Issue linkage versus Ringfencing in Trade Agreements

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Abstract

Issue linkage is often regarded as a means to achieve or improve international cooperation in the presence of a sovereignty constraint. This constraint implies that a country can leave an agreement whenever it likes, and it will do so if the perceived gains from leaving are larger than the gains from staying in the agreement. We set up a model of trade agreements in which it is uncertainty about future gains from cooperation that may lead to exit. In this environment, we show that ringfencing dominates issue linkage, even in the absence of complimentarities between separate issues, if the degree of uncertainty is sufficiently large.

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1 Introduction

Countries typically find it gainful to enter into international agreements on trade and related issues, such as cross border labor mobility, capital mobility, intellectual property rights protection, and so on.[1] An interesting fact is that many of these agreements are designed as a "package deal" (treating several issues in the same treaty) rather than as a collection of separate agreements (say, one treaty would cover trade while a separate treaty would deal with cross boder labor mobility). Once a country has signed a package deal treaty, it is practically impossible for it to withdraw from a subset of clauses of the treaty while keeping the remaining subset. The UK's difficulty with Brexit is a striking illustration of what we call "the impossibility of partial exit" principle (or ImPEx for short). Arguably, without the ImPEx principle, the UK would want to keep free goods trade with the rest of the EU, while dropping out of the cross border labor mobility clauses.

While almost all treaties allow members to drop out of the package deal agreement (at some stage in the future), they typically do not allow a partial exit. Our research question is: under what conditions do countries find it optimal (*ex ante*) to require members of a package deal treaty to be (at any stage in the future) either completely "in", or completely "out"? On one hand, allowing a country to drop out is a good provision, because all countries recognize that any member may, at some stage in the future, face country-specific adverse shocks which make it individually rational to leave. On the other hand, when a country leaves, it potentially imposes externalities on the remaining members, about which it no longer cares. To mitigate against this, ImPEx serves as a counter-incentive against leaving. We may view ImPEx as a "constitutional clause" that partially ties the hands of future politicians.

This general setup can be thought of as in the standard approach to issue linkage – tying two not necessarily related issues together in a policy package to induce cooperation over both, where neither might stand alone – but also applies to the question of the *scope* of a preferential trading agreement, for instance: do two countries agree on trade policy alone (internal and, in a customs union, external), or do they also have agreements on labour mobility, bilateral investment, technical and professional standards, monetary pol-

[1] For example, NAFTA – now USMCA – is a comprehensive treaty that covers not only trade in goods and services, but also cross-border investment.

icy, emissions controls and so on? In this paper, we focus on the problem of choice between linking issues in a single overarching agreement versus having separate agreements, in the context of free trade agreements.

There is a significant number of papers on issue linkage. The basic idea that linking two issues might make an agreement succeed where separate agreements would not goes back at least to Tollison and Willett (1979): essentially, in a world of certainty, if country A (B) gains a lot on issue 1 (2) but loses a bit on issue 2 (1) then, absent side-payments, no agreement would be reached on each issue alone but a joint agreement on 1 and 2 combined would succeed. It has been applied most frequently in the context of environmental economics (see, e.g., Geng and Woodland, 2018). One of the main concerns of this literature is whether making participation in an environmental agreement a co-requisite for participation in a trade agreement will induce more countries to agree and, if so, if the nature of the agreement is changed.[2] Alesina *et al.* (2005) look at heterogeneous countries forming a union and consider the forces that determine the equilibrium size and composition of unions in a couple of cases. Their concern is primarily with the membership of the agreement, rather than the nature of it. Finally, Maggi (2016) reviews and attempts to draw together a lot of the literature in a unifying framework. He distinguishes between the role of issue linkage for enforcement, for negotiations and for participation, and he notes that models of the first of these typically focus on repeated games, models of the second on bargaining games and models of the third on participation games.[3] His model captures all of these but, critically, there is no uncertainty in the model at all. He notes that there is a general presumption in the literature that linkage is desirable and he addresses the fact that it is not so frequent in reality as the analysis suggests it should be, primarily by referring to the existence of negotiation transaction costs.

In contrast, our approach emphasizes the role of uncertainty and the possibility of exit. Given uncertainty about future country-specific shocks that would affect the payoffs of member countries, we consider whether countries wish to enter into linked (pooled) or unlinked (ringfenced) agreements. The main contribution of our model is its focus on the advantages and disadvantages of issue linkage in a context of uncertainty where parties

[2]It has been argued that while linkage might increase the number of participants in an agreement on an issue with a free-riding problem (like emissions control), it might reduce the number involved in the linked area (like trade policy). See, e.g., Carraro and Marchiori (2003).

[3]Our focus is on a mix of the second and third: negotiation over participation.

can renege if, due to unfavorable shocks, things are anticipated to turn out poorly for them if they were to remain with the original agreement. This is an important question as we will show that it is not *a priori* obvious whether pooling two risky issues together is better than ringfencing them away from each other and dealing with them separately – the linkage affects the riskiness of exit (in different ways for different distributions, as our examples show) but also affects the expected payoff in states where exit does not occur. In our analysis there is no general presumption that issue linkage is preferable to ringfencing.

2 A simple model of exit

In this section, we consider a model in which countries can agree only on a single issue, and the agreement is subject to country-specific, idiosyncratic shocks.[4] These shocks imply the possibility of two different realizations. We assume two countries, denoted by h (the home country) and f (the foreign country). Since there is only one trade issue on the table in this first model, countries must evaluate the desirability of entering a bilateral agreement on this issue. The countries are identical *ex ante*, and the agreement covers two periods. In period 1, the countries decide on whether to sign a trade agreement that will be in force in period 2. The agreement requires that policies are to be coordinated so as to maximize the expected value of the sum of their (period two) payoffs. Each country realizes that its partner may renege and "exit" upon experiencing an unfavourable shock in period 2, which would render its payoff under cooperation less attractive than otherwise.

To fix ideas, we suppose each country is subject to a country-specific shock at the beginning of period 2 that determines the realization of country-specific benefits from cooperation. In this and in the subsequent section, the resulting realization is binary: it can take one of only two values, "good"or "bad", and the economic environment in period 2 is as follows. At the beginning of period 2, country $c \in \{h, f\}$ observes its country-specific realization, r_c, which would affect the country's period 2 payoff under policy coordination as prescribed by the agreement.[5] The country-specific realizations

[4]This model is a simplified version of the exit model of Richardson and Stähler (2019). They also endogenize the degree of cooperation and exit risks, and they show that exit risks will never be optimally completely avoided if they exist for full cooperation.

[5]We assume the shock does not affect the country's period 2 payoff if it exits. The payoff under "exit" is

are assumed to be independent and each may be a good realization, g, or a bad one, b. The vector of realizations, $(r_{h,}r_f)$, can thus take one of four possible values, (g_h, g_f), (g_h, b_f), (b_h, g_f), or (b_h, b_f). The probability that a country has a good (respectively, bad) realization is q (respectively, $1 - q$), where $0 < q < 1$. As this is a 2-country agreement, if a country exits the agreement, the realized payoffs of both countries are zero (regardless of the realizations of the shocks).

We also assume that the country-specific realizations are private information. A country may "report" its observed realization to the other country, but the latter cannot verify such information, so this reporting is cheap talk. This has two implications: first, the agreement cannot specify transfer payments conditional on the realization of the random variable and, second, it is not possible that a country that has a good realization and is thus interested in keeping the agreement alive will be able to compensate the other country for staying in the agreement. Under asymmetric information, any "Coasian solution" is infeasible, as each country would have an incentive to pretend to have a bad realization in order to receive compensation.

Hence, it does not matter which state each country would report or not. What matters is that countries may either elect to "remain" members of the agreement or to exit. If both remain, the resulting realized payoffs vector (y_h, y_f) is given by

$$(y_h, y_f) = \pi(r_h, r_f) = \begin{cases} (G, G) & \text{if } (r_h, r_f) = (g_h, g_f) \\ (G, B) & \text{if } (r_h, r_f) = (g_h, b_f) \\ (B, G) & \text{if } (r_h, r_f) = (b_h, g_f) \\ (B, B) & \text{if } (r_h, r_f) = (b_h, b_h) \end{cases}$$

Here, G is a positive real number and B is a negative real number, and we assume that cooperation makes sense *ex ante* such that the expected gain from cooperation is positive, i.e., $qG + (1 - q)B > 0$. Furthermore, we assume that $B + G > 0$ such that cooperation is jointly desirable even if a single country has a bad realization. This means that, with the exception of the case (b_h, b_f), the sum of payoffs is higher under "remain" than under "leave". Therefore, ideally both countries should commit to "remain" when their reports of the realizations are not both bad, and to "exit" only when their reports are (b_h, b_f).

Let $Pr\left[(r_h, r_f)\right]$ denote the probability of the realization (r_h, r_f). If each country could commit to stay in the agreement whenever their realizations are not both bad ones, the

zero by normalization.

social value of the agreement would be equal to

$$\begin{aligned} W &= \Pr[(g,g)] \times (2G) + \Pr[(g,b)] \times (G+B) + \Pr[(b,g)] \times (B+G) \\ &= 2Gq^2 + 2(B+G)q(1-q) = 2q\left[qG + (1-q)(B+G)\right], \end{aligned}$$

and consequently each country would realize $V = \frac{1}{2}W = q\left[qG + (1-q)(B+G)\right]$ in expected terms.

However, each country only cares about its own payoff in period 2 in the absence of commitment. It will exit after learning that its country-specific realization is b. Therefore, under the non-commitment scenario, the agreement will survive only if both countries get good realizations, so the value of the agreement to each country is only equal to

$$V_N = Gq^2 < V$$

where the subscript N refers to the non-commitment scenario. When a country exits while the other's country realization is g, the exit inflicts a "negative externality" on the other country. In this benchmark model, it is not possible to punish a country for imposing this negative externality.

3 The scope of issue linkage

Now suppose there are two issues (e.g., the free flows of goods and the free flows of labor) each of which can yield, on average, higher benefits to each country if they can coordinate their policies. The two countries can now have two separate agreements, one for each issue (ringfencing), or they can pool the two issues together in a single agreement (pooling or issue linkage). Ringfencing is the same as having two independent single-issue agreements as described in the previous section but things are different for issue linkage/pooling: in this case, we assume the ImPEx principle holds and we suppose that period 1 provisions for policy coordinations in period 2 are so much intertwined that any country that wishes to stop cooperating on one issue in period 2 must exit the pooled agreement altogether, thus obtaining a payoff of zero for both issues.

Under what conditions, if any, is pooling preferable to ringfencing? Obviously, if the realizations were strongly negatively correlated, issue linkage would provide insurance. If the realizations were strongly positively correlated, issue linkage becomes less attractive as the exit risk will increase with including a second issue. We do not consider any correlation, as we want to focus squarely on the role of uncertainty; thus, as noted, we assume that the realizations are independently distributed. As before, countries are *ex ante* identical in terms of gains and losses. For any country c, let $G_i > 0$ and $B_i < 0$ denote respectively the good outcome and the bad outcome relating to issue i, where $i = 1, 2$. We denote by q_{ic} the probability that a country-specific realization affecting country c on issue i is good, and we assume that $q_{1c} = q_{2c} = q$, for $c = h, f$. However, we allow the possibility that $G_1 \neq G_2$ and $B_1 \neq B_2$; that is, that the outcomes of good and bad realizations differ across issues. We keep the assumptions $qG_i + (1 - q)B_i > 0$ and $G_i + B_i > 0$ for $i = 1, 2$, which imply that the expected gains from cooperation are positive *ex ante*, and if one country has a good realization and the other country has a bad realization for issue i, it is still socially desirable that both countries would cooperate on issue i.

As demonstrated in the previous section, if the countries enter into separate agreements on the two issues, a country c will quit the agreement on issue i as soon as it learns that its country-specific realization of that issue is bad, i.e., $r_{ci} = b$. Thus, the expected value of the agreement on issue i, under non-commitment, is equal to $EV_{iN} = G_i q^2$, and consequently the expected value of having two separate agreements is then given by

$$E(V^{ring}) = (G_1 + G_2)q^2. \tag{1}$$

If instead the issues are pooled together in a single agreement, a country c will exit if and only if it has realizations that indicate that its payoff under "remain" is negative for the two issues together. Clearly, if the realizations in country c are (b, b), i.e., bad on both issues, then it will exit. What happens if country c's realizations are good on issue 1 and bad on issue 2? The answer is that country c will exit the pooled agreement if $G_1 + B_2 < 0$ and remain if $G_1 + B_2 > 0$ (i.e. if the good outcome in issue 1 more than compensates for the bad outcome in issue 2). We now have to distinguish four different cases, and we do so by defining four different configurations. Configuration 1 will be defined as the most favorable parameter configuration, i.e., both $G_1 + B_2 > 0$ and $B_1 + G_2 > 0$ hold such that a bad outcome for one issue can always be made up by a good outcome for the other one. Configuration 2 will be defined by $G_1 + B_2 > 0$ and $B_1 + G_2 < 0$ such that only a bad realization of issue 2 can also be made up by a good realization of issue 1, but not vice versa, and similarly $G_1 + B_2 < 0$ and $B_1 + G_2 > 0$ will define configuration 3. Configuration 4 is the least favorable and defined by $G_1 + B_2 < 0$ and $B_1 + G_2 < 0$ such that each country will want to exit unless both of its realizations are good.

Consider first the parameter configuration most favorable for remaining in the agreement, configuration 1, for which the probability that a country wants to exit is given by $(1-q)^2$. The probability that a country 'remains' is then equal to $1-(1-q)^2 = q(2-q)$. Conditional on its partner choosing to 'remain', the expected gain to a country from entering into a pooled agreement under configuration 1 is given by

$$\begin{aligned} & q^2(G_1+G_2)+q(1-q)(G_1+B_2)+(1-q)q(B_1+G_2) \\ = \; & [qG_1+(1-q)B_1]+[qG_2+(1-q)B_2]\,. \end{aligned}$$

Multiplying this expression by the probability that its partner does not exit, $q(2-q)$, we get the expected value of the pooled agreement under configuration 1:

$$E_1(V^{pool}) = q(2-q)\left\{[qG_1+(1-q)B_1]+[qG_2+(1-q)B_2]\right\}. \tag{2}$$

Next, consider configuration 2 for which a country will want to exit the pooled agreement if it receives a bad shock on issue 1. Under this configuration, the (conditional) expected gain to a country for entering into a pooled agreement is equal to

$$q^2(G_1+G_2)+q(1-q)(G_1+B_2) = qG_1+q\,[qG_2+(1-q)B_2]\,.$$

Multiplying this by the probability q that its partner does not exit, we get the expected value of the pooled agreement under configuration 2, and we observe that it is smaller than the expected value of having two separate agreements, $E(V^{ring})$:

$$E_2(V^{pool}) = q^2\left\{G_1+[qG_2+(1-q)B_2]\right\} < E(V^{ring}) = (G_1+G_2)q^2.$$

Configuration 3 is identical to configuration 2, except that the subscripts are swapped so, clearly, $E_3(V^{pool}) < E(V^{ring})$. Finally, consider configuration 4 for which $G_1+B_2<0$ and $B_1+G_2<0$. Each country will want to exit unless both of its realizations are good. Again, it is straightforward to show that $E_4(V^{pool}) < E(V^{ring})$.

It follows then that a necessary condition for pooling to be better than ringfencing is that the two countries are in configuration 1, i.e. the good outcome in one issue would more than compensate for the bad outcome in the other issue. However, this is not sufficient. Comparing (2) with (A.1) shows that ringfencing welfare-dominates pooling if and only if $q(G_1+G_2)+(2-q)(B_1+B_2)>0$ holds in addition to having both $G_1+B_2>0$ and $B_1+G_2>0$. Thus, we conclude:

Proposition 1. *Pooling is superior to ringfencing if and only if the following three conditions are simultaneously satisfied:*

(i) $G_1 + B_2 > 0$,

(ii) $B_1 + G_2 > 0$, *and*

(iii) $q(G_1 + G_2) + (2 - q)(B_1 + B_2) > 0$.

While conditions (i) and (ii) here echo the reasoning of Tollison and Willett (1979), in an environment of uncertainty, as modelled here, these are not sufficient for issue linkage to be preferable to ringfencing. Note, too, that an expected welfare gain for each issue, that is, $qG_i + (1 - q)B_i > 0$, is not sufficient to satisfy condition (iii) in Proposition 1 and thus to guarantee superiority of issue linkage. The reason why pooling is more attractive under the conditions stated in Proposition 1 is as follows. Under ringfencing, a country will exit an issue-specific agreement if it has a bad realization that adversely affects its payoff under cooperation on that issue. Such an exit imposes an externality on the other country, denying it the benefit of cooperation, if the other country's realization is favorable. Under pooling, a country does not exit provided that the bad realization in one issue is more than compensated for by a good realization in the other issue (conditions (i) and (ii) above). However, preventing exit by means of pooling would make sense only if the loss incurred by the country that would have chosen to exit under ringfencing is not too large compared with the expected value of the externality inflicted on the other country by such an exit. This is condition (iii) above. The importance of Proposition 1 is that it shows that pooling is superior only under rather stringent conditions. Thus it provides a direct counterexample to any presumption that issue linkage would be beneficial whenever each of the issues has positive expected value.

So far, we have considered the case of identical probabilities and differences in payoffs from the different issues. We now want to consider the role of issue linkage if success probabilities of good realizations differ across issues, and for this reason we now assume that outcomes do not, i.e., $G_1 = G_2 = G$ and $B_1 = B_2 = B$ holds. Let q_i denote the probability that G will materialize for issue i. In order to scrutinize the role of probabilities for issue linkage, we now assume that the aggregate expected payoff from both issues, that is, $(q_1 + q_2)G + [1 - (q_1 + q_2)]B$, stays constant, implying that $q_1 + q_2 = \gamma$, where $\gamma < 2$ is a constant. It is now clear that only configurations 1 and 4 can arise in this setup as

$B + G$ is either positive or negative. Again, it is straightforward to show that ringfencing will welfare-dominate issue linkage for configuration 4.

If $B + G > 0$, we are in configuration 1. The expected value of issue linkage and ringfencing now depends on the different probabilities q_1 and q_2. We have relegated the details to Appendix A.1, and we find

Proposition 2. *Issue linkage is more (less) likely to welfare-dominate ringfencing the more equal (different) the success probabilities are. The difference between expected issue linkage welfare and expected ringfencing welfare is maximal if* $q_1 = q_2 = \gamma/2$.

Proof. See Appendix A.1 □

Proposition 2 shows that issue linkage has the best chance to dominate ringfencing if the success probabilities of the issues are sufficiently similar. It is not a good idea to combine an issue with a large success probability with one with a low success probability, given that the expected *ex ante* welfare across issues stays constant. In that case, the chances are too great that one issue will have a bad realization that cannot be avoided by issue linkage. Ringfencing ensures that agreements are implemented only upon good realizations and, with different success probabilities, it is better not to compromise on a high-probability success for one issue with a high probability of a bad realization for the other issue.

4 A more general model of issue linkage and ringfencing

In the preceding sections, a country-specific realization pertaining to an issue can take on only one of two values: good or bad. We now consider the case where the realizations are random variables with a continuous density function. As before, at the beginning of period 2, each country $c \in \{h, f\}$ observes its country-specific realizations (r_{c1}, r_{c2}) pertaining to issue 1 and issue 2, and decides whether to withdraw from an agreement. The value taken by the realization r_{ci} is a perfect predictor of country c's payoff in issue i if c honors the agreement. If it withdraws, the payoff is zero (regardless of the realizations).

Again, we assume that the two countries are *ex ante* identical, and the country-specific realizations on issue i ($i = 1, 2$) are identically and independently distributed. Let x_c

(respectively, y_c) denote country c's payoff on issue 1 (respectively, 2) if its realization for this issue takes on the value x_c (respectively, y_c). For tractability, we assume that the density functions $g(x)$ and $g(y)$ are uniform, defined over the interval $[\gamma - \delta, \gamma + \delta]$ where $\gamma > 0$ and $\gamma - \delta < 0$.

Again, we want to compare the merit of a ringfencing regime with that of a pooling regime. Panel (a) of Figure 1 illustrates the distribution of payoffs for a single issue. Under ringfencing, if both x_h and x_f are positive, then both countries will cooperate on issue 1 in period 2. If one of the x_c is negative, one country will withdraw, and the payoff on issue 1 is zero for each country. It follows that country h's expected payoff from joining the agreement on issue 1 is given by

$$\Pr[x_f > 0] \times \int_0^{\gamma+\delta} x_h g(x_h) dx_h = \frac{\gamma+\delta}{2\delta} \int_0^{\gamma+\delta} \frac{x}{2\delta} dx = \frac{(\gamma+\delta)^3}{8\delta^2}$$

where $\Pr[x_f > 0]$ denotes the probability of no exit by partner country f. The same calculation applies to country f. Similarly, a country's expected payoff on issue 2 is $(\gamma + \delta)^3/8\delta^2$. Summing over issues, the expected payoff of a country under the ringfencing regime is given by

$$E(V^{ring}) = \frac{(\gamma+\delta)^3}{4\delta^2}. \tag{3}$$

We now turn to the expected payoff under the pooling regime. In this case, a country c would leave if and only if $x_c + y_c < 0$. Define $z_c = x_c + y_c$. It can be shown that the density function of z_c, being a convolution of two identical uniform distributions, has the shape of an isosceles triangle centered on 2γ. This is illustrated in panel (b) of Figure 1. The density function, denoted by $\phi(z)$, has the slope $1/(4\delta^2)$ in the interval $[2(\gamma - \delta), 2\gamma]$ and $-1/(4\delta^2)$ in the interval $[2\gamma, 2(\gamma + \delta)]$ such that

$$\phi(z) = \begin{cases} \frac{z-2(\gamma-\delta)}{4\delta^2} & \text{for} \quad 2(\gamma-\delta) \le z \le 2\gamma, \\ \frac{2(\gamma+\delta)-z}{4\delta^2} & \text{for} \quad 2\gamma \le z \le 2(\gamma+\delta). \end{cases}$$

Each country will gain only if both countries stay in. Under pooling, the expected gain to country h is given by

$$\begin{aligned} E(V^{pool}) &= \Pr[z_f > 0] \int_0^{2(\gamma+\delta)} z_h \phi(z_h) dz_h \qquad (4) \\ &= \frac{1}{6\delta^4} \left(\delta^2 - \gamma^2 + 2\delta\gamma\right) \left(\delta^3 - \gamma^3 + 3(\delta^2\gamma + \gamma^2\delta)\right) \end{aligned}$$

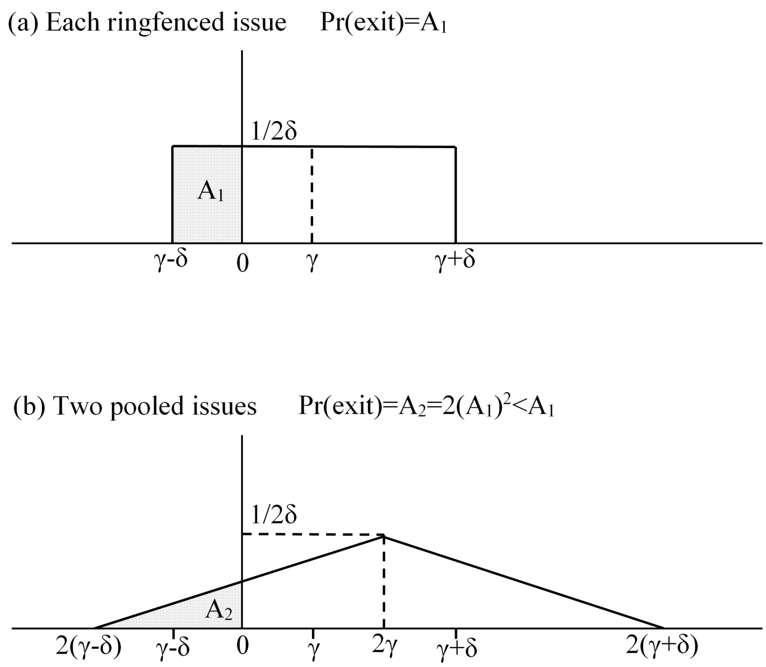

Figure 1: Identical uniform probability distributions, ringfenced and linked

where $\Pr[z_f > 0]$ denotes the probability of no exit under issue linkage. Comparing (3) and (4), we can show:

Proposition 3. *Let $k \equiv \delta/\gamma > 1$. Under the uniform distribution, pooling dominates ring fencing if and only if δ is sufficiently small such that the following condition holds: $1 < k < \overline{k}$ where $\overline{k} \approx 3.065$.*

Proof. See Appendix A.2 □

According to Proposition 3, ringfencing dominates pooling if $\delta > \overline{k}\gamma$. Recall that by assumption $\gamma - \delta < 0$. Thus $\delta - \gamma$ is the absolute value of the greatest possible loss to a country on any issue. Condition $\delta > \overline{k}\gamma$ is equivalent to

$$\delta - \gamma > (\overline{k} - 1)\gamma$$

Thus if the greatest possible loss is greater that 2.065 times the mean γ, then ringfencing is better than pooling. This result is consistent with that stated in Proposition 1 that shows that pooling requires “not too bad” realizations. In this more general model, ringfencing similarly dominates pooling if the degree of uncertainty is sufficiently large relative to the mean.

How does our model extend to differences in the distributions? Suppose the support of the density function for x is $[\gamma - \varepsilon, \gamma + \varepsilon]$ and that for y is $[\gamma - \delta, \gamma + \delta]$ with $\delta > \varepsilon > \gamma$. Under ringfencing, the expected values of the two separate agreements are

$$E\left[W_1^{ring}\right] = \frac{(\gamma + \varepsilon)^3}{8\varepsilon^2}$$

and

$$E\left[W_2^{ring}\right] = \frac{(\gamma + \delta)^3}{8\delta^2}.$$

and their sum is equal to

$$E\left[V^{ring}\right] = \frac{\varepsilon^2(\gamma + \delta)^3 + \delta^2(\gamma + \varepsilon)^3}{8\delta^2\varepsilon^2} \tag{5}$$

Under pooling, let $z = x + y$ denote the realization of the sum of the two issues. The distribution of z is a convolution of the distributions of x and y, and the density function of z can be shown to have the shape of a trapezoid and is given by

$$f_z(z) = \begin{cases} \frac{z - 2\gamma + \varepsilon + \delta}{4\delta\varepsilon} & \text{for} \quad 2\gamma - (\delta + \varepsilon) \le z \le 2\gamma - (\delta - \varepsilon) \\ \frac{1}{2\delta} & \text{for} \quad 2\gamma - (\delta - \varepsilon) \le z \le 2\gamma + (\delta - \varepsilon) \\ \frac{2\gamma + \delta + \varepsilon}{2\delta\varepsilon} & \text{for} \quad 2\gamma + (\delta - \varepsilon) \le z \le 2\gamma + \delta + \varepsilon \end{cases}$$

Figure 2 shows the probability distribution, and the resulting cumulative distribution is given by

$$F_z(z) = \begin{cases} \frac{(z - 2\gamma + \delta + \varepsilon)^2}{8\delta\varepsilon} & \text{for} \quad 2\gamma - (\delta + \varepsilon) \le z \le 2\gamma - (\delta - \varepsilon) \\ \frac{z + 2\gamma + \delta}{2\delta} & \text{for} \quad 2\gamma - (\delta - \varepsilon) \le z \le 2\gamma + (\delta - \varepsilon) \\ \frac{8\delta\varepsilon - (2\gamma + \delta + \varepsilon - z)^2}{8\delta\varepsilon} & \text{for} \quad 2\gamma + (\delta - \varepsilon) \le z \le 2\gamma + \delta + \varepsilon \end{cases}$$

To compute the expected value of the pooled agreement, we must consider two distinct cases. In case 1, the flat segment of the density function $f_z(z)$ lies entirely to the right of zero, i.e., $2\gamma - (\delta - \varepsilon) > 0$ and in case 2, $2\gamma - (\delta - \varepsilon) \le 0$. Figure 2 depicts the second case. For case 1, the probability that the partner country remains “in” is equal to

$$1 - F_z(0) = \frac{8\varepsilon\delta - (2\gamma - \delta - \varepsilon)^2}{8\varepsilon\delta},$$

and we can show that

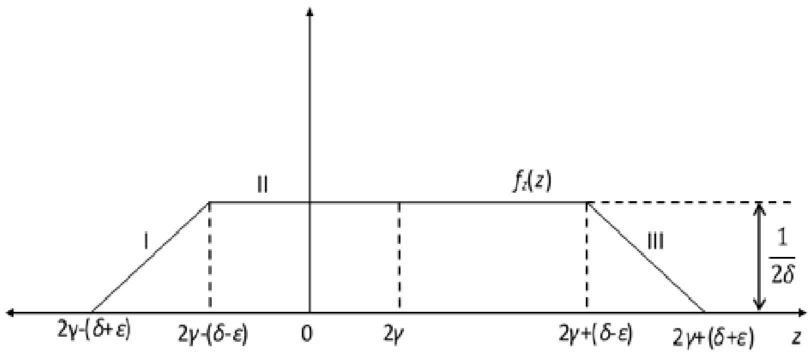

Figure 2: Probability distribution of z

$$
\begin{aligned}
E(V^{pool}) &= \frac{8\varepsilon\delta - (2\gamma-\delta-\varepsilon)^2}{8\varepsilon\delta} \\
&\times \left(\frac{(2\gamma-\delta+\varepsilon)^2(5\varepsilon+\delta-2\gamma)}{24\delta\varepsilon} + \frac{2\gamma(\delta-\varepsilon)}{\delta} + \frac{(6\gamma+3\delta-\varepsilon)\varepsilon}{6\delta} \right).
\end{aligned} \tag{6}
$$

We want to find out whether the disparity between the supports of x and y matters. For this purpose, let us define $q = (\delta+\varepsilon)/2$ and $\delta = q+\theta$ and $\varepsilon = q-\theta$, with $q \geq \theta \geq 0$. If $\theta = 0$, we are back to the case of identical supports. A larger θ means a greater difference between the two supports. It is also convenient to define $\kappa = q/\gamma \geq 0$ and $t = \theta/\gamma \geq 0$. Since $\gamma - \varepsilon < 0$ or $\gamma - q + \theta < 0$, division by q implies that $\kappa > t + 1$. For case 1, $2\gamma > \delta - \varepsilon = 2\theta$, so case 1 implies $\gamma > \theta$ which implies $t < 1$. Without loss of generality, set $\gamma = 1$, so that case 1 implies $\kappa > t + 1$ and $t \in [0, 1]$. We have relegated the details of the computations to Appendix A.3, which shows that case 1 is confined to $\kappa \in [1, 3.56683]$ (and $t \in [0, 1]$). Figure 3 shows the contour plot of the gains from issue linkage for this range, with κ on the horizontal axis and t on the vertical axis, taking into account that $\kappa > t + 1$.

Issue linkage is welfare-preferred only in the brightest area below the $\kappa > t+1$ constraint, and Figure 3 shows that the attraction of issue linkage is weakly reduced by an increase

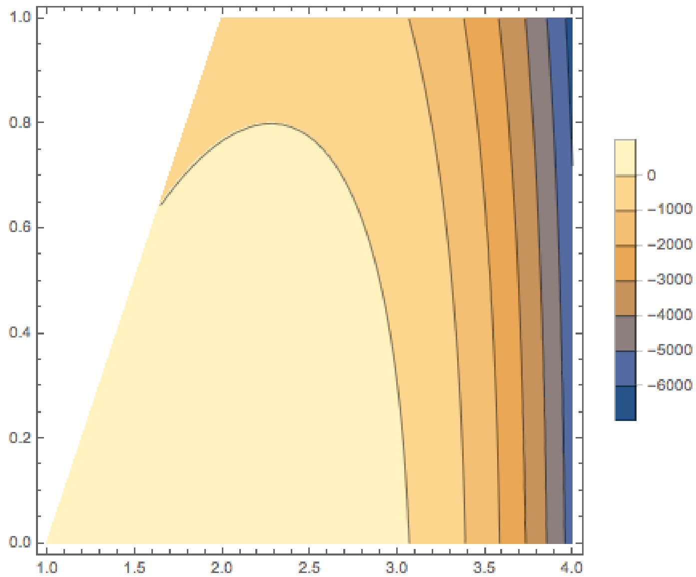

Figure 3: Case 1

in t, measuring the difference in the two uniform distributions.

Case 2, assuming $2\gamma \leq \delta - \varepsilon$, implies an even larger difference in distributions, and it cannot include the symmetric case of $\delta = \varepsilon$. This case now implies $t \geq 1$ and $\kappa \geq t+1$: $2\gamma \leq \delta - \varepsilon$ holds only if $t \geq 1$. Also, we require that negative payoffs occur with positive probability, and thus $\delta > \varepsilon > \gamma$, implying $\kappa - t > 1 \Leftrightarrow \kappa > t + 1$ (and thus also implying $\kappa > 2$). The probability that a country stays in the pooling agreement is now given by

$$1 - F_z(0) = 1 - \frac{\delta - 2\gamma}{2\delta} = \frac{\delta + 2\gamma}{2\delta},$$

and thus the expected payoff from pooling is now equal to

$$\begin{aligned} E(V^{pool}) &= \frac{\delta + 2\gamma}{2\delta}\left(\frac{(2\gamma + \delta - \varepsilon)^2}{4\delta} + \frac{(6\gamma + 3\delta - \varepsilon)\,\varepsilon}{6\delta}\right) \\ &= \frac{1}{24\delta^2}\,(\delta + 2\gamma)\left(12\gamma^2 + 12\gamma\delta + 3\delta^2 + \varepsilon^2\right). \end{aligned} \tag{7}$$

The details of comparing (7) with (5) are also relegated to Appendix A.3. Figure 4 shows the contour plot of the gains from issue linkage, taking the constraint $\kappa > t + 1$ into account.

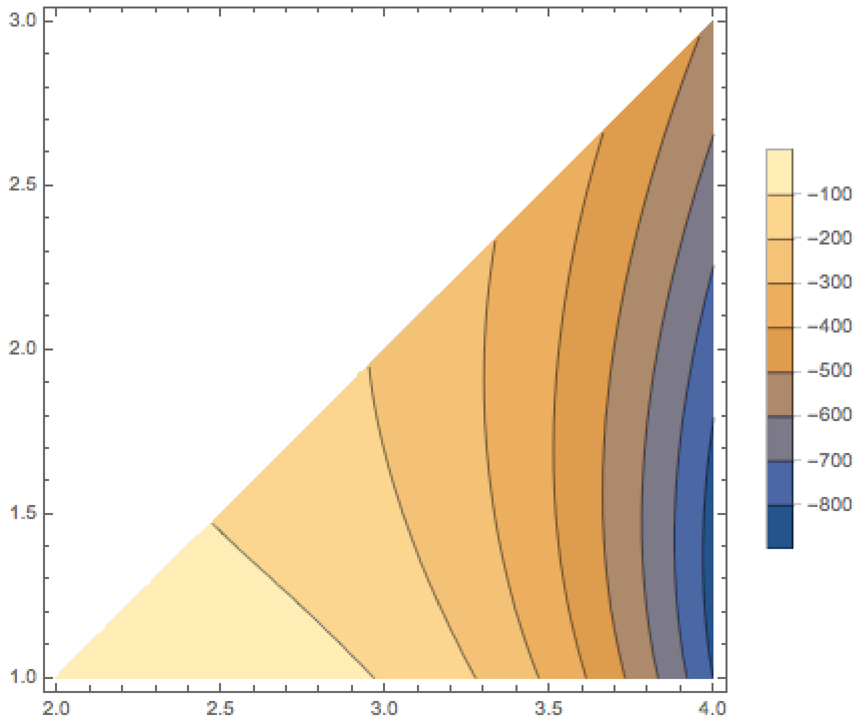

Figure 4: Case 2

We see for the ranges here that issue linkage will never welfare-dominate ringfencing. Since κ and t are unbounded, the question is whether this could happen for very large κ and t. Searching for a maximum numerically indicates that this maximum welfare difference between issue linkage and ringfencing is given by $\kappa = 2$ and $t = 1$, but for these values, issue linkage will be welfare-inferior.[6] Thus, we conclude that ringfencing will always welfare-dominate issue linkage for case 2.

5 Concluding remarks

This paper has made a contribution to a better understanding of why we do not see universal issue linkage. We have employed a simple model of potential exit from an agreement to show that issue linkage does not always welfare-dominate ringfencing. Our model does not rely on transaction and/or coordination costs as previous analyses have done. Instead

[6]The Mathematica code is available upon request.

we show that issue linkage can harm parties because it will not allow them to drop out of a part of the agreement when both parties face a very bad realization. We have shown that even when cooperation on each of the issues has positive value, the pooling of issues may be inferior to ringfencing if the degree of uncertainty is large.

Our objective in this analysis was to offer a framework in which the trade-off between ringfencing and issue linkage can be scrutinized in a simple way. For this reason, we have deliberately left out any insurance aspect of issue linkage in our analysis, by assuming that all random variables are independently distributed. If issue realizations are negatively (positively) correlated with each other, issue linkage becomes more (less) attractive. We leave this aspect of issue linkage to future research.

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Appendix

A.1 Proof of Proposition 2

With $G_1 = G_2 = G$ and $B_1 = B_2 = B$, the expected value of ringfencing two agreements is equal to

$$E(\tilde{V}^{ring}) = G\left(q_1^2 + q_2^2\right), \tag{A.1}$$

and the expected value of an issue linkage agreement is equal to

$$E(\tilde{V}^{pool}) = [1-(1-q_1)(1-q_2)]\left[2q_1q_2G + (G+B)\left(q_1(1-q_2)+q_2(1-q_1)\right)\right]. \quad \text{(A.2)}$$

Since $1-(1-q_1)(1-q_2) = q_1+q_2-q_1q_2$ and $q_1(1-q_2)+q_2(1-q_1) = q_1+q_2-2q_1q_2$, we find that $E(\tilde{V}^{pool}) > E(\tilde{V}^{ring})$ requires

$$\frac{G+B}{G} > \frac{q_1^2+q_2^2-2q_1q_2(q_1+q_2-q_1q_2)}{(q_1+q_2-q_1q_2)(q_1+q_2-2q_1q_2)}. \quad \text{(A.3)}$$

The LHS of (A.3) is between zero and unity since $B < 0$ and gives the ratio of a mixed outcome to a good outcome only. Since $\gamma = q_1+q_2$ and $q_1^2+q_2^2 = \gamma^2-2q_1q_2$, we can rewrite condition (A.3) as

$$\frac{G+B}{G} > f(\delta) = \frac{(\gamma^2-2\delta)-2\delta(\gamma-\delta)}{(\gamma-\delta)(\gamma-2\delta)},$$

where $\delta = q_1q_2$. Note that $f(0) = 1$ while $(G+B)/G < 1$, implying that ringfencing will always dominate if $q_1q_2 = 0$. Differentiation yields

$$f'(\delta) = -\frac{(2-\gamma)(\gamma^2-2\delta^2)}{[(\gamma-\delta)(\gamma-2\delta)]^2} < 0$$

because $\gamma = q_1+q_2 < 2$ and $\gamma^2-2\delta^2 = q_1^2+q_2^2+2q_1q_2-2q_1^2q_2^2 > 0$ because $q_1q_2 > q_1^2q_2^2 \Leftrightarrow 1 > q_1q_2$. Thus, the RHS of condition (A.3) becomes less demanding with an increase in δ. The maximum $\delta = q_1q_2$ subject to $\gamma = q_1+q_2$ is given by $q_1 = q_2 = \gamma/2$. Consequently, $q_1 = q_2 = \gamma/2$ minimizes the RHS of condition (A.3).

A.2 Proof of Proposition 3

Pooling yields a higher expected payoff iff

$$\begin{aligned}
\frac{(\delta^2-\gamma^2+2\delta\gamma)\left(\delta^3-\gamma^3+3(\delta^2\gamma+\gamma^2\delta)\right)}{6\delta^2} &> \frac{(\gamma+\delta)^3}{4} \\
\Leftrightarrow 4\left(\delta^2-\gamma^2+2\delta\gamma\right)\left(\delta^3-\gamma^3+3(\delta^2\gamma+\gamma^2\delta)\right)-6\delta^2(\gamma+\delta)^3 &> 0 \\
\Leftrightarrow 4\gamma^5-20\gamma^4\delta+2\gamma^3\delta^2+14\gamma^2\delta^3+2\gamma\delta^4-2\delta^5 &> 0.
\end{aligned}$$

Since $\delta > \gamma$ we can write $\delta = k\gamma$, where $k > 1$. Then the above condition becomes

$$4\gamma^5-20k\gamma^5+2k^2\gamma^5+14k^3\gamma^5+2k^4\gamma^5-2k^5\gamma^5 > 0$$

i.e., pooling is better than ringfencing iff

$$\Delta(k) \equiv 4-20k+2k^2+14k^3+2k^4-2k^5 > 0.$$

Note that $\Delta(1) = 0$, and if k is very large, then $\Delta(k) < 0$. Also, $\Delta'(k) = -20 + 4k + 42k^2 + 8k^3 - 10k^4$ with $\Delta'(1) > 0$, and $\Delta''(k) = 4 + 84k + 24k^2 - 40k^3$. Calculating the roots of the polynomial $\Delta(k) = 0$ in the relevant range, we find that $\Delta(k_1 = 1) = 0$ and $\Delta(k_2 = 3.0654) = 0$ are the relevant solutions. Furthermore, the only extremum in the relevant range is given by $\Delta'(k_3 = 2.44681) = 0$, and since $\Delta''(k_3) = -232.731$; k_3 defines a local maximum and proves that $\Delta(k) > 0$ for $1 < k < 3.0654$ and $\Delta(k) \leq 0$ for $k \geq 3.0654$.

A.3 Extension to different uniform distributions

Case 1

Comparing (6) with (5) shows that pooling welfare-dominates ringfencing iff

$$\begin{aligned} & \left(8\varepsilon\delta - (2\gamma - \delta - \varepsilon)^2\right)\left((2\gamma - \delta + \varepsilon)^2(5\varepsilon + \delta - 2\gamma) + 48\gamma(\delta - \varepsilon)\varepsilon + 4(6\gamma + 3\delta - \varepsilon)\varepsilon^2\right) \\ > \; & 24\left(\varepsilon^2(\gamma + \delta)^3 + \delta^2(\gamma + \varepsilon)^3\right). \end{aligned}$$

Using the definitions of κ and t, pooling dominates ringfencing iff t and κ satisfy

$$\begin{aligned} & \left(8(\kappa + t)(\kappa - t) - (2 - 2\kappa)^2\right) \\ \times \; & \left((2 - 2t)^2(5(\kappa - t) + (\kappa + t) - 2) + 48(2t)(\kappa - t) + 4(6 + 3(\kappa + t) - (\kappa - t))(\kappa - t)^2\right) \\ & -24\left((\kappa - t)^2(1 + \kappa + t)^3 + (\kappa + t)^2(1 + \kappa - t)^3\right) \geq 0 \end{aligned}$$

for some $t > 0$ and $\kappa \geq t + 1$:, which is equivalent to

$$-16\kappa^5 + 16\kappa^4 + 32\kappa^3 t^2 + 112\kappa^3 - 96\kappa^2 t^2 + 16\kappa^2 - 48\kappa t^4 - 432\kappa t^2 - 160\kappa + 240t^4 + 208t^2 + 32 \geq 0.$$

Take this condition for pooling to welfare-dominate, and create a new term in which (i) all terms that are negative and contain t are set equal to zero, and (ii) all terms that are positive and contain t are evaluated at $t = 1$. This new term is thus larger than the net difference in welfare from pooling versus ringfencing and given by $\Lambda(\kappa) = (\kappa - 1)\kappa(\kappa + 2)(5 - (\kappa - 2)\kappa) + 480$. It is straightforward to show that $\Lambda(\kappa_1) = 0$ for $\kappa_1 = 3.56683$ and $\Lambda(\kappa) > 0$ for $\kappa \in [1, \kappa_1]$. Thus we can constrain our analysis to the ranges $\kappa \in [1, \kappa_1]$ and $t \in [0, 1]$.

Case 2

Comparing (7) with (5) shows that pooling dominates ringfencing iff

$$\frac{(\delta + 2\gamma)\left(12\gamma^2 + 12\gamma\delta + 3\delta^2 + \varepsilon^2\right)}{24\delta^2} > \frac{\varepsilon^2(\gamma + \delta)^3 + \delta^2(\gamma + \varepsilon)^3}{8\delta^2\varepsilon^2}$$

i.e., iff

$$\varepsilon^2\left(\delta + 2\gamma\right)\left(12\gamma^2 + 12\gamma\delta + 3\delta^2 + \varepsilon^2\right) - 3\varepsilon^2(\gamma + \delta)^3 - 3\delta^2(\gamma + \varepsilon)^3 > 0.$$

Again, using $\delta = q + \theta$ and $\varepsilon = q - \theta$, this condition can be rewritten as

$$\begin{aligned} & (q-\theta)^2 (q+\theta+2\gamma) \left(12\gamma^2 + 12\gamma(q+\theta) + 3(q+\theta)^2 + (q-\theta)^2\right) \\ - \;& 3(q-\theta)^2(\gamma+q+\theta)^3 - 3(q+\theta)^2(\gamma+q-\theta)^3 > 0, \end{aligned}$$

and after factoring out as

$$\begin{aligned} & -2q^5 + 2q^4\gamma + 8q^3\theta^2 - 8q^3\theta\gamma + 18q^3\gamma^2 - 4q^2\theta^3 + 12q^2\theta^2\gamma \\ & -36q^2\theta\gamma^2 + 18q^2\gamma^3 - 6q\theta^4 - 8q\theta^3\gamma - 18q\theta^2\gamma^2 - 48q\theta\gamma^3 \\ & +4\theta^5 + 2\theta^4\gamma + 36\theta^3\gamma^2 + 18\theta^2\gamma^3 > 0. \end{aligned}$$

Again, we use $q = \kappa\gamma$ and $t = \theta\gamma$. Then, the condition for the welfare dominance of pooling can be written as

$$\begin{aligned} \Delta(\kappa, t) &= -2\kappa^5 + 2\kappa^4 + 8\kappa^3 t^2 - 8\kappa^3 t + 18\kappa^3 - 4\kappa^2 t^3 + 12\kappa^2 t^2 \\ &- 36\kappa^2 t + 18\kappa^2 - 6\kappa t^4 - 8\kappa t^3 - 18\kappa t^2 - 48\kappa t + 4t^5 + 2t^4 + 36t^3 + 18t^2 > 0. \end{aligned}$$