aart de Zeeuw (1996, 158), respectively.

2 This is a well-known difference between the two chambers. For example, Nugent (2003, 357) writes, “The European Council has been instrumental in formulating some of the EU’s grander compromises and linked deals [while] other EU institutions... are ill-adapted to the linking of different policy areas [because] they certainly do not have the means.”

3 Graimne De Burca and Joanne Scott (2000, 1). Moreover, the World Trade Organization (WTO) relies on uniformity by applying formulas for tariff negotiations, and its “reciprocity principle” requires that concessions should be similar across countries. Even the Kyoto protocol is uniform in that the requirements are relative to the 1990-level for each country.

4 Arguably, the uniformity assumption is “not derived from any explicit model of government behavior” (Ben Lockwood 2002, 313) and “it is neither empirically nor theoretically satisfactory” (Timothy Besley and Stephen Coate 2003, 2612). Empirically, US funds for infrastructure do vary across states (Brian Knight 2004) while, for liquor control, some states “chose a centralized, uniform policy” (Koleman Strump and Felix Oberholzer-Gee 2002, 2).

5 To some extent, the political economy approach (surveyed by Lockwood 2005) does help explain uniformity, since centralization makes politicians less accountable to local needs (Seabright 1996). Jean Hindriks and Lockwood (2005) suggest tax uniformity to increase accountability, while Massimo Bordignon and Enrico Minelli (2001) argue for “simple rules.” These explanations rely on asymmetric information between voters and politicians, but the traditional justification for uniformity is that “information about countries’ preferences is not publicly available” (Alesina, Angeloni, and Etro 2005, 604). Uniformity can also be a response to median voters (Jacques Crémer and Thomas R. Palfrey 2000), lobbying (Gregory Besharov 2002), Bertrand competition between districts (Matthias Wrede 2006), or strategy-proofness (Antoine Loeper 2006).
lead to delay. Centralization, if we rely on assumption (i), leads to uniformity but no delay. Hence, centralization outperforms decentralized cooperation exactly when uniformity outperforms differentiation, as analyzed in this paper.

The paper also contributes to the literature on bargaining under private information (surveyed by Lawrence M. Ausubel, Peter Cramton, and Raymond J. Deneckere 2002). In political bargaining, Alesina and Allan Drazen (1991) predict a war of attrition between groups trying to stabilize the economy. Giving in early reveals a high willingness to pay, and the proposal-maker is thus forced to bear most of the cost (Chang-Tai Hsieh 2000). Such inefficiencies often arise in bargaining under private information. I follow Anat R. Admati and Motty Perry (1987) and Cramton (1992) who endogenize the timing of offers, and allow each negotiator to delay before making its next offer. With two types and alternating offers, I get a simple, unique equilibrium, which actually implements the best "reasonable" mechanism. The possibility to delay is actually not crucial for the results below, since a region could alternatively signal by proposing an inefficient or less ambitious agreement. The conclusion that simple constraints, such as prohibiting side payments, in specified cases mitigate inefficiencies in bargaining is novel and relevant in many contexts, for example, for the debate on issue linkages (see, e.g., Roman Inderst 2000).

The next section presents the model of the economy and the bargaining game. Section II describes the equilibrium when side payments are not possible, and investigates when a uniform policy is beneficial. Section III repeats this exercise for the case with side payments, while Section IV compares the two cases and derives conditions under which side payments are good. Section V lays out the implications for international cooperation, fiscal federalism, and the uniformity assumption. Robustness is discussed in Section VI, while Section VII concludes. All proofs are relegated to the Appendix.

I. The Model

A. The Economic Environment

Consider a typical situation with regional public goods. Region A's marginal value of the public good is \( v_A \), its contribution is measured by \( g_A \), and the marginal cost of contributing is normalized to one. The externality \( e \) denotes the fraction of \( A \)'s contribution that "crosses the border" to the benefit of region \( B \). Since symmetric assumptions are made for region \( B \), the level of public good in region \( A \) is \( (1 - e)g_A + eg_B \). In addition, let \( s \) be a (possibly negative) side payment from \( B \) to \( A \). The regional utility functions are:

\[
\begin{align*}
(1) & \quad u_A = v_A [(1 - e)g_A + eg_B] - g_A + s, \\
& \quad u_B = v_B [(1 - e)g_B + eg_A] - g_B - s.
\end{align*}
\]

To avoid trivial cases, assume that \( 1/(1 - e) > v_i > 1,^6 \) the first inequality ensures that no region will contribute without an agreement, the second that both regions would benefit from an agreement with equal contributions. The positive externality implies that the regions benefit from cooperation.

Specifying \((g_A, g_B, s)\) is equivalent to specifying \((g, d, s)\), where \( g = g_A + g_B \) measures the size of the agreement and \( d \) measures how the policy is differentiated across the regions,

\[
(2) \quad d = g_B - g_A.
\]

A uniform policy requires that both regions contribute the same amount \( (d = 0) \) or, equivalently, that the level of public good is the same in both regions. But even with different policies, there may be natural or technological limitations to the extent to which the policy can be differentiated, such that

\[
(3) \quad d \in [-D, D] \quad \text{for some } D > 0.
\]

For example, requiring \( g_i \in (g, \bar{g}) \) would imply \( D = \bar{g} - g \). In general, \( D \) may capture the extent to which it is reasonable or efficient to differentiate the policy. If we believe the real cost of

\[
^6 \text{In statements that may be true for either region, } i \text{ denotes any of these, i.e., } i \in \{A, B\}.
\]

\[
^1 \text{I thus abstract from the problem of participation: if } v_i < 1 \text{, possible, } i \text{ would not participate without differenti-}
\]

\[
^6 \text{A negative externality can become positive by simply changing the sign of } g_A \text{ and } g_B \text{ while the externality of}
\]

\[
\text{pollution is negative, the externality of cleaning or reducing pollution is positive.}
\]
contributing to be a more (less) convex function, then it is cheapest to spread the contributions more (less) evenly. To approximate this in the linear model, $D$ should be small (large). $D$ plays no role in the next section, however.

Since the utility functions are linear, the regions would like $g$ to be infinitely large. But there are several reasons why $g$ may be limited in reality. If $g$ must be financed by local taxes or loans, and the sum of the tax bases is normalized to one, the budget constraint (when the regions can borrow from each other) is $g_A + g_B \leq 1$. This constraint will bind in equilibrium, so that in any agreement,\(^9\)

$$g_A + g_B = 1. \tag{4}$$

Besides reflecting the regions' joint budget constraint, a fixed size of the project is also reasonable in other cases. In Alesina and Drazen (1991), for example, two groups negotiate whether and how to stabilize debt, where the current level of debt defines the required total contribution. Similarly, ratifying an environmental agreement may commit the EU to reduce its total pollution by a certain amount, but how the contributions should be allocated between countries remains to be negotiated. To fix ideas, suppose that $A$ and $B$ negotiate whether and how to implement an agreement cleaning or reducing the total amount of emission by one unit: $d$ measures how much $B$ cleans relative to $A$, $e$ represents the fraction of emissions crossing the border, while $v_i$ quantifies $i$'s marginal value of clean air.

The constraint (4) allows us to focus on the distributive issues $d$ and $s$. Combining (2) and (4), $g_A$ and $g_B$ become functions of $d$. Substituted in (1) gives

$$u_A = (v_A - 1)/2 + d[1 - (1 - 2e)v_A]/2 + s,$$

$$u_B = (v_B - 1)/2 - d[1 - (1 - 2e)v_B]/2 - s.$$

Total welfare can be defined as

$$u = u_A + u_B$$

$$= \frac{v_A + v_B}{2} - 1 + d(v_B - v_A)\left(\frac{1}{2} - e\right).$$

The last equation shows there exist potential benefits from differentiating the policy, whenever $e \neq \frac{1}{2}$ and the regions are heterogeneous ($v_A \neq v_B$). If $e < \frac{1}{2}$, pollution is mainly a local problem, and $d(v_B - v_A) > 0$ is optimal: the region with the highest value of clean air should reduce its emission the most. If $e > \frac{1}{2}$, most of the emission crosses the border and $d(v_B - v_A) < 0$ is optimal: the region with the lowest value of clean air should reduce its emission the most.\(^{10}\)

However, $A$ and $B$ have conflicting interests in how the policy should be differentiated: each region prefers that the other region contributes most. Moreover, local preferences are assumed to be local information.\(^{11}\) Region $i$ knows only its own type $v_i \in \{v, \tilde{v}\}$, and the fact that the other region's type is either low ($v$) or high ($\tilde{v} > v$) with equal probability.

**B. The Bargaining Game**

The bargaining game is quite standard. The two regions make alternating offers over $(d, s)$, time is continuous, and the time horizon is infinite. $A$ makes the first offer $(d, s) \in \mathbb{R}^2$. If $B$ rejects, $B$ makes the next offer, and so on. An agreement is made as soon as one offer is accepted by the other region. Agreeing early is preferred to agreeing later, since $i$'s present value of an agreement settled at time $t$ is $\delta^t u_i$, where $\delta < 1$ is the regions' common discount factor. As is typically assumed, the minimum time between offers is small and approaching zero. However, I follow Admati and Perry (1987) and Cramton (1992) by relaxing the

---

\(^9\) Without regional loans, an alternative assumption could be to let there be upper boundaries for regional contributions, $g_i \leq \tilde{g}_i$. This would lead, however, to an unrealistic bias toward uniformity, since the first best would simply require $g_i = \tilde{g}_i$, without capturing the intuition that the policy should be differentiated according to the $v_B$ in optimum.

\(^{10}\) When would it be reasonable that $e > \frac{1}{2}$? For the pollution example, this means that polluting plants are quite strategically located in each region. For international trade, it implies that a domestic tariff reduction is mostly beneficial to foreigners.

\(^{11}\) This is in line with the federalism literature (see footnote 5) and often empirically reasonable. For sulphur emission in Europe, Miller (1991, 266) observes that "the control costs and environmental damage in one country are known to that country only."
standard assumption that a region must make a proposal at a particular time. Timing is endogenous, as each region is allowed to delay as long as it wishes before making its next offer. Besides generalizing the standard game, the possibility that a region can delay implies that the opponent cannot revise its offer in this period. Cramton justifies this assumption by suggesting that negotiators may find it unwise to revise their offers, if doing so has an adverse effect on their reputation. Admati and Perry suggest that a player may actually “disappear” for some time, but explain that the same results would prevail if a player can simply decline to receive an offer. This possibility seems reasonable for international negotiations, which cannot efficiently resume before both countries have agreed to schedule a new meeting. The assumption simplifies the analysis, since each region can then signal its type by delaying appropriately. In fact, there is a unique sequential equilibrium satisfying the Intuitive Criterion by In-Koo Cho and David M. Kreps (1987). This equilibrium is separating, and no pooling equilibria exist.

The possibility of delaying is not crucial in the model, Section VI argues, because the regions may otherwise signal their types by proposing inefficiently “small” projects, \( g < 1 \). Under certain assumptions, this would give identical results. In the present model, however, signaling by proposing \( g < 1 \) is not an equilibrium, since it is cheaper to signal by delay.\(^{12}\) Section VI also discusses how the results may survive in more general bargaining models, and shows that no “reasonable” procedure (or mechanism) can do better than the bargaining game outlined here.

### II. Without Side Payments: Uniform or Different Policies?

This section assumes that side payments are not possible. In the model, this is achieved by simply requiring \( s = 0 \). In international negotiations, side transfers may be impossible if the negotiating ministers have little discretion over other political variables. In federal unions, side payments may be difficult if tax rates must be the same across regions. In any case, the results provide a benchmark case, which will later be contrasted to the case with side payments (Section III) to evaluate the effect of the side payments themselves (Section IV).

#### A. The Outcome with Differentiation

This subsection presents the outcome under differentiation and explains how the negotiations will proceed. Without side payments, the regions bargain over \( d \) only.

**PROPOSITION 1:** If the regions negotiate \( d \), the unique sequential equilibrium satisfying the Intuitive Criterion has the following outcome \((d, t)\):

\[
\begin{array}{c|cc}
A's \ type & \hat{v} & \nu \\
\hline
\nu & (0, t_2) & (d', t_1) \\
\hat{v} & (-d', t_1) & (0, 0)
\end{array}
\]

where \( d', t_1, \) and \( t_2 \) are defined by:

\[
(5) \quad d' = \min \left\{ \frac{1}{2} \left[ \frac{\hat{v} - 1}{1 - \hat{v}(1 - 2\epsilon)} - \frac{\nu - 1}{1 - \nu(1 - 2\epsilon)} \right], D \right\},
\]

\[
(6) \quad \delta_1 = \frac{\hat{v} - 1}{\hat{v} - 1 + (1 - \hat{v}(1 - 2\epsilon))d'},
\]

\[
(7) \quad \delta_2 = \frac{\nu - 1 - (1 - \nu(1 - 2\epsilon))d'}{\hat{v} - 1 + (1 - \hat{v}(1 - 2\epsilon))d'}.
\]

The negotiations will proceed as follows. If region \( A \) is of high type, it will immediately propose equal contributions \((d = 0)\). A high-type \( B \) immediately accepts. A low-type \( B \), however, rejects \( A \)'s offer and delays until time \( t_1 \) before suggesting \((by \proposing \ -d')\) that \( A \) contribute most. This is immediately accepted by \( A \). If \( A \) is, instead, of low type, it does not make any immediate offer. Instead, \( A \) delays until \( t_1 \) before suggesting \((by \proposing \ d')\) that \( B \) contributes most. A high-type \( B \) immediately accepts. A low-type \( B \), however, rejects \( A \)'s offer and delays until \( t_2 \) before suggesting equal contributions, which \( A \) immediately accepts.

\(^{12}\) The intuition for this is that the other region can always suggest \( g = 1 \) in its next offer, while it cannot suggest to return to \( r = 0 \) after some delay. Thus, the other region demands less in the latter case.
In equilibrium, the region with the highest value of clean air will have to contribute the most. If \((v_A, v_B) = (\bar{v}, \bar{v})\), for example, \(B\) is very eager to quickly settle the agreement. Since eagerness reduces \(B\)'s bargaining power, \(A\) forces \(B\) to contribute most to the agreement \((d = d' > 0)\). The amount of differentiation \(d'\) is determined by the difference in bargaining power; it thus increases in \(\bar{v}\) but decreases in \(\bar{v}\). The final agreement \(d'\) is actually identical to the bargaining outcome if information were complete (see the Appendix). This property is defined as fair by Cramton (1992, 11), since then “neither trader has an incentive to renegotiate the deal based on information available after the settlement.” This feature is particularly appealing in the context of international agreements, where there is no third party enforcing the agreement.\(^{14}\) If \(A\) and \(B\) agreed to \(d > d'\), for example, \(B\) could easily declare the agreement to be invalid, after which each region would contribute zero until a new agreement were formed. Since regions’ types would be revealed at this stage, they would immediately negotiate a new agreement with \(d = d'\) as defined above. Thus, only fair agreements are stable toward such a unilateral request to renege on the agreement.

It is clearly attractive to be perceived as having a low value of the agreement, since the other region will then contribute more. With incomplete information, \(A\) wishes to pretend that it is of low type, even if this is false. To signal its reluctance credibly, a low-type \(A\) must delay in making an offer. The delay will be (exactly) so long that it would be too costly to afford for a high-type \(A\).\(^{15}\) If \(\bar{v}\) is small but \(e\) and \(d'\) large, it is less attractive to contribute locally; pretending to be a low type is more attractive, and the necessary delay (6)–(7) is large. Since only low types will delay, the agreement is settled earlier if more regions value it highly. Note that the bargaining outcome is symmetric.

B. Uniform or Different Policies?

Suppose the two regions are committed to uniform policies should they ever reach an agreement. In the model, this requires that \(d = 0\) in any offer. Then, the bargaining outcome is simple: \(A\) immediately suggests an agreement, and \(B\) immediately accepts, whatever are their types. Although the regions could demonstrate bargaining power by delaying or proposing \(g < 1\), this is not attractive, since the regions have to contribute by the same amount in any case. No type desires to imitate another type, so there is no delay. With uniform policies and no side payments, the unique sequential equilibrium outcome is thus \((d, t) = (0, 0)\).

We can use the results above to characterize the expected and discounted utility. In the case of uniform and differentiated policies, respectively, this can be written as

\[
(8) \quad u^0 = \frac{1}{4} (\bar{v} - 1) + \frac{1}{4} (v - 1) + \frac{1}{2} \left(\frac{\bar{v} + v}{2} - 1\right),
\]

\[
(9) \quad u^d = \frac{1}{4} (\bar{v} - 1) + \frac{1}{4} (v - 1) \delta^t + \frac{1}{2} \left(\frac{\bar{v} + v}{2} - 1 + \left(\frac{1}{2} - e\right) (\bar{v} - v) d'\right) \delta^t.
\]

The fractions \(\frac{1}{4}\), \(\frac{1}{4}\), and \(\frac{1}{2}\) are the probabilities that the regions are both low types, both high types, or different types, respectively. The parentheses contain the total utility in each case, discounted appropriately. By comparison, differentiation provides costs as well as benefits. The potential benefit is that the region with the highest value of clean air will reduce its emission most. The cost is that such an agreement is delayed.

It is useful to define the expected value as

\[
v = \frac{\bar{v} + v}{2},
\]
and the heterogeneity by the relative difference in the two types’ net value of a uniform agreement,

\[ h = \frac{\bar{v} - 1}{v - 1} > 1. \]

**PROPOSITION 2:** \( u^0 \geq u^d \) if and only if condition (10) holds. This is more likely if the externality \( e \) is large, the heterogeneity \( h \) small, and the value \( v \) low:

\[ (10) \quad h \left[ 2(v - 1) \left( \frac{1 - 2e}{e} \right) - 1 \right] \leq 3. \]

The intuition is as follows. If the externality \( e \) is low, it is beneficial that the high-type region cleans more, since this will imply that the air is cleaner where this is more appreciated. Thus, the differentiation following from the bargaining game is valuable. If \( e \approx \frac{1}{2} \), however, it is of less importance where cleaning is located, since the amount of clean air will, in any case, be similar in both regions. The value of differentiation is then low. If \( e > \frac{1}{2} \), it is optimal that the low-type region contributed more. In equilibrium, however, the high-type region ends up contributing more, since it has the lower bargaining power. Requiring harmonization would then clearly be better. Overall, a larger \( e \) decreases the benefit from differentiation (9). The delays (6)-(7) increase: as \( e \) increases, each region benefits more from the other region’s contribution, and the high type becomes more tempted to imitate the low type’s strategy. To signal bargaining power credibly, delay must increase. In sum: if \( e \) increases, uniformity becomes better relative to differentiation.

As noticed, it is necessary that \( e < \frac{1}{2} \) for differentiation to be good. If \( v \) then increases, there is an increase in the gains from cleaning domestically, and the high-type region becomes less tempted to signal bargaining power. Consequently, the delay decreases, and differentiation becomes better relative to uniformity.

If the heterogeneity \( h \) becomes larger, differentiation becomes more valuable and, thus, better relative to uniformity.

The chain of causation is admittedly somewhat more complex: if \( e, h, \) or \( v \) changes, so does the amount of equilibrium differentiation \( d' \). And when \( d' \) changes, so do both the cost (the delay) and the benefit (the amount) of differentiation. In fact, the cost and benefit increase similarly when \( d' \) increases, and the two effects cancel (shown in the proof of Proposition 2). This is also the reason why the upper boundary \( D \) does not appear in equation (10), and why it does not matter whether it binds.\(^\text{16}\)

### III. With Side Payments: Uniform or Different Policies?

As issue linkages and logrolling become intrinsic in the political debate, some kind of side payments between regions can be included and maybe not excluded from the bargaining agenda. As already noticed, side payments can also be achieved by negotiating federal taxes differing (instead of being uniform) across regions. Thus, this section returns to the original problem in Section I by letting the regions negotiate side payments as well as policy differentiation.

The Pareto frontier of a final agreement is drawn in Figure 1, assuming \((v_A, v_B) = (\bar{v}, \bar{v})\). The point \( d = 0 \) represents the utility-pair with uniformity and no side payments. Policy differentiation makes all utility-pairs along the \( d \)-line possible. The \( s \)-line shows the Pareto frontier when side payments are also allowed.

\(^\text{16}\) Neither does the discount factor \( \delta \) appear in (10). For signaling, it is necessary that the cost of delay is sufficiently large. If \( \delta \) increases, the cost per unit of delay decreases and delay thus increases, thereby keeping the overall cost of delay unchanged.
A. The Outcome with Side Payments and Differentiation

This subsection states the bargaining outcome and explains how the negotiations will proceed.

PROPOSITION 3: If the regions negotiate $d$ and $s$, the unique symmetric sequential equilibrium satisfying the Intuitive Criterion has the following outcome $(d, s, t)$:

If $e \leq \frac{1}{2}$:

<table>
<thead>
<tr>
<th>A’s type</th>
<th>$\bar{v}$</th>
<th>$\bar{\bar{v}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$v$</td>
<td>$(0, 0, t_2)$</td>
<td>$(D, s, t_1)$</td>
</tr>
<tr>
<td>$\bar{v}$</td>
<td>$(-D, \bar{s}, t_1)$</td>
<td>$(0, 0, 0)$</td>
</tr>
</tbody>
</table>

If $e \geq \frac{1}{2}$:

<table>
<thead>
<tr>
<th>A’s type</th>
<th>$\bar{v}$</th>
<th>$\bar{\bar{v}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$v$</td>
<td>$(0, 0, t_2)$</td>
<td>$(-D, \bar{s}, t_1)$</td>
</tr>
<tr>
<td>$\bar{v}$</td>
<td>$(D, \bar{s}, t_1)$</td>
<td>$(0, 0, 0)$</td>
</tr>
</tbody>
</table>

where $t_1, t_2, s$, and $\bar{s}$ are defined by:

\[(11) \quad \delta^i = \min \left\{ \frac{2(\bar{v} - 1)}{2(\bar{v} - 1) + (\bar{v} - \bar{v})(1 - |1 - 2e|D)}, 1 \right\}, \]

\[(12) \quad \delta^s = \min \left\{ \frac{2(\bar{v} - 1) - (\bar{v} - \bar{v})(1 - |1 - 2e|D)}{2(\bar{v} - 1) + (\bar{v} - \bar{v})(1 - |1 - 2e|D)}, 1 \right\}, \]

\[(13) \quad s = \frac{1}{4} (\bar{v} - \bar{v}) - \frac{D}{4} [2 - (\bar{v} + \bar{v})(1 - 2e)], \]

\[\bar{s} = \frac{1}{4} (\bar{v} - \bar{v}) + \frac{D}{4} [2 - (\bar{v} + \bar{v})(1 - 2e)].\]

The negotiations will proceed as follows. Suppose that $e \leq \frac{1}{2}$. If region $A$ is of high type, it proposes $(d, s) = (0, 0)$ at $t = 0$. A high-type $B$ immediately accepts. A low-type $B$ rejects $A$’s offer and delays to $t_1^0$ before it counteroffers $(-D, -s)$, which $A$ accepts. If region $A$ is of low type, it does not make any immediate offer. Instead, $A$ delays to $t_1^0$ before proposing $(D, s)$. A high-type $B$ immediately accepts. A low-type $B$ rejects $A$’s offer and delays to $t_2^0$ before it counteroffers $(0, 0)$, which $A$ immediately accepts. If $e > \frac{1}{2}$, the behavior is similar, but now a low-type region suggests that it will make the largest contribution itself. Naturally, the side payment to the low-type region must then be larger ($\bar{s} > s$). Just as in the previous section, the outcome is fair in that it is identical to the outcome if information were complete; the policy is optimally differentiated and the side payments are such that both regions benefit equally from the agreement.

The side payment consists of two parts. The first is a transfer from the high-type to the low-type region, since the latter has more bargaining power. This would take place even without differentiation ($D = 0$). The second part is a transfer to compensate the region that contributes most. If $e < \frac{1}{2}$, the high-type region should claim most and the two parts have opposite signs. The first dominates if $D$ is small, and $s$ is then positive. If $D$ is large, the second part dominates and there is a net transfer from the low-type to the high-type region. If $e > \frac{1}{2}$, the low type cleans most and both parts imply a transfer from the high-type to the low-type region ($\bar{s} > 0$).

Just as in the previous section, a low-type region delays to signal its bargaining power credibly. A high-type region finds the low-type region’s strategy unattractive for two reasons. As before, a high-type region is less patient and cannot afford a delay. Second, imitating the low type would imply inefficient differentiation. If $e < \frac{1}{2}$ and $s < 0$, for example, the low-type region pays the other region to contribute most. A high-type region has a lower willingness to pay for such a “trade.” Thus, a region signals its type by proposing a certain “direction of trade.” If $D|1 - 2e|$ is large, the gains from efficient trade are large, the high type is little tempted to imitate the low type, and the necessary delay to separate the two types is small. If $D|1 - 2e| \geq 1$, proposing a direction of trade is a sufficient signal: delay is not necessary and the bargaining outcome is first best.
B. When Is Uniformity Better?

When both differentiation and side payments are possible, total expected utility can be written as

\begin{equation}
\begin{aligned}
\text{(14)} \quad u^{ds} &= \frac{1}{4} (\bar{v} - 1) + \frac{1}{4} (\nu - 1) \delta^k \\
+ \frac{1}{2} \left[ \bar{v} + \frac{\nu}{2} - 1 + (\bar{v} - \nu) \left| \frac{1}{2} - e \right| D \right] \delta^s.
\end{aligned}
\end{equation}

As in the previous section, we now study whether uniformity can be beneficial. Suppose uniformity is required and that the regions bargain over \( s \) only. Obviously, the outcome will be exactly as above by setting \( D = 0 \). Define the resulting total expected utility as \( u^s \). By comparison:

PROPOSITION 4: \( u^{ds} > u^s \) always.

The proposition holds simply because \( u^{ds} \) increases in \( D \), which is true for two reasons. First, as \( D \) increases, it becomes possible to concentrate more of the cleaning in one region, and the gain from efficient differentiation increases (14). Second, regions can signal their types by proposing a certain “direction of trade,” as discussed in the previous subsection. The larger is \( D \), the more credible is this signal, and the less delay is necessary (11)-(12). Thus, allowing differentiation makes the final agreement better as well as the delay shorter.

While Proposition 4 says that differentiation is better whenever side payments must be on the agenda, it does not imply that differentiation is good whenever side payments can be part of the agenda. It may be beneficial to prohibit both side payments and differentiation, since this ensures zero delay:

PROPOSITION 5: \( u^0 \geq u^{ds} \) if and only if both \( D|1 - 2e| < 1 \) and (15) hold. This is more likely if the heterogeneity \( h \) is small, the possibility to differentiate \( D \) small, and \( |\frac{1}{2} - e| \) small:

\begin{equation}
\begin{aligned}
\text{(15)} \quad h \left( \frac{2}{1 - |1 - 2e|D} - 3 \right) \leq 3.
\end{aligned}
\end{equation}

As discussed above, \( u^{ds} \) increases in \( D \), so \( u^{ds} > u^0 \) only if \( D \) is sufficiently large. In the special case where \( D = 0 \), the policy cannot be differentiated, and allowing side payments leads to delay but no benefits. Thus, \( u^0 > u^s \) follows as a corollary.

If \( e \approx \frac{1}{2} \), it is of less importance where cleaning takes place, and there is little value in differentiation. Again, \( u^0 > u^{ds} \) because of the delay. If \( e < \frac{1}{2} \), most of the cleaning takes place in the high-type region in equilibrium, and the benefit of this is decreasing in \( e \). If \( e > \frac{1}{2} \), optimal differentiation implies that the low-type region does most of the cleaning, and this benefit is increasing in \( e \). In either case, the value of differentiation is increasing in \( |\frac{1}{2} - e| \). A larger heterogeneity \( h \) raises the value of differentiation, just as before.\(^{17}\)

IV. Are Side Payments Good?

While the previous section analyzed the negotiations with side payments, Section II studied the game without. Whether side payments are possible may sometimes be a deliberate choice, and thus endogenous. For example, bundling trade and environmental negotiations may facilitate side payments. Delegating the bargaining power to a minister with little discretion over other policies may instead preclude effective

\(^{17}\) Note that the value \( \nu \) does not appear in (15). Both the benefit of differentiation and the cost of delay increase proportionally in \( \nu \), which therefore does not affect the comparison between them.
side payments. In federal unions, side payments may be prevented by a constitution that requires tax rates to be uniform across regions. In evaluating these alternatives, it is necessary to ask whether side payments are good.

Figure 1 illustrates the traditional justification for side payments. There are gains from trade, in the sense that the policy is optimally differentiated in equilibrium, while side payments are used to compensate the region that contributes most. In addition, the previous section showed that a region can signal its type by the proposed direction of trade, thus reducing the need to signal by delay.

There is, however, a third effect. Without side payments, the value of bargaining power is limited by the possibilities of differentiating policy (3). With side payments available, a low-type region may force a high-type region to pay in side payments what it cannot pay in politics. Then, bargaining power pays off more when side payments are available, and imitating the low-type’s strategy becomes more tempting. There are then stronger incentives to signal bargaining power, which might outweigh the reduced necessity to use delay as a signaling device. This is certainly the case if \( D \approx 0 \), since Proposition 5 implies that \( u^D > u^d \). The general conclusion requires a comparison between \( u^d \) and \( u^{ls} \).

**PROPOSITION 6**: \( u^d \geq u^{ls} \) if and only if \( D \) is small, the externality \( e \) small, and the value \( v \) large. If \( e \leq \frac{1}{2} \), the exact condition is given by (16):

\[
D \left( \frac{1 - v(1 - 2e)}{v - 1} \right) \leq \frac{h - 1}{h + 1}.
\]

To understand the general intuition for the result, first consider the case without side payments. If \( v \) is large and \( e \) small, the high type is quite happy to clean locally since it acquires most of the benefits itself (since \( e \) is small) and these benefits are large (since \( v \) is large). It is not very tempting to delay just to contribute less; the conflict of interest is low, and so is delay (6)–(7). If, in addition, \( D \) is small, there is not much to fight over anyway. Introducing side payments destroys the peace. Then, the low type requires side payments from the high type, the incentives to signal bargaining power increase as does delay. Therefore, in this case, side payments are bad. In the opposite case (\( v \) is low but \( e \) and \( D \) are large), there is already a great deal of conflict and delay without side payments. In equilibrium, transfers will be used to compensate the region that contributes most. Proposing to pay to contribute less is a credible signaling device, making delay less necessary. Moreover, there are gains from trade (unless the policy is first-best differentiated without side payments), which increase in \( D \). Thus, if \( D \) is large, \( e \) large, and \( v \) small, side payments are beneficial.

The intuition is particularly simple if \( e \leq \frac{1}{2} \). Suppose that (3) binds, such that \( d' = D \). Then, there is no gain from trade by allowing side payments, and side payments are good if and only if they reduce delay. Clearly, it is more tempting to demonstrate bargaining power if the equilibrium transfer goes from the high to the low type, i.e., if \( \gamma > 0 \). If \( \gamma < 0 \), on the other hand, the high type will require compensation for bearing the lion’s share of the burden. This makes it less attractive to imitate the low type, and delay decreases when side payments are possible. Thus, the condition for when side payments are bad (16) coincides with the condition for when \( \gamma \geq 0 \) (13). If (3) does not bind (\( d' < D \)), there are gains from trade and \( \gamma < 0 \). Side payments are always good and condition (16) is never fulfilled.\(^{18}\)

The general lesson can be formulated in short: side payments provide gains from trade as well as a possibility to signal by the proposed direction of trade. However, side payments also increase the conflict of interest and, thus, the incentives to signal bargaining power by delay. If the gains from trade are large, the first two effects dominate, and side payments are good. If the gains from trade and the existing conflict of interest are small, the latter effect dominates, and side payments are detrimental to total welfare.

V. Interpretations

Straightforwardly, the results can be interpreted as recommendations on how to organize

---

\(^{18}\) The role of \( h \) is, in general, ambiguous. A larger \( h \) increases \( s \) and thus the incentives to signal bargaining power, making (16) more likely to be fulfilled. If \( e \gg \frac{1}{2} \) however, there are gains from trade, which increase in \( h \). If \( D \) is small, the first effect dominates and increasing \( h \) makes side payments bad. If \( D \) is large, the second effect dominates and increasing \( h \) makes side payments good. The exact conditions are derived in the Appendix.
international negotiations. The first subsection summarizes the results in this light. In addition, the second subsection argues that the results locate the optimal allocation of authority under the standard assumption that centralization implies uniformity. A novel theoretical foundation for this assumption is provided in the final subsection.

A. International Cooperation

Negotiating agreements between autonomous states or regions can be a difficult task. Two important questions are: To which extent should the policies be harmonized across regions? Should side payments be used? The possible bargaining agendas can be represented by the following table:

<table>
<thead>
<tr>
<th>Side payments?</th>
<th>Policy differentiation?</th>
<th>$u^o$</th>
<th>$u^d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section II compared the bargaining agendas in the first row of the table. Without side payments, harmonization is good ($u^0 > u^d$) when the externality is large while the heterogeneity and the value of the public good are low. Section III compared the bargaining agendas in the second row. With side payments, differentiation is always good ($u^{ds} > u^d$), but it would be better to prohibit both side payments and differentiation ($u^0 > u^{ds}$) if the externality is large, heterogeneity low, and the possibility to differentiate small. The comparison between the rows, in Section IV, revealed that it is efficient to prohibit side payments ($u^d > u^{ds}$) if the externality and the possibility to differentiate are small, while the value of the agreement is large; $u^0 > u^d$ follows as a corollary. While both differentiation and side payments make the negotiations flexible and tie the policy to local conditions, they create conflicts of interest and, thus, delay. Notice that the two are complements: with side payments, differentiation is always good; without differentiation, side payments are always bad.

B. Decentralization or Centralization? Ministers or Heads of State?

As mentioned in the introduction, whether side payments and differentiation are possible may depend on the institutions. Side payments can be allowed or prohibited, respectively, by allocating control to the head of government or a minister with less discretion over other policies. While decentralized cooperation does not imply uniformity, centralization does, under the standard uniformity assumption. With this interpretation, $u^0 > u^d$ implies that centralization is better than decentralizing to local ministers; $u^0 > u^{ds}$ means that centralization is better than decentralizing to local heads of governments; while $u^d > u^{ds}$ states that local ministers should be in charge rather than the heads of local governments. Together, the results locate the optimal allocation of authority depending on the externality, the heterogeneity, and the value of the agreement.

As compared to the traditional literature (e.g., Oates 1972), certain results are confirmed: centralization is better if heterogeneity is low and the externality large. If the value of the public good is large, differentiation is optimal. More important issues should thus be decentralized, since the regions bargain over these efficiently, just as in Peter Klibanoff and Jonathan Morduch (1995). In contrast to the literature, however, the existence of asymmetric information is an argument for centralization. If information were complete, differentiation would be first-best, as would decentralized coordination. With asymmetric information, instead, decentralized coordination is inefficient and centralization may be better. Moreover, the central government’s uniform policy is not a drawback, calling for more decentralization (as normally argued). Quite the opposite; it is uniformity that makes the case for centralization, since it reduces the costs of reaching an agreement.

C. The Uniformity Assumption: A Theoretical Foundation

Since the bargaining equilibrium above is unique and in separating strategies, differentiation and side payments will always be requested.

---

19 A related trade-off is studied by Patrick Bolton and Joseph Farrell (1990). Decentralizing firms’ entry in a market leads to delay, but the most efficient firm is likely to enter first. A clumsy government, they assume, will immediately but randomly pick one firm.
by a low-type region whenever possible.\textsuperscript{20} Thus, characterizing the best bargaining agenda is relevant only if the regions can precommit to this before learning their own types. One way of committing may be to use trigger strategies in frequent interaction, where regions stick to the agenda to sustain future cooperation. This can be achieved, for example, by a norm against using cash to settle trade agreements. A more formal way of committing is to write treaties or a constitution, calling for harmonized policies for certain issues. Either way, regions constituting a federal union should be better able to commit to uniform policies when this is beneficial. Hence, the theory predicts more uniformity between regions that form a federal union than between regions that do not, and politician integration should lead to more uniformity. The analysis above thus provides a theoretical foundation for the uniformity assumption, and characterizes when it is likely to hold.

VI. Robustness

To keep the analysis concise and tractable, the model is as simple as possible. The results continue to hold, however, in more general models. For example, the model can easily be extended to allow for heterogeneity in externalities, cleaning costs, type-sets, or probabilities of being low types.

Any bargaining game is just an example of how negotiations may proceed, and it is important to ask whether the results would hold under different procedures. The assumption that proposal power is alternating is quite standard. By relaxing the assumption that a region must make its offer at a particular time, however, I indi-

\textsuperscript{20} Nevertheless, even a low-type region may benefit from committing to uniformity. Without and with side payments, respectively, these conditions are

\[ h\left(2(v-1)\left(\frac{1-2e}{e}\right) - 1\right) \leq 3 - h(h-1) \quad \text{and} \]

\[ h\left(\frac{2}{1 - |1 - 2e|D} - 1\right) \leq 3, \]

thus stronger than the corresponding optimality conditions (10) and (15). Still, there is no pooling equilibrium where all types propose uniformity. If there were, a low type could deviate, propose differentiation, and, thus, signal its type without delay. This deviation, it turns out, benefits the low type.

\textsuperscript{21} Notice that \( \delta' \) may, alternatively, be interpreted as the size of the agreement or the probability of the agreement
payments, set \( s = 0 \) and define the mechanism by \( M^d : (\psi, \theta) \mapsto \mathbb{R}^2 \). As argued in Section II A, it may be necessary to require the outcome to be \textit{fair}, since one region would otherwise request renegotiation. And, to ensure robustness, Robert Wilson (1985, 1101) argues that mechanisms should “not rely on features of the agents’ common knowledge, such as their probability assessments.” In our context, this is equivalent to requiring the mechanism to be implementable in dominant strategies, or that honest revelation is an ex post equilibrium. With these two restrictions, no procedure can do better than the equilibria above.

\textbf{PROPOSITION 7:} The equilibria in Propositions 1 and 3 implement, respectively, the most efficient mechanisms \( M^d \) and \( M^d_s \) that are fair and implementable in dominant strategies.

Thus, no “reasonable” procedure can mitigate the inefficiencies above. The conditions for when uniformity is good and side payments bad hold for all such procedures.  

\textbf{VII. Concluding Remarks}

The paper combines a regional public good model with bargaining under private information. Conditions are derived under which policy uniformity is good and side payments are bad. Besides providing normative recommendations for how to organize international cooperation, the results determine where control should be located: central or local governments; heads of government or ministers. The analysis also explains why centralization may imply uniformity, a critical and controversial assumption in the federalism literature.

The empirical predictions of the model are clear. For example, uniformity is good if and only if the externality is large. While the requirements are harmonized for air and water quality, “the EU does not yet have a common waste management policy” (McCormick 2001, 168). Since the regional externality appears to be smaller in the latter case, this is in line with the theory. As the EU expands, heterogeneity is likely to increase, and uniformity should be less desirable, according to the theory. Indeed, De Burca and Scott (2000) argue that the EU has moved toward more flexibility as more members have been accepted.  

A careful empirical investigation is beyond the scope of this paper, but seems to be an interesting topic for future research.

Theoretically, the analysis evaluates uniformity and side payments in a simple bargaining context. Institutional details are ignored, although they are likely to play important roles in reality. Rules shaping bargaining, voting, or the status quo may affect the desire to signal by delay; future research should explore how. The trade-offs above may also appear in settings quite different from political cooperation. For example, while side payments are the means of transaction in the market, they rarely take place within firms. Drawing on the analysis above, the advantage of the market should be larger gains from trade. Transactions within the firm, however, are less costly in terms of signaling or delay. Hence, when private information is important, firms should outperform markets.

Taking place. Thus, there is no loss of generality by looking at deterministic mechanisms.  

\textit{Uniformity and prohibiting side payments may do better than \( M^d \) and \( M^d_s \), since the outcome is then not necessarily fair.}

\textit{22 Prior to the Maastricht Treaty, Article 94 referred to “the approximation, or harmonisation.” Nugent (2003, 301) writes that “the word harmonisation was dropped to reflect the more flexible and less rigid approach that had developed towards differences in national standards and requirements.”}

\textbf{APPENDIX}

\textbf{PROOF OF PROPOSITION 1:}

First, some notation is introduced. A \textit{history} after \( N \) offers is the set of proposed and rejected offers, \( H_N = \{d_N, t_N\}_N \). Let \( H_N \) denote the set of possible histories, define \( H_0 = (0, 0) \), and let \( H \) be the set of all possible histories. A \textit{pure strategy} for \( A \) is a rule \( f_A \) that says, whenever \( N \) is even, whether \( A \) should accept the previous offer or make a counteroffer \( d_{N+1} \) with delay \( t_{N+1} - t_N \geq 0 \), \( f_A : H \to \{ \text{accept} \} \cup (\mathbb{R}, \mathbb{R}_+) \). \( A \)'s belief \( b_A : H \to [0, 1] \) denotes the probability \( A \) puts on the state
$v_B = v$ after some history $H_N$. Similarly, $f_B$ and $b_B$ denote $B$'s strategy and beliefs. At $t = 0$, $b_A = b_B = \frac{1}{2}$.

Roughly speaking, a *sequential equilibrium* (Kreps and Wilson 1982) is a set of strategies and beliefs such that after every history, each player’s strategy is optimal, given its beliefs and the other player’s strategy, and the beliefs are consistent with Bayes’s rule. The *intuitive criterion* (Cho and Kreps 1987) is a refinement restricting the beliefs outside the equilibrium. In essence, it requires that any action out of equilibrium that is beneficial for exactly one type implies that beliefs place probability one on this type. For the case without side payments, this may be defined as follows:

**DEFINITION 1**: Let $(d, i)$ denote the (expected) equilibrium outcome if $i$ is of high type, given $i$’s belief. Let $F_i = \{(d, i)\mid (d, t) \succ_i (d, i)\}$ if and only if $v_i = v$. The intuitive criterion requires that $b_j = 1$ after $i \neq j$ has taken some action leading to an outcome in $F_i$.

An earlier version of this paper (Harstad 2004) let each region be of low type with probability $p$, and found that a pooling equilibrium might exist if $p \geq \tilde{p}$ for some $\tilde{p} > \frac{1}{2}$. Since a pooling equilibrium is thus impossible when $p = \frac{1}{2}$, I will restrict the attention to separating equilibria.

If information were complete, an argument similar to that of Ariel Rubinstein (1982) implies that the unique sequential equilibrium is the one defined by Proposition 1 with zero delay.\(^{24}\) This level of differentiation is the best anyone can hope for in a separating equilibrium, since anything better would be rejected by the other region when the types are revealed.

Suppose that $A$ is revealed to be of low type by making its last offer at $t_A$. A high-type $B$ will not be able to convince $A$ that $B$ is of low type. Thus, $B$ accepts any $d \leq d'$, and will itself immediately propose $d'$ if $A$ proposes $d > d'$. Should $A$ understand that $B$ is of low type, $A$ would accept any $d \geq 0$. Thus, a low-type $B$ maximizes its utility by proposing an offer in $F_B$ which is acceptable to $A$ if $b_A = 1$. That is, the offer must be unattractive to a high-type $B$ and acceptable to a low-type $A$ with beliefs $b_A = 1$.\(^{25}\)

\[
\max_{(d,t_2)} \frac{1}{2} \left[ v - 1 - (1 - v(1 - 2e))d \right] \delta^{t_2} \quad \text{s.t. } d \geq 0 \quad \text{and}
\]

\[
\frac{1}{2} \left[ \bar{v} - 1 - (1 - \bar{v}(1 - 2e))d' \right] \delta^{t_2} \geq \frac{1}{2} \left[ \bar{v} - 1 - (1 - \bar{v}(1 - 2e))d \right] \delta^{t_2}
\]

\[
\Rightarrow d = 0 \quad \text{and} \quad \delta^{t_2-t_4} = \frac{\bar{v} - 1 - (1 - \bar{v}(1 - 2e))d'}{\bar{v} - 1}.
\]

Suppose, instead, that $A$ is revealed to be of high type by making an offer at $t_A$. A high-type $B$ will not be able to convince $A$ that $B$ is of low type, and $B$ accepts any $d \leq 0$, and will itself immediately

\(^{24}\) Note that an affine transformation of the utilities gives

\[
\tilde{u}_A = \frac{u_A}{(1 - v_A(1 - 2e))} = w_A + d \quad \text{and} \quad \tilde{u}_B = \frac{u_B}{(1 - v_B(1 - 2e))} = w_B - d, \quad \text{where} \quad w_i = \frac{v_i - 1}{1 - v_i(1 - 2e)}
\]

is $i$’s willingness to pay for the agreement in terms of $d$. In the Rubinstein (1982) alternating offer bargaining game, as the time between offers approaches zero, $d$ will be set such that $\tilde{u}_A$ and $\tilde{u}_B$ are equalized: $d = (w_B - w_A)/2 \Rightarrow (5)$.

\(^{25}\) Any other offer would either be less desirable for the low type, or also desirable for the high type. Thus, only this offer can constitute a separating equilibrium satisfying the Intuitive Criterion.
propose \( d = 0 \) if \( A \) proposes \( d > 0 \). A low-type \( B \), on the other hand, maximizes its utility by proposing an acceptable offer in \( F_B \). The problem is similar to that above, and the solution is

\[
d = -d' \quad \text{and} \quad \delta^{i_A} = \frac{\bar{v} - 1}{\bar{v} - 1 + (1 - \bar{v}(1 - 2e))d'}.
\]

Having found \( B \)'s optimal strategy, let us turn to \( A \). In a separating equilibrium, \( A \) makes an offer which only a high-type \( B \) accepts. If \( A \) is of high type, it cannot persuade \( B \) to believe that \( b_B = 1 \). Thus, a high-type \( A \) proposes \( d = 0 \) at \( t_A = 0 \), which gives \( A \) the expected utility

\[
\bar{u}_A = \frac{1}{4}(\bar{v} - 1) + \frac{1}{4}[\bar{v} - 1 - (1 - \bar{v}(1 - 2e))d']\delta^{i_A}.
\]

The low-type \( A \)'s problem is then to make an offer which is not attractive to a high-type \( A \), but acceptable to a high-type \( B \) with beliefs \( b_B = 1 \):

\[
\max_{d(t_A)} \left\{ \frac{1}{4}[\bar{v} - 1 + (1 - \bar{v}(1 - 2e))d]\delta^{i_A} + \frac{1}{4}(\bar{v} - 1)\delta^{i_A} \delta^{i_B} \right\} \quad \text{s.t.} \quad d \leq d' \quad \text{and} \quad \bar{u}_A \geq \frac{1}{4}[\bar{v} - 1 + (1 - \bar{v}(1 - 2e))d]\delta^{i_A} + \frac{1}{4}(\bar{v} - 1)\delta^{i_A} \delta^{i_B}.
\]

The solution is \( d = d' \) and

\[
\delta^{i_A} = \frac{\bar{v} - 1}{\bar{v} - 1 + (1 - \bar{v}(1 - 2e))d'}.
\]

Combined, it follows that \( \delta^{i_A} = \delta^{i_A} = \delta^{i_B} \) and \( \delta^{i_A} \) are such as defined in (6)–(7).

**PROOF OF PROPOSITION 2:**

Note that \( 1 - \delta^v = 2(1 - \delta^v) \). Comparing (8) and (9), \( u^d \leq u^0 \) requires:

\[
\frac{1}{2} \left[ \frac{1}{2} e \right] (\bar{v} - \bar{v})d \delta^{i_A} \leq \frac{1}{2} \left[ \frac{1}{2} + \frac{1}{2} (\bar{v} + \bar{v}) - 1 \right] (1 - \delta^v) + \frac{1}{4} (\bar{v} - 1)(1 - \delta^v)
\]

\[
\iff (1 - 2e)(\bar{v} - \bar{v})(\bar{v} - 1)d' \leq (3\bar{v} + \bar{v} - 4)(1 - \bar{v}(1 - 2e)]d' \iff (d' \text{ cancels!}) \quad 2(1 - 2e)(\bar{v} + \bar{v} - 2)(\bar{v} - 1) \leq 2e(3\bar{v} + \bar{v} - 4) \iff (1 - 2e)2(\bar{v} - 1)h \leq e(h + 3) \iff (10).
\]

**PROOF OF PROPOSITION 3:**

The proof is quite similar to the proof of Proposition 1, so only the key differences will be mentioned. The relevant concepts are defined in the analogous way. If information were complete, the unique sequential equilibrium would be given by Proposition 3 with no delay: this can be shown as a similar reasoning to that of Rubinstein (1982). As previously, no pooling equilibrium exists, so the attention can be restricted to separating equilibria.

Suppose that \( e \leq \frac{1}{2} \), and that \( A \) is revealed to be of low type by making an offer at \( t_A' \). A high-type \( B \) will be unable to convince \( A \) that \( B \) is of low type, and will propose \( d = D \) and \( s = s \), giving \( B \) utility \( \bar{u}_B = [\bar{v} + \bar{v} - 2 + (\bar{v} - \bar{v})(1 - 2e)D]/4 \). This offer equalizes and maximizes \( A \)'s and \( B \)'s utility of the agreement, and it is the best \( B \) can hope for. Thus, in considering \( A \)'s offer, a high-type \( B \) accepts anything that would make \( B \)'s utility at least as large as \( \bar{u}_B \). If we restrict the attention to
symmetric outcomes (where \( d = s = 0 \) if \( v_A = v_B \)), a low-type \( B \) proposes a stable agreement \((0, 0, t^*_A)\) acceptable to \( A \) but unattractive for a high-type \( B \):

\[
\text{max}_{t^*_A} \frac{1}{2} (v - 1) \delta^t_A \quad \text{s.t.} \quad \bar{u}_B \delta^t_A \geq \frac{1}{2} (\bar{v} - 1) \delta^t_A \Rightarrow \delta^t_A - t^*_A = \min \left\{ \frac{\bar{v} + \bar{v} - 2 + (\bar{v} - \bar{v})(1 - 2e)D}{2(\bar{v} - 1)}, 1 \right\}.
\]

Suppose, instead, that \( A \) is revealed to be of high type by making an offer at \( t^*_A \). A high-type \( B \) accepts/proposes \( d = s = 0 \), giving \( B \) utility \((\bar{v} - 1)/2\). A low-type \( B \) proposes the best agreement acceptable to \( A \) but not for a high-type \( B \). This is \((-D, -\bar{s}, \bar{t}_B)\), where

\[
\delta^t_A = \min \left\{ \frac{\bar{v} - 1}{\bar{v} - 1 + (\bar{v} - \bar{v})(1 - (1 - 2e)D)/2}, 1 \right\}.
\]

The high-type \( A \) makes an offer that only a high-type \( B \) accepts \((d = s = 0)\) at \( t^*_A = 0 \), giving

\[
\bar{u}_A = \frac{1}{4} (\bar{v} - 1) + \frac{1}{4} (\bar{v} - 1 - (\bar{v}(1 - 2e)) D - \bar{s}) \delta^t_A.
\]

The low-type \( A \)'s problem is then to make an offer that is not attractive to a high-type \( A \), but acceptable to a high-type \( B \) with beliefs \( \bar{b}_B = 1 \). It can easily be shown that a low-type \( A \) will make a screening offer \((D, \bar{s}, \bar{t}_A)\) where

\[
\delta^t_A = \min \left\{ \frac{\bar{v} - 1}{\bar{v} - 1 + (\bar{v} - \bar{v})(1 - (1 - 2e)D)/2}, 1 \right\}.
\]

If \( e > \frac{1}{2} \), the proof proceeds in the same way, but since \( d \) changes signs in the optimal agreement, \((1 - 2e)D \) should be replaced by \(|1 - 2e|D \). Combined, it follows that \( \delta^t_A = \delta^t_B = \delta^t \) and \( \delta^t \) are such as defined in Proposition 3.

**PROOF OF PROPOSITION 5:**

If \( D|1 - 2e| \geq 1 \), the policy is optimally differentiated with no delay. Thus, assume that \( D|1 - 2e| < 1 \). Requiring \( u^d \leq u^d \) implies

\[
\frac{1}{2} \left( \bar{v} - \bar{v} \right) \left( \frac{3}{2} - e \right) D \delta^t_A \leq \frac{1}{2} \left( \frac{\bar{v} + \bar{v}}{2} - 1 \right) (1 - \delta^t_A) + \frac{1}{4} (\bar{v} - 1)(1 - \delta^t_A) \Leftrightarrow (\bar{v} - \bar{v})|1 - 2e|D \\
\leq \frac{3\bar{v} + \bar{v} - 4}{2(\bar{v} - 1)} \left( \bar{v} - \bar{v} \right)(1 - |1 - 2e|D) \Leftrightarrow 2h|1 - 2e|D \leq [3 + h](1 - |1 - 2e|D) \Leftrightarrow (15).
\]

**PROOF OF PROPOSITION 6:**

Comparing (6)–(7) and (11)–(12), notice that side payments increase delay whenever

\[
(A1) \quad (\bar{v} - \bar{v})(1 - |1 - 2e|D) \geq (1 - \bar{v}(1 - 2e))d'.
\]

---

26 Why restrict the attention to symmetric offers? If both regions are of low type, \( B \) can signal this most cheaply by proposing that \( A \) contribute most \((d = -D)\) and adjusting the side payments to equalize utilities. This would be quite expensive for a high-type \( B \), so less delay is necessary. Allowing such an offer would make the outcome with differentiation more efficient, but the results would not change qualitatively. If small transaction costs were related to the side payments, \( A \) and \( B \) would prefer to renegotiate and set \( d = s = 0 \), when both are proven to be of low type. Hence, signaling by proposing \( d = -D \) would not be credible, since the agreement would not be fair.
Substituting for $d'$ reveals that this condition never holds when $d' < D$. Then, side payments reduce delay (in addition to permitting optimal differentiation) and are always good. Thus, suppose (3) binds and $d' = D$. If $e \leq \frac{1}{2}$, there are no gains from trade, and side payments are bad if and only if (A1) holds. This requires

$$
(\bar{v} - v)(1 - (1 - 2e)D) \geq 2[1 - \bar{v}(1 - 2e)]D \Leftrightarrow (\bar{v} - v) \geq D[2 - (\bar{v} + v)(1 - 2e)] \Leftrightarrow (16).
$$

If $e > \frac{1}{2}$, there are gains from trade since $d = -D$ is optimal, while $d' = D$ without side payments. Prohibiting side payments is good if $u^{di} < u^d$, requiring:

$$
\frac{1}{2} \left[ \frac{\bar{v} + v}{e} - 1 + (\bar{v} - v) \right] - e \left[ \frac{1}{2} - e \right] D \delta_i' + \frac{1}{4} (v - 1) \delta_i' \leq \frac{1}{2} \left[ \frac{\bar{v} + v}{e} - 1 + \left( \frac{1}{2} - e \right) (\bar{v} - v) D \right] \delta_i' + \frac{1}{4} (v - 1) \delta_i' \Leftrightarrow \left[ (\bar{v} - v) \right] \left( \frac{1}{2} - e \right) D \delta_i' + \delta_i' < \left[ \frac{\bar{v} + v}{e} - 1 \right] (\delta_i' - \delta_i')
$$

$$
(I) \Rightarrow (h - 1) ED \frac{h}{2} + 3/2 < (h - 1)(1 - ED) - 2(e(h + 1)/n + hE) D < \delta_i' - \delta_i' \Leftrightarrow \frac{h}{2} \leq (h - 1)(1 - ED) + 2(h + 1)/n + hE) D + 4h,
$$

where $E \equiv e - \frac{1}{2}$ and $n = v - 1$. By introspection, this inequality is more likely to hold if $D$ and $e$ are small while $v$ is large. Both sides may increase in $h$, but the derivative with respect to $h$ of the left-hand side increases in $D$, while that of the right-hand side decreases in $D$. Thus, for a small (large) $D$, side payments become worse when $h$ increases (decreases).

**PROOF OF PROPOSITION 7:**

Requiring the outcome to be “fair” means that $d$ and $(d, s)$ should be equal to the outcome if information were complete, i.e., as in Proposition 1 and 3, respectively. All participation constraints are then fulfilled. Requiring strategies to be dominant means that the incentive constraints should hold whatever type the opponent announces, or even when the opponent’s type is known. I will now calculate the most efficient mechanism given these constraints. Let $t_0$, $t_1$, and $t_2$ denote the time of the settlement when, respectively, neither, one, and both regions announce low type. Since the game is symmetric, $t_1$ will not depend on which of the regions announces low type.

With differentiation but no side payments, the problem is

$$
\max_{t_0, t_1, t_2 \geq 0} u^d = \frac{1}{4} (\bar{v} - 1) \delta_i' + \frac{1}{4} (v - 1) \delta_i' + \frac{1}{4} (v + \bar{v}) - 1 + \left( \frac{1}{2} - e \right) (\bar{v} - v) d' \delta_i' \quad \text{s.t.}
$$

$$
\frac{1}{2} (\bar{v} - 1) \delta_i' \geq \frac{1}{2} [\bar{v} - 1 + (1 - \bar{v}(1 - 2e)) d'] \delta_i' \quad (IC),
$$

$$
\frac{1}{2} [\bar{v} - 1 - (1 - \bar{v}(1 - 2e)) d'] \delta_i' \geq \frac{1}{2} (\bar{v} - 1) \delta_i' \quad (IC).
$$

$(IC)$ and $(IC)$ are the high type’s incentive constraints when the other region announces high and low type, respectively. Both $(IC)$ and $(IC)$ must hold in an ex post equilibrium. It is easily checked that
the low type’s incentive constraints are not binding and can be ignored. It is also easy to see that the solution is as in Proposition 1.

With side payments, and if $e \geq \frac{1}{2}$, the problem is

$$\max_{\delta', e} u^d = \frac{1}{4} (\tilde{v} - 1) \delta'^4 + \frac{1}{2} \left[ \frac{\tilde{v} + \tilde{v}}{2} - 1 + \left( \frac{1}{2} - e \right) \left( \frac{1}{2} - e \right) D \right] \tilde{\delta}'^4 + \frac{1}{4} (v - 1) \tilde{\delta}'^4 \quad \text{s.t.}$$

$$\frac{1}{2} (\tilde{v} - 1) \delta'^4 \geq \frac{1}{2} [\tilde{v} - 1 + (1 - \tilde{v}(1 - 2e)) D + \tilde{s}] \tilde{\delta}'^4 \quad (IC'),$$

$$\frac{1}{2} [\tilde{v} - 1 - (1 - \tilde{v}(1 - 2e)) D - \tilde{s}] \tilde{\delta}'^4 \geq \frac{1}{2} (\tilde{v} - 1) \tilde{\delta}'^4 \quad (IC).$$

If $e > \frac{1}{2}$, the problem is the same if just $(1 - 2e)D$ and $\tilde{s}$ are replaced by $|1 - 2e|D$ and $\tilde{s}$. Substituting for $\tilde{s}$ and $\tilde{s}$, it is easy to see that the solution is as in Proposition 3.

REFERENCES


