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Take one or more at a time? Issue linkage versus ringfencing with common shocks

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Abstract

Countries cooperate on certain issues like trade and environmental policies through international agreements. These agreements can be comprehensive and cover several issues (issue linkage) or deal with issues separately (ringfencing). A sovereign country experiencing a negative shock may want to withdraw from an agreement even if its exit harms other countries. Under ringfencing, each issue is subject to a separate agreement, and this agreement is terminated if one country has a bad outcome. Under issue linkage, the agreement is only terminated if one country has a bad realization for both issues. Common shocks make ringfencing relatively more attractive since they increase (decrease) the probabilities for all cases in which ringfencing (issue linkage) is the preferred mode of cooperation.

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1. Introduction

Any type of international policy cooperation is subject to a sovereignty constraint: a country can, at any time, withdraw from an agreement when it finds it more beneficial to do so. This will happen if a country realizes a bad country-specific shock in an area of international policy cooperation. In principle, partner countries can decide to either cooperate on two issues separately (so-called ringfencing) or have a comprehensive agreement which ties these two issues together (issue linkage). In this context, issue linkage seems to support international cooperation, for example when each country has a substantial gain for one and a moderate loss for the other issue, and vice versa for the other country, and side-payments are not possible (see Tollison and Willett 1979). For example, a trade and an environmental agreement could be linked such that a country can only leave both or honor both agreements. However, Long *et al.* (2023) show that this is not true in general. The reason is that issue linkage may want countries to continue cooperation in a policy area for which both countries have a bad realization and thus would be better off by terminating cooperation on this issue.

The innovation of this paper is that we allow for common shocks: the probability that one country has a good (bad) realization for a single issue is positively correlated with the probability that the other country has a good (bad) realization for the *same* issue.[1] For example, we allow for the fact that a positive or negative shock for a common trade policy outcome in one country increases the probability of that same shock in the other country, but there is no effect on the other issue, say, environmental policy outcomes. Common shocks are in particular relevant for macroeconomic cooperation, and we show that common shocks make ringfencing relatively more attractive.

There is a substantial literature on issue linkage; for a summary, see Maggi (2016) who discusses and summarizes the role of issue linkage for enforcement, negotiations and participation, but without any uncertainty.[2] The role of issue linkage as a potential tool to improve participation has been in particular discussed for international environmental agreements.[3] Barrett (1997) discusses the role of trade sanctions to overcome the free rider problem in environmental agreements, and Nordhaus (2015) suggests a Climate Club whose members adopt and implement measures to reduce global CO_2 emissions while they impose penalties on non-participating countries in form of import duties. He also offers a calibration of the effects of issue linkage and shows that no large and stable coalition can form a Climate Club without trade sanctions. There is, however, little empirical evidence of the role of issue linkage except Poast (2013) who claims that issue linkage has been

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[1]Note carefully that we assume that the realizations *across* issues remain uncorrelated. A negative correlation of realizations across issues would work like an insurance under issue linkage, so these effects are obvious.

[2]Sebenius (1983) shows that issue linkage can help overcome heterogeneity in negotiations while Limão (2007) scrutinzes the implications for global free trade and welfare of linking trade with non-trade issues within preferential trade agreements. He concludes that issue linkage can generate regional gains in particular for large economies. Limão (2005) analyses enforcement in a self-enforced pooled agreement and finds that issue linkage supports enforcement if the policies are strategically complementing each other. As for compliance, Ederington (2003) considers issue linkage and implicit cooperation in a supergame where the former actions of partners are mis-observed with some probability.

[3]The role of participation is also discussed by Alesina *et al.* (2005) and Carraro and Marchiori (2003) in other contexts.

successful when trade and security issues have been tied together in an observation period from 1860 to 1945.

Overall, the existing literature has found that issue linkage can support international cooperation, but this leaves us with the question why we do not see many more comprehensive agreements. Maggi (2016) refers to transaction costs, since sophisticated and comprehensive agreements require complex negotiations and specifications, and subsequent compliance becomes more costly. Horn and Mavroidis (2014) assume convex contracting costs of setting up comprehensive agreements, making any pooled agreement much more expensive than two individual agreements. We do not follow any of these approaches as our focus is on the potential role of exit from an agreement. Thus, we follow Long *et al.* (2023) and Richardson and Stähler (2019) and allow for the possibility of negative shocks as to endogenize potential exit from an agreement.

Why is it important to scrutinize the role of common shocks in this context? In the recent past, we have seen a global financial crisis, a pandemic, the outbreak of wars of which at least one caused an energy crisis, disruptions of supply chains due to severe weather effects etc. We have also observed a much more negative perception of globalization and the rise of populist parties campaigning against migration. These events have global effects that have shocked many countries similarly. It is thus important to understand how common shocks affect the chances of international cooperation in the two different regimes of ringfencing and issue linkage. Consequently, the remainder of this paper is organized as follows. Section 2 introduces the model, and section 3 develops the *ex ante* payoffs of ringfencing and issue linkage and how they change with common shocks. Section 4 concludes.

2. The model

As in Long *et al.* (2023), we assume two countries, country h (home) and f (foreign), that are *ex ante* identical. In the main body of this paper, we will focus on the case of symmetric payoffs and shocks across countries, but in Appendix A.2 we show that all our results also extend to issue-dependent payoffs, issue-dependent common shocks and issue-dependent shock probabilities. Both countries can agree on two issues either through two separate agreements (ringfencing) or through a pooled agreement (issue linkage). In the case of a pooled agreement, the exit rule prohibits partial exit such that a country can only leave or honor the comprehensive agreement. Countries decide on an agreement with ringfencing or issue linkage before they learn the potential outcomes in the first stage. After they have learned the potential outcomes, they decide whether they want to honor a pooled agreement in case of issue linkage and whether they want to honor one or both of the ringfenced agreements in the second stage.

To keep the model as simple as possible, we assume that each country can have a good realization, denoted by G, or a bad realization, denoted by B, where $G > 0 > B$ and where $G + B > 0$. The latter condition implies that a good realization in one country can make up for a bad realization in the other country if the latter country did not exit the agreement. Furthermore, a good realization for one issue can make up for a bad realization for the other if both are tied in a comprehensive agreement. *Ex ante*, the probability of a good realization for one issue is given by the probability $q, q > 0.5$, where we assume that the good realization is more likely than the bad realization to begin with. $q > 0.5$ implies that the expected *ex ante* payoff is positive, that is, $qG + (1 - q)B > 0$, given that $G + B > 0$.[4] The outside option of no cooperation, also prompted by unilateral exit by one country, is normalized to zero for each issue such that cooperation is always *ex ante* beneficial. In what follows, we will scrutinize the effect of common shocks on the two agreement designs, and in order to do so immediately in the subsequent section, we have relegated the microeconomic foundations on how actions translate into the payoffs G and B to Appendix A.1.

What is the role of common shocks in this setting? Consider a certain issue like trade policy. While we have already specified that a good realization has a larger probability than a bad outcome, we have not yet specified how good and bad outcomes for the two countries for one issue may be correlated. We assume that the probability that both countries will have a good realization is given by $q^2 + z$ where $z, 0 \leq z < q(1-q)$, denotes the correlation parameter, and similarly that the probability that both have a bad realization is given by $(1-q)^2 + z$. Thus, any welfare shock of trade policies is more likely to be experienced by both countries at the same time. On the contrary, the probability that one country has a good while the other one has a bad realization is given by $q(1-q) - z$. The correlation parameter implies a covariance between good and bad realizations, respectively, across countries of size $z(G-B)^2$ which increases with the correlation parameter. Note carefully that the probability that a country has a good (bad) realization remains unaffected by the correlation parameter. For example, the probability of a country to have a good realization is equal to the sum of the probability that both have a good realization and the probability that this country has a good while the other one has a bad realization, that is, $q^2 + z + q(1-q) - z = q$.

3. Issue linkage versus ringfencing

We now want to learn how the existence of common shocks may change the choice of ringfencing versus issue linkage for the design of an international agreement. In case of ringfencing, a country will honor the agreement if and only if it has a good realization. Table 1 shows the probability matrix. In case of ringfencing, country c stays in the agreement on an issue if and only if its respective realization is G, but exits an agreement if B is realized. Hence, the agreement will survive with probability $q^2 + z$, and the expected payoff under ringfencing for the two issues is given by

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

In Table 1, all probabilities that will lead to exit and thus zero payoffs for both countries are colored red. Ringfencing leads to exit if one country has a bad and the other one has a good realization. Since $G + B > 0$, the exit of one country leads to an aggregate welfare loss. If both countries have a bad realization, cooperation is also terminated, and this termination is efficient.

This is different in the case of issue linkage. In that case, a country can only leave the comprehensive agreement and thus will only leave the agreement if it has bad realizations

[4] If the bad outcome had a larger probability, we would consider the rather irrelevant case in which aggregate gains for a good and a bad realization were positive, but the *ex ante* expectation could be negative.

Table 1: Probability matrix for ringfencing

		Country h		
		G	B	$\sum$
Country f	G	$q^2 + z$	$q(1-q) - z$	q
	B	$q(1-q) - z$	$(1-q)^2 + z$	$1-q$
	$\sum$	q	$1-q$	1

for both issues. If it has a good and a bad realization, the country will stay in the agreement because $G + B > 0$. Table 2 gives the potential outcomes which now depend on the realization of both issues. As in Table 1, all probabilities that will lead to exit and thus zero payoffs for both countries are colored red.

Issue linkage looks like an improvement compared to ringfencing, but this is not true in general. Issue linkage implies that both countries continue to honor a comprehensive agreement also if they both have a good realization for the same issue and the same bad one for the other issue, although they would be better off by abondoning the bad realization jointly. It should thus be clear that the welfare ranking is not clear to begin with.

How can we compute the *ex ante* expected payoff of issue linkage for each country? Consider country h. Country h will realize a good outcome for both issues, that is, $2G$, if it has two good realizations and country f has at least one good realization. The probability of country h realizing $2G$ is thus given by summing up the probabilities of the first three cells of the first column of Table 2, and this sum is given by $(q^2+z)^2 + 2((1-q)q - z)(q^2+z)$. Furthermore, country h will realize a good realization for one issue and a bad realization for the other issue only if country f has at least one good realization. Country h thus realizes G for issue 1 and B for issue 2 with a probability that is the sum of the first three cells of the second column of Table 2 which adds up to $(q^2+z)((1-q)q-z) + (q^2+z)((1-q)q+z) + ((1-q)q-z)^2$. Due to symmetry, it realizes B for issue 1 and G for issue 2 with the same probability, and thus the *ex ante* expected payoff of issue linkage is given by

$$
\begin{aligned}
E(V^{pool}) &= 2G[(q^2+z)^2 + 2((1-q)q-z)(q^2+z)] \\
&\quad + 2(G+B)[(q^2+z)((1-q)q-z) + (q^2+z)((1-q)q+z) + ((1-q)q-z)^2] \\
&= 2(2-q)q^2(G + B(1-q)) + 2(1-q)(G + B(1-2q))z + 2Bz^2.
\end{aligned} \tag{2}
$$

The trade-off is that ringfencing implies socially excessive exit while issue linkage may imply socially too little exit. Let us consider the case of no correlation, that is, $z = 0$, first. Comparing (1) and (2) for $z = 0$ replicates the result of Long *et al.* (2023) who show that issue linkage dominates ringfencing if $G + (2-q)B > 0$. Note that this condition

Table 2: Joint probability matrix for issue linkage

		Country h			
		(G,G)	(G,B)	(B,G)	(B,B)
Country f	(G,G)	$(q^2+z)^2$	$(q^2+z)*[q(1-q)-z]$	$[q(1-q)-z]*(q^2+z)$	$[q(1-q)-z]^2$
	(G,B)	$(q^2+z)*[q(1-q)-z]$	$(q^2+z)*[(1-q)^2+z]$	$[q(1-q)-z]^2$	$[q(1-q)-z]*[(1-q)^2+z]$
	(B,G)	$[q(1-q)-z]*(q^2+z)$	$[q(1-q)-z]^2$	$[(1-q)^2+z]*(q^2+z)$	$[(1-q)^2+z]*[q(1-q)-z]$
	(B,B)	$[q(1-q)-z]^2$	$[q(1-q)-z]*[(1-q)^2+z]$	$[(1-q)^2+z]*[q(1-q)-z]$	$[(1-q)^2+z]^2$
	$\sum$	q^2	$(1-q)q$	$(1-q)q$	$(1-q)^2$

does neither follow from $G + B > 0$ nor from $qG + (1 - q)B > 0$. We can rewrite this condition as $G + B + (1 - q)B > 0$. Thus, if $G + B$ and/or q is relatively small and B is large in absolute terms, we may find that countries prefer ringfencing over issue linkage. The reason is that the gains from staying in an agreement if one country has a bad while the other has a good realization is not large if $G + B$ is relatively small. At the same time, if B is large in absolute terms, the loss from staying in the agreement if both have a bad realization for the same issue (but the same good one for the other) is large, and its probability is given by $(1 - q)^2$ if $z = 0$ which is the larger the smaller q is.

This result shows that the welfare ranking is ambiguous in general. We now ask whether common shocks affect the two designs differentially. We find:

Proposition 1. *An increase in the correlation parameter z increases both the expected ex ante payoff of ringfencing and issue linkage, but the increase is larger for ringfencing.*

Proof. Differentiating (1) and (2) w.r.t. z yields

$$\frac{\partial E(V^{ring})}{\partial z} = 2G > 0, \frac{\partial E(V^{pool})}{\partial z} = 2(1 - q)(G + B - 2Bq) + 4Bz.$$

$\partial E(V^{pool})/\partial z > 0$ because $z < q(1-q)$ and $B < 0$ imply that $2(1-q)(G+B-2Bq)+4Bz > 2(1 - q)[G + B - 2Bq + 2Bq] = 2(1 - q)[G + B] > 0$. Given that $0.5 < q < 1$, we observe that $2(1 - q) < 1$ and $B - 2Bq < -B$ which implies that $2(1 - q)(G + B - 2Bq) + 4Bz < G - B + 4Bz < 2G + 4Bz < 2G$ because $G + B > 0 \Leftrightarrow -B < G$.

□

Proposition 1 shows that an increase in z will increase the *ex ante* payoff of ringfencing more than that of issue linkage. Consider the benchmark of no common shocks, that is, $z = 0$, and consider the example of trade and environmental policies. If the expected payoff of linking these issues is larger than the one of ringfencing because $G + (2 - q)B > 0$, an increase in z may imply that this ranking is turned around, and ringfencing both trade and environmental policies may become the preferred mode of cooperation although it is not without common shocks. If the expected payoff of ringfencing is larger than the one of issue linkage because $G + (2 - q)B < 0$, an increase in z will emphasize this preferred mode of international cooperation of separating trade and environmental policies as the *ex ante* payoff of ringfencing increases more with z than the expected *ex ante* payoff of issue linkage.

Why do common shocks make ringfencing *relatively* more attractive? It is obvious that common shocks increase the probability that both countries have a good realization, and this improves the outcome of both ringfencing and issue linkage. For issue linkage, we have to consider different outcomes and how they will be affected by common shocks. Let us first consider the case of non-aligned realizations, that is, if (B, G) for country h and (G, B) for country f or (G, B) for country h and (B, G) for country f. In this case, a pooled agreement would be better than two single agreements: cooperation prevails with issue linkage, but not under ringfencing as all cooperation would be terminated by the respective country with a bad realization. But this outcome is now less likely to occur: its probability $[q(1 - q) - z]^2$ decreases with z.

If the realizations are aligned, that is, if (G, B) for country h and (G, B) for country f or (B, G) for country h and (B, G) for country f, issue linkage makes cooperation prevail, but both countries would be better off by terminating the agreement on the issue for which they both have a bad realization. Under ringfencing, cooperation will be terminated for the mutually bad realization and will continue for the mutually good realization. In that case, ringfencing is better than issue linkage, and common shocks increase the probability of this outcome since its probability $[(1-q)^2+z](q^2+z)$ increases with z.

Finally, we consider non-aligned realizations for one issue and aligned realizations for the other issue: (G,G) for country h and (G,B) for country f or (G,G) for country h and (B,G) for country f or (G,B) for country h and (G,G) for country f or (B,G) for country h and (G,G) for country f. In this case, pooling the two issues is preferable to ringfencing two agreements because one agreement would be terminated under ringfencing although the aggregate gains $G+B$ are positive. The probability with which these outcomes occur is given by $(q^2+z)[q(1-q)-z]$ and decreases with z.[5] Thus, we can conclude that common shocks reduce the probability for all cases in which issue linkage welfare-dominates ringfencing and increase it for the cases in which ringfencing welfare-dominates issue linkage.

4. Concluding remarks

This paper has shown that common shocks make issue linkage relatively less attractive when countries may realize bad outcomes. The reason is that it increases the probabilities for outcomes for which ringfencing dominates issue linkage and decreases them for outcomes for which issue linkage dominates ringfencing. Maggi (2016) writes that "[o]ne recurrent theme $[\cdots]$ has been that issue linkage is relatively uncommon in reality, in spite of the fact that theory highlights a number of potential benefits from issue linkage." We have shown that an increase in the propagation of common shocks can explain why countries prefer more separate agreements. Thus, we may expect more ringfencing agreements for areas in which common shocks prevail, as it is the case for most areas of macroeconomic cooperation.

We have used the simplest model that can imply exit from an agreement. One extension of our analysis could be to include at least three countries as treaty parties, and the UK's exit from the European Union has shown the relevance of a single country leaving a comprehensive agreement. In this case, the exit rule has to be more specific on what happens if one country decides to leave the agreement. A strict exit rule would be that a single exit terminates any ringfenced or the comprehensive agreement, but such a rule may not be in the best interest of the remaining parties. An alternative exit rule could specify that all countries that do not want to exit continue cooperation either on already specified terms or on terms that will have to be negotiated. In that respect, Article 50 of the Treaty on European Union (TEU) is an example of that kind of exit rule for a comprehensive agreement. The design of the agreement (ringfencing versus pooling) would then also take into account how continued cooperation will affect the probability that a country will want to leave unilaterally.

Similarly, a further extension could be to include more issues. We would expect that common shocks would continue to make ringfencing relatively more attractive. At the same time, we have assumed that the realizations across issues remain uncorrelated. If

[5] Differentiating this probability w.r.t. z yields $q-2q^2-2z<0$ where the negative sign follows from $q-2q^2<0$ due to $q>0.5$.

we allow for both, a positive correlation of shocks across countries for an issue and a negative correlation across issues for all countries, the scope of an agreement will have to balance the insurance effect of the latter correlation with the effect which we discussed in this paper. In the end, the optimal design and scope of agreements is then similar to an optimal portfolio choice of policy issues that countries want to include in one treaty or deal with in separate treaties. We leave these questions to future research.

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Appendix

A.1 Game structure and microeconomic foundations

Table 3 shows the structure of the game and illustrates how the agreed upon actions translate into outcomes (see also Long *et al.* 2023). Before the game starts, both countries agree to have an agreement in principle which does not yet commit them to anything except to inform the other partner country about future actions (for details, see Long *et al.* 2023). Then they negotiate about actions where a zero action implies business as usual and α^i for issue i is the alternative action that may have two outcomes. Without any cooperation, the Nash equilibrium is the zero action vector which implies a payoff of $U_j^i(0,0) = 0$ of country j. If both countries decide to cooperate subject to the potential exit risk, they agree on the action vector (α^i, α^i) and on a transfer T_{hf}^i from country h to country f. In case of a (more likely) positive realization, the payoff of country j is given by $\overline{U}_j^i(\alpha^i, \alpha^i) = G > 0$ while it is given by $\underline{U}_j^i(\alpha^i, \alpha^i) = B < 0$ in case of a (less likely) negative realization.

Table 3: Game structure

Stage I: Both countries agree to take actions (a_h^i, a_f^i) for each issue i where $a_j^i \in \{0, \alpha^i\}$, on a transfer $T_{hf}^i \gtrless 0$ from country h to country f related to issue i and on the exit rule for both issues in period 1.
Stage II: Each country j observes each potential realization privately.
Stage III: Each country j decides to honor or to exit the agreement(s) and informs the other country about its decision(s).
Stage IV: If both countries honor the agreement on issue i, both countries implement (a_h^i, a_f^i) for each issue i. If one country exits on issue i, $(0,0)$ is implemented.

Since cooperation is *ex ante* beneficial, both countries will agree on the action vector (α^i, α^i) irrespective whether cooperation is organized in form of two separate agreements (ringfencing) or in form of a comprehensive agreement. If a country decides to exit and thus chooses the zero action instead after it learns its potential realization, the best response of the other country is to choose the zero action as well, and since the only binding commitment is that countries inform each other, exit implies that both countries realize a zero payoff for one or both issues, respectively.

Three remarks are in order now. First, we allow transfers between the two countries such that the two countries can divide and redistribute the *ex ante* expected gains from cooperation via transfers T^i_{hf} from country h to country f, contrary to Tollison and Willett (1979). Therefore, the results do neither depend on the relative bargaining power nor do we have to assume equal bargaining power.[6] These transfers are paid before the realizations are (privately) revealed to countries. Second, the game does not allow for renegotiation. Even if it did, renegotiation would not help as realizations are private information, so each country would have an incentive to claim a bad outcome if it could potentially be compensated for this claim.[7] Third, this game structure warrants a minimum commitment of countries only. Even if they agreed on actions in line with cooperation, they can still exit the agreement. The only commitment is that the partner country will learn about the exit decision of the other country and will not have to form an expectation.

A.2 The general model

Let $G_i(B_i)$ denote the payoff of a good (bad) realization for issue i where $B_i < 0 < G_i$, $G_i + B_i > 0$ and $G_i + B_j > 0$ for $j \neq i$. The correlation parameter for issue 1 is denoted by x while the correlation parameter for issue 2 is denoted by y. As before, $0 < x, y < q(1-q)$. The outcome for ringfencing is similar as in Table 1 with x replacing z for issue 1 and y replacing z for issue 2. If any of the countries has a bad realization, it will exit the agreement such that the *ex ante* expected payoff of ringfencing is now given by

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

The outcomes for issue linkage are given by Table 4 where we also have colored red all probabilities that will lead to exit and thus zero payoffs for both countries. Consider country h. Country h will realize the two good realizations G_1 and G_2 with a probability, denoted by $P(G_1, G_2)$, that is given by adding up the first three cells in the first column. Similarly, it will respectively realize G_1 and B_2 with a probability, denoted by $P(G_1, B_2)$, that is given by adding up the first three cells in the second column and B_1 and G_2 with a probability, denoted by $P(B_1, G_2)$, that is given by adding up the first three cells in the third column. These probabilities are given by

$$\begin{aligned}
P(G_1, G_2) &= (2-q)q^3 + (1-q)q(x+y) - xy, \\
P(G_1, B_2) &= ((1-q)q - x)((2-q)q - y) + x, \\
P(B_1, G_2) &= ((2-q)q - x)((1-q)q - y) + y,
\end{aligned}$$

so that the *ex ante* expected payoff of issue linkage is given by

$$E(V^{pool}) = P(G_1, G_2)(G_1 + G_2) + P(G_1, B_2)(G_1 + B_2) + P(B_1, G_2)(B_1 + G_2). \tag{A.2}$$

[6] In this symmetric model and with equal bargaining power, we would expect $T^i_{hf} = 0$. But the model does not rely on equal bargaining power.

[7] Long *et al.* (2023) discuss the details of potential renegotiations of a pooling agreement and show that they will not be able to change the agreement when realizations are private information.

For $z = 0$, Long *et al.* (2023) show that both countries prefer issue linkage (ringfencing) over ringfencing (issue linkage) if $(G_1 + G_2) + (2 - q)(B_1 + B_2) > (<)0$. How do common shocks change the relative preference? We consider an increase in x (a similar exercise can be done with an increase in y with the same result). Differentiating (A.1) w.r.t x yields $\partial E(V^{ring})/\partial x = G_1$, and differentiating (A.2) w.r.t. x yields

$$\begin{aligned}\frac{\partial E(V^{pool})}{\partial x} &= (1-q)\left(G_1 - qB_1\right) + B_2\left((1-q)^2 + y\right) + B_1 y \\ &< (1-q^2)G_1 < G_1 = \frac{\partial E(V^{ring})}{\partial x}\end{aligned}$$

because $G_1 + B_1 > 0$ implies $-qB_1 < qG_1 \Leftrightarrow G_1 - qB_1 < (1+q)G_1 \Leftrightarrow (1-q)\left(G_1 - qB_1\right) < (1-q^2)G_1$ and $B_1, B_2 < 0$. Thus, we can confirm that a larger common shock, measured by an increase in x, implies a larger increase in the *ex ante* payoff of ringfencing compared to issue linkage also for the case of issue-dependent outcomes and shocks.

We now scrutinize the role of issue-dependent probabilities $q_i, 0.5 < q_i < 1$, and we do so for the case that $G_i = G$ and $B_i = B$. First, the probability of non-aligned realizations for both issues is now given by $[q_1(1-q_1) - z][q_2(1-q_2) - z]$ which decreases with z. Issue linkage is the preferred arrangement in this case, but its probability also decreases for issue-dependent probabilities. Second, the case of a positive common shock for issue 1 (issue 2) and a negative common shock for issue 2 (issue 1) has now a probability that is equal to $(q_1^2 + z)[(1-q_2)^2 + z]$ and $[(1-q_1)^2 + z](q_2^2 + z)$, respectively. In that case, ringfencing is the preferred arrangement, and its probability increases with z. Finally, we consider the four cases characterized by a positive common shock for one issue and non-aligned realizations for the other issue. Note that all these cases survive only under issue linkage, and with $q_1 \neq q_2$, they do not have the same probability anymore. The probability for the two cases with a positive common shock for issue 1 is given by $(q_1^2 + z)[q_2(1-q_2) - z]$, and the probability for the two cases with a positive common shock for issue 2 is given by $[q_1(1-q_1) - z](q_2^2 + z)$. Differentiating $(q_1^2 + z)[q_2(1-q_2) - z]$ w.r.t z yields $-2z - q_1^2 + q_2 - q_2^2 < 0$. Note that the maximum of $q_2 - q_2^2$ is equal to 0.25 (for $q_2 \to 0.5$), so this derivative is negative because $q_1^2 > 0.25$ and $q_2 - q_2^2 < 0.25$. Similarly, differentiating $[q_1(1-q_1) - z](q_2^2 + z)$ w.r.t. z yields $-2z - q_2^2 + q_1 - q_1^2 < 0$ which is also negative in sign because $q_2^2 > 0.25$ and $q_1 - q_1^2 < 0.25$. Thus, a common shock decreases this probability. We may conclude that Proposition 1 extends to the case of issue-dependent probabilities as the common shock reduces the probability for all cases in which issue linkage is preferable and increases the probability for all cases in which ringfencing is preferable.

Table 4: Joint probability matrix for issue linkage – general model

		Country h			
		(G_1, G_2)	(G_1, B_2)	(B_1, G_2)	(B_1, B_2)
Country f	(G_1, G_2)	$(q^2 + x) * (q^2 + y)$	$(q^2 + x) * [q(1-q) - y]$	$[q(1-q) - x] * (q^2 + y)$	$[q(1-q) - x] * [q(1-q) - y]$
	(G_1, B_2)	$(q^2 + x) * [q(1-q) - y]$	$(q^2 + x) * [(1-q)^2 + y]$	$[q(1-q) - x] * [q(1-q) - y]$	$[q(1-q) - x] * [(1-q)^2 + y]$
	(B_1, G_2)	$[q(1-q) - x] * (q^2 + y)$	$[q(1-q) - x] * [q(1-q) - y]$	$[(1-q)^2 + x] * (q^2 + y)$	$[(1-q)^2 + x] * [q(1-q) - y]$
	(B_1, B_2)	$[q(1-q) - x] * [q(1-q) - y]$	$[q(1-q) - x] * [(1-q)^2 + y]$	$[(1-q)^2 + x] * [q(1-q) - y]$	$[(1-q)^2 + x] * [(1-q)^2 + y]$
	$\sum$	q^2	$(1-q)q$	$(1-q)q$	$(1-q)^2$