Dynamic formation of preferential trade agreements: The role of flexibility

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Abstract. In practice, free trade agreements (FTAs) vastly outnumber customs unions (CUs). Nevertheless, the literature traditionally views CUs as optimal for members because CU members coordinate external tariffs. I show that a dynamic FTA flexibility benefit can help explain the prevalence of FTAs: individual FTA members have the flexibility to form their own future FTAs whereas CU members must jointly engage in future CU formation. I show how the relative prevalence of FTAs versus CUs depends on the structure of market size asymmetry across countries and use these predictions to shed some light on FTA versus CU formation in Europe and South America.

Résumé. Formation dynamique d'accords commerciaux préférentiels : le rôle de la flexibilité. En pratique, les accords de libre-échange (ALE) sont plus nombreux que les unions douanières (UD). Néanmoins, la littérature spécialisée perçoit traditionnellement que les UD sont optimales pour les membres parce qu'ils peuvent coordonner leurs tarifs externes. On montre qu'une flexibilité dynamique de l'ALE peut aider à expliquer la prévalence des ALE : les membres des ALE ont la flexibilité de former leurs propres ALE dans l'avenir alors que les membres des UD s'engagent conjointement pour la formation des UD futures. On montre comment la prévalence des ALE versus les UD dépend de la structure de l'asymétrie de la taille entre les pays, et on utilise ces prévisions pour éclairer les choix entre la formation de ALE et de UD en Europe et en Amérique du Sud.

JEL classification: C73, F12, F13

1. Introduction

SINCE THE early 1990s, the world has witnessed unprecedented growth of preferential trade agreements (PTAs). While about only 50 agreements existed in the late 1980s (figure B.1, WTO 2011), nearly 300 PTAs were

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I would like to thank a co-editor, Josh Ederington, and two anonymous referees for their valuable comments. I would also like to thank Richard Chisik, Mark Melatos, Ray Riezman, Santanu Roy, Peri da Silva and Murat Yildiz as well as seminar and conference participants at Monash University, the University of New South Wales, the Spring 2013 Midwest Trade Meetings and the 2013 Australasian Trade Workshop for helpful comments and discussion.

Canadian Journal of Economics / *Revue canadienne d'économique* 2019 52(1)
February 2019. Printed in Canada / *Février 2019. Imprimé au Canada*

ISSN: 0008–4085 / 19 / pp. 132–177 /

in force and notified to the WTO by April 2017.[1] This trend has spawned numerous strands of literature, both empirical, e.g., what characteristics determine PTA partners (for example, Baier and Bergstrand 2004, Chen and Joshi 2010), and theoretical, e.g., whether PTAs are "building blocs" or "stumbling blocs" en route to global free trade (Bhagwati 1991). Despite some important customs unions (CUs) covering substantial bilateral trade relationships (e.g., among members of the European Union (EU)), the sheer number of free trade agreements (FTAs) vastly outnumber CUs with the WTO (2011, p. 6) listing this phenomenon as one their five stylized facts regarding PTA formation.[2] However, as recently argued by Melatos and Woodland (2007a, p. 904) and Facchini et al. (2012, p. 136), the lack of literature explaining this fact is surprising because the existing literature largely suggests CUs are the optimal type of PTA for members.

Unsurprisingly, the standard reason for the attractiveness of CUs relative to FTAs rests on a coordination benefit whereby CU members coordinate their external tariffs. In practice, complications associated with tariff revenue sharing and choosing the level of the common external tariff may weaken this coordination benefit.[3] Nevertheless, the requirement that CU members set a common external tariff implies that *individual* CU members do not have the flexibility to form their own subsequent PTAs.[4] That is, FTAs possess a dynamic flexibility benefit because they allow *individual* FTA members to form future agreements. Indeed, this notion of an FTA flexibility benefit has permeated the mainstream media. Some have argued that the common external tariff of the MERCOSUR CU has prevented Uruguay from forming an FTA with the US.[5] Similar arguments have been made in that the UK (in either the pre-Brexit or post-Brexit world) and Turkey should have FTAs rather than CUs with the EU to exploit the FTA flexibility benefit.[6]

1 For the April 2017 number, see `rtais.wto.org/UI/PublicMaintainRTAHome.aspx`. Unlike this number, figure B.1 in WTO (2011) includes PTAs not notified to the WTO.

2 FTAs differ from CUs because FTA members individually set their tariffs on non-members while CU members set common tariffs on non-members.

3 See Gatsios and Karp (1991), Syropoulos (2002, 2003) and Melatos and Woodland (2007b, 2009) for theoretical models that take these complications seriously.

4 If an individual CU member forms a PTA with a non-member then these two countries eliminate tariffs between themselves. But then the other CU members still have non-zero tariffs with the non-member, which violates the common external tariff.

5 See `en.mercopress.com/2011/03/11/how-argentina-torpedoed-uruguay-s-fta-with-the-us-according-to-wikileaks`.

6 For the UK case in the post-Brexit world, Dhingra and Sampson (2016, p. 10) point out that "...Brexit would enable the UK to seek trade agreements tailored to the interests of UK businesses and consumers rather than having to make

Using a three-country dynamic model where PTAs form over time and countries choose between FTAs and CUs, I highlight how the flexibility benefit of FTAs helps explain the prevalence of FTAs relative to CUs. In the background, intra-industry trade in segmented international markets is characterized by oligopolistic competition and countries with asymmetric market size. With an eye towards insights relating market size asymmetry to the relative prevalence of FTAs versus CUs, I follow Saggi et al. (2013) and focus on two forms of asymmetry: a "large" world with two large countries and one small country and a "small" world case with two small countries and one large country.[7] For the protocol governing PTA formation, I follow the spirit of Aghion et al. (2007) and assume the large country, or one of the large countries, is the "leader country" who can make PTA proposals each period. But, unlike Aghion et al. (2007), I assume the other countries can propose PTAs if they reject the leader country's proposal or the leader country makes no proposal.

The tension between the FTA flexibility and CU coordination benefits shape whether CUs or FTAs emerge in equilibrium. Because individual FTA members set their own external tariffs on non-members, individual FTA members have the flexibility to form *future* FTAs with non-members. Thus, FTA formation permits a country to become the "hub" whereby it has FTAs with each of the other two countries but these "spoke" countries do not have an FTA between themselves. Forward-looking countries value this FTA flexibility benefit because it affords sole reciprocal preferential access in the future with each spoke country.

Conversely, CUs possess a coordination benefit that, in general, consists of myopic and forward-looking components. The "myopic CU coordination benefit" is merely the difference between the one-period CU and FTA payoffs. Like many other models, the oligopoly model features the well-known phenomena of tariff complementarity (i.e., PTA members voluntarily reduce tariffs on non-members). Because this represents an intra-PTA negative externality, the coordination of external tariffs confers a myopic coordination benefit on CUs. Absent any forward-looking components of the CU coordination benefit, the

compromises to meet the needs of other EU countries." For the UK case in a pre-Brexit world, see Hannan (2012). For the Turkish case, see, for example, `english.alarabiya.net/en/business/economy/2013/05/26/Turkey-fears-being-left-out-in-the-cold-by-EU-free-trade-deals-.html`. The Turkish case is somewhat different in that, as part of its CU with the EU, and perhaps in anticipation of EU membership, Turkey agreed to extend any external tariff concessions to future FTA partners of the EU, (see `bloomberg.com/view/articles/2017-04-12/turkey-deserves-a-better-eu-trade-deal`).

7 Formally, these results are derived from a more general specification where the size of the "medium" countries varies from that of the small country to that of the large country. Section 3.3 discusses the additional insights gleaned from this generalized setting.

discount factor mediates the relative magnitude of the FTA flexibility and myopic CU coordination benefits with the FTA flexibility benefit dominating when countries are sufficiently patient.

Because of the CU common external tariff, CU expansion that includes the non-member requires joint member approval. CU members value the joint approval feature of CUs when they hold a “CU exclusion incentive” meaning that they want to exclude the non-member because CU expansion lowers member payoffs. Here, while an FTA member may precipitate global free trade by exploiting the myopic incentive to become the hub, CU members can block CU expansion to global free trade. In turn, this “joint authority motive” represents the forward-looking component of the CU coordination benefit. Thus, in the presence of a CU exclusion incentive, the FTA flexibility benefit outweighs the CU coordination benefits only when countries are neither sufficiently patient nor sufficiently impatient.

Intuitively, the key insight underlying the equilibrium structure is that the second largest country is more likely to accept an FTA proposal from the leader country when the leader country has other similarly attractive partners with whom it could instead form an FTA. While the large leader country may prefer FTA formation over CU formation to exploit the FTA flexibility benefit, its PTA partner prefers CU formation. Specifically, the second largest country prefers a CU rather than an FTA with the large leader country because it cannot become the hub and obtain the FTA flexibility benefit. Thus, to induce the second largest country’s acceptance of an FTA proposal, the large leader country must threaten that it would prefer an FTA with the smallest country rather than ceding a CU with the second largest country. To the extent that the second largest country is larger than the smallest country, and hence a more attractive PTA partner, the myopic CU coordination benefit grows. Indeed, this growth in the CU coordination benefit drives the key observation that the prevalence of FTA relative to CU formation is higher in a “small world” than a “large world.” Indeed, this logic plays an important role in section 3.3 when discussing real world CUs and FTAs in Europe and South America.

This paper is closely related to the three-country static model of Missios et al. (2016). There, countries hold FTA *and* CU exclusion incentives: members of any bilateral PTA receive a higher payoff than under global free trade and, hence, want to exclude the PTA non-member from expansion to a three-country PTA. Missios et al. (2016) show that, unlike FTAs, CUs undermine global free trade. The joint authority motive allows CU members to block CU expansion but FTA formation yields global free because, in equilibrium, the flexibility of FTAs prevents members exploiting their FTA exclusion incentive.

Conceptually, the most important difference between this paper and Missios et al. (2016) is that my model characterizes the situations where the flexibility of FTAs generates the endogenous equilibrium emergence of FTAs rather than CUs. Indeed, as described above, FTAs rather than CUs emerge in equilibrium when the FTA flexibility benefit dominates the CU coordination benefit. Although their analysis focuses on comparing a "CU formation game" versus an "FTA formation game," Missios et al. (2016) extend their main analysis to allow for the endogenous choice between FTAs and CUs. However, CUs always emerge endogenously because the flexibility of FTAs prevents exploitation of the FTA exclusion incentive in their *static* setting. However, my *dynamic* setting allows an FTA member to exploit the FTA flexibility benefit by becoming the hub on the *path* to global free trade. Thus, my results rely on forward-looking motivations that are fundamentally different economic motivations than the static motivations of Missios et al. (2016).

This paper is also closely related to a small literature investigating how broad notions of flexibility and coordination affect the endogenous choice between CUs and FTAs. In a dynamic three-country model, Seidmann (2009) views countries as bargaining over surplus division from PTA formation. Even though global free trade maximizes the aggregate payoff, and hence global free trade always emerges in equilibrium, countries can use PTA formation along the path to global free trade to strategically influence their outside options and, thus, the bargaining outcome under global free trade. When an initial PTA benefits the insiders relative to the outsider, the insiders can manipulate the outside options and "strategically position" themselves to extract more than their equal share of the global free trade surplus. But doing so requires direct expansion of a bilateral PTA to global free trade, which makes a CU more attractive to PTA insiders than an FTA. That is, the flexibility of FTAs makes FTAs problematic for exploiting the "strategic positioning" motive.

Indeed, given the trade model in this paper, FTAs never emerge in equilibrium in Seidmann (2009). In this paper, countries enjoy a myopic CU coordination benefit, via eliminating the negative intra-PTA externality of tariff complementarity, whereby the one-period payoff as a CU insider exceeds that as an FTA insider. Moreover, countries prefer being a CU insider over being discriminated against as a CU outsider. Under these conditions, equilibrium FTAs never emerge in Seidmann (2009), contrasting starkly with the equilibria of this paper driven by the fundamental trade-off between the FTA flexibility and CU coordination benefits.[8] Formally, this contrast emerges from: (i) the presence versus absence of transfers, which crucially impacts the motives of PTA formation, and (ii) the protocol described above, which, effectively, ensures the large country becomes the hub in a hub–spoke network, solidifying the FTA flexibility benefit, versus Seidmann's protocol where the country proposing PTAs changes over time, severely weakening the FTA flexibility benefit.

Despite a static setting, Appelbaum and Melatos (2016) show uncertainty generates a coordination-flexibility trade-off underlying the choice between CUs and FTAs. When cost and demand uncertainties are realized after PTA

8 Specifically, see theorem 3.3 in Seidmann (2009, p. 148) noting that, in his notation, $v^{CU} > v^{FTA}$ and $v^{CU} > w^{CU}$.

formation but prior to tariff setting, the type of uncertainty matters greatly. Because larger differences in market size polarize each country's ideal external tariff, greater demand uncertainty makes FTAs more attractive relative to CUs. Conversely, greater cost uncertainty makes CUs more attractive relative to FTAs because larger cost differences increase the value of coordinating external tariffs to internalize the negative intra-PTA externalities posed by tariff complementarity. Note, this flexibility-coordination tension derives from *myopic* tariff setting motivations. In contrast, *forward-looking* motivations drive the flexibility-coordination tension underlying my results.

In contrast to the static but "uncertain trading environment" of Appelbaum and Melatos (2016), Melatos and Dunn (2013) analyze a dynamic and "evolving trading environment" that also features notions of flexibility and coordination. The most important differences between Melatos and Dunn (2013) and the current paper are the fundamentally different economic environment and, in turn, the fundamentally different question of interest. Using a three-country two-period model, Melatos and Dunn (2013) analyze how the types of PTAs formed in period one depend on evolution of the world trade system in period two via: (i) entrance of a third country or (ii) departure of an existing country.[9] In practice, part of the prevalence that FTAs have over CUs may be driven by countries anticipating other countries may enter or leave the world trading system in the future. However, the overwhelming pervasiveness of FTAs relative to CUs also suggests a mechanism that does not rely on such anticipations.[10]

Finally, this paper relates to the small, but broader, literature analyzing the endogenous choice between CUs and FTAs. While Riezman (1999) finds CU formation emerges when there are two large countries and one small country (because such countries have a "CU exclusion incentive"), FTAs never emerge in equilibrium. Similarly, Melatos and Woodland (2007a) find FTAs never emerge in a unique equilibrium despite greater preference or endowment asymmetries between countries increasing the attractiveness of FTAs relative to CUs. Conversely, Facchini et al. (2012) find FTAs rather than CUs emerge in equilibrium when income inequality is not too high but CUs can emerge in equilibrium only when members have low income inequality and share similar

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9 Specifically, the former is modelled as an autarkic period one country becoming non-autarkic in period two while the latter is modelled as a non-autarkic period two country becoming (with respect to countries with whom it has not formed a PTA) autarkic in period two. The obvious motivation for the former is WTO accession by countries like China or Russia.

10 This paper also differs in a number of other ways from Melatos and Dunn (2013). First, I do not assume a discount factor equal to one; indeed, I show that whether the FTA flexibility benefit outweighs the CU coordination benefit depends on the discount factor. Second, I do not rely on simulations to establish equilibria. Third, I adopt a non-cooperative rather than a cooperative solution concept.

production structures. Because of their static nature, none of these papers address the flexibility versus coordination issue at the heart of this paper and only Facchini et al. (2012) addresses the prevalence of FTAs.

The paper proceeds as follows. Section 2 describes the game theoretic and network theoretic structure of PTA formation and also describes the underlying oligopolistic economic structure. Section 3 describes the equilibrium path of PTA networks in the "large world" and "small world" environments and also links the theoretical results to real world PTA formation in Europe and South America. Section 4 discusses extensions and interpretations of the baseline analysis. Finally, section 5 concludes. The appendix contains all proofs.

2. Model

This section serves three purposes. First, section 2.1 introduces basic notation that describes the PTA network and country payoffs. Section 2.1 also describes how the network of PTAs can evolve over time. Second, section 2.2 describes the oligopolistic model of trade. While this is an intra-industry model of trade in imperfectly competitive markets, section 4.1 shows the results are robust to a competing exporters model where inter-industry trade in perfectly competitive markets stems from supply-side comparative advantage forces. Third, section 2.3 formally describes the strategies of countries and the equilibrium concept.

2.1. Preliminaries

Starting with Goyal and Joshi (2006) and Furusawa and Konishi (2007), the trade agreement literature has borrowed useful notation and terminology from the network literature to describe networks of PTAs. Visually, the network literature views players as nodes on a "graph" and views edges between nodes as bilateral "links" between players. The graph g is then described by the set of bilateral links between players. As recognized by Goyal and Joshi (2006) and Furusawa and Konishi (2007), this network language can compactly describe networks of PTAs by recognizing FTAs and CUs as links between countries.

Figure 1 describes the possible networks and terminology between three countries i, j and k. In the absence of any FTAs or CUs, $g_{\varnothing}$ denotes the "empty network." When countries i and j have the sole FTA, g_{ij}^{FTA} denotes the "FTA insider–outsider network," where the FTA members i and j are "FTA insiders" and the FTA non-member k is the "FTA outsider." Analogously, when countries i and j have the sole CU, g_{ij}^{CU} denotes the "CU insider–outsider network". When country i is a member of the two existing FTAs, g_i^H denotes the "hub–spoke" network where country i is the hub and the other countries j and k are spokes. Finally, g^{FT} denotes the "free trade network," where all countries are linked via FTAs or CUs.

Like the dynamic trade agreement model of Seidmann (2009), I assume at most one agreement can form in any given period and agreements formed in

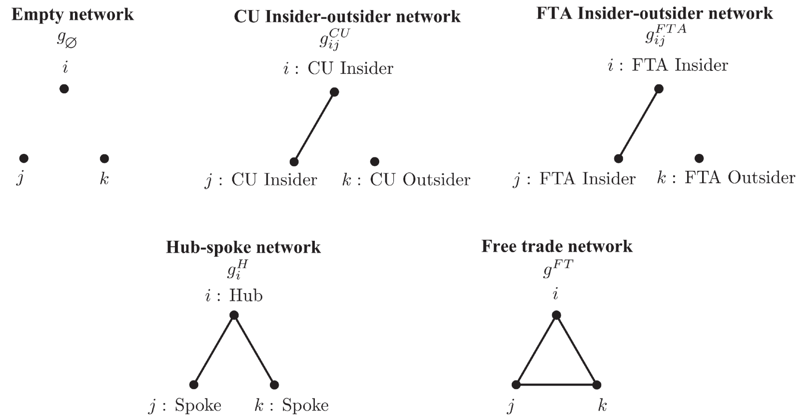

FIGURE 1 Networks and network positions

previous periods cannot be severed.[11,12] Table 1 illustrates the feasible transitions in any given period with $g_{t-1} \rightarrow g_t$ denoting the feasible transition when the network at the beginning of the current period is g_{t-1} and the network at the end of the current period is g_t. In turn, the network remains unchanged forever once one of the following conditions are met: (i) no agreement forms in a given period or (ii) global free trade is attained. In the former case, the assumption of Markov strategies implies no agreement will form in any subsequent period. In the latter case, the above assumption that previously formed agreements cannot be severed implies global free trade remains forever once attained. Thus, ultimately, the network remains unchanged from no later than the third period onwards.

Given a network g, country i's one-period payoff is denoted $v_i(g)$ with section 2.2 describing how $v_i(g)$ depends on the network structure in the oligopoly model. Given the dynamic nature of the model, countries also have continuation payoffs in period t resulting from the infinite sequence of transitions $g_{t-1} \rightarrow g_t \rightarrow g_{t+1} \rightarrow \cdots$. Because the context will make clear the sequence of transitions beyond g_t, I simply let $V_i(g_t)$ denote the continuation payoff for country i resulting from the current period transition $g_{t-1} \rightarrow g_t$ and the future transitions $g_t \rightarrow g_{t+1} \rightarrow g_{t+2} \rightarrow \cdots$. Given the network remains unchanged forever from no later than the third period onwards, as explained above, I let

11 Many authors (e.g., Ornelas 2008 and Ornelas and Liu 2012) argue the binding nature of trade agreements is both realistic, in terms of real world observation, and pervasive in the literature. They also argue realism as a reduced form shorthand for more structural justifications such as sunk costs (see McLaren 2002 and, for empirical support, Freund and McLaren 1999).

12 Essentially, I interpret a period as the required time to negotiate an agreement. Indeed, negotiations often take many years to complete; for example, despite not being signed until 1992, NAFTA negotiations date back to 1986 (Odell 2006, p. 193). I discuss this issue further in section 4.5.

TABLE 1
Feasible network transitions

Network at beginning of current period	Network at end of current period
$g_\varnothing$	$g_\varnothing, g_{ij}^{FTA}, g_{ik}^{FTA}, g_{jk}^{FTA}, g_{ij}^{CU}, g_{ik}^{CU}, g_{jk}^{CU}$
g_{ij}^{FTA}	$g_{ij}^{FTA}, g_i^H, g_j^H$
g_{ij}^{CU}	g_{ij}^{CU}, g^{FT}
g_i^H	g_i^H, g^{FT}
g^{FT}	g^{FT}

the last network in the sequence of transitions denote the network that remains in place forever after.[13]

For concreteness, consider the current period transition $g_\varnothing \to g_{ij}^{FTA}$ and the future transitions $g_{ij}^{FTA} \to g_i^H \to g^{FT}$ where, as described above, g^{FT} remains forever once attained. Then, letting $\delta \in (0,1)$ denote the common discount factor, country i's continuation payoff in the current period is $V_i(g_{ij}^{FTA}) = v_i(g_{ij}^{FTA}) + \delta v_i(g_i^H) + \delta^2 v_i(g^{FT})/(1-\delta)$. Alternatively, country i's continuation payoff in the current period from the current period transition $g_\varnothing \to g_{ij}^{CU}$ followed by no further agreements in any subsequent period is $V_i(g_{ij}^{CU}) = v_i(g_{ij}^{CU})/(1-\delta)$.

2.2. Oligopolistic model of trade

Three countries each have a single firm producing a homogenous good in segmented international markets. x_{ij} denotes the quantity sold by country i in country j's market. Country i's demand is $d_i(p_i) = \alpha_i - p_i$ where p_i denotes the price in country i.[14]

Assuming a common and constant marginal cost normalized to zero, the firm from country i faces the standard maximization problem in country j:

$$\max_{x_{ij}} \left[\left(\alpha_j - \sum_i x_{ij} \right) - \tau_{ji} \right] x_{ij}. \tag{1}$$

Given a network g, the equilibrium quantity is

$$x_{ij}^*(\tau_j, g) = \frac{1}{4} \left[\bar{d}_j + \left(3 - \eta_j(g)\right) \tau_j - 4\tau_{ji}(g) \right], \tag{2}$$

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13 For example, the sequence of transitions $g_\varnothing \to g_{ij}^{FTA} \to g_i^H \to g^{FT}$ indicates that the free trade network remains in place forever once attained. Alternatively, the sequence of transitions $g_\varnothing \to g_{ij}^{CU}$ indicates the CU between i and j remains in place forever once formed.

14 In the background, a representative consumer has a quasi-linear utility function that is linear in a numeraire good and quadratic in the oligopolistic good. This implies linear demand for the oligopolistic good and that the numeraire good absorbs income effects. The numeraire good balances trade across countries.

where: (i) $\eta_j(g)$ is the number of countries facing a zero tariff in country j (including country j itself), (ii) per WTO rules, τ_j is the MFN (most favoured nation), i.e., non-discriminatory, tariff faced by countries who do not have an FTA with country j and (iii) $\tau_{ji}(g)$ is the tariff imposed by country j on country i given the network g and, thus, takes on the value zero if i and j are PTA partners but value τ_j if i and j are not PTA partners. Ruling out prohibitive tariffs, country i's equilibrium profits in country j are $\pi_{ij}(\tau_j, g) = (x^*_{ij}(\tau_j, g))^2$ and country i's total profits are $\pi_i(\tau_i, \tau_j, \tau_k, g) = \sum_h \pi_{ih}(\tau_h, g)$.

Countries choose MFN tariffs recognizing that, per Article XXIV of GATT (General Agreement on Tariffs and Trade), PTA members levy zero tariffs on each other. If country i has two FTA partners or global free trade prevails (i.e., $g = g^H_i, g^{FT}$) then, by definition, $\tau_i(g) = 0$. Moving beyond these cases, let $v_i(\tau_i, \tau_j, \tau_k, g)$ be country i's national welfare (i.e., the sum of consumer surplus, producer surplus and tariff revenue). Then, country i's optimal tariff given a network g is

$$\tau_i(g) \equiv \arg\max_{\tau_i} v_i\left(\tau_i, \tau_j, \tau_k, g\right) = \frac{3\alpha_i}{11\eta_i\ (g) - 1}. \tag{3}$$

Country i's optimal MFN tariff depends on the PTA network. If country i has no PTA partners (i.e., $\eta_i(g) = 1$) then (3) reduces to

$$\tau_i(g) = \frac{3\alpha_i}{10} \text{ for } g = g_\varnothing, g^{FTA}_{jk}, g^{CU}_{jk}, \tag{4}$$

with the invariance of country i's optimal tariff to PTA formation by others stemming from the segmented nature of markets. However, country i's optimal tariff depends on its own PTA formation. If country i has one FTA partner (i.e., $\eta_i(g) = 2$) then (3) reduces to

$$\tau_i(g) = \frac{3\alpha_i}{7} \text{ for } g = g^{FTA}_{ij}, g^{FTA}_{ik}, g^H_j, g^H_k. \tag{5}$$

In contrast to FTA members whose external tariffs maximize their individual national welfare, CU members set a common external tariff. I follow the standard approach in the literature (e.g., Saggi et al. 2013), where CU members do so by maximizing their joint welfare:

$$\tau_i\left(g^{CU}_{ij}\right) \equiv \arg\max_{\tau_i} v_i\left(\tau_i, \tau_j, \tau_k, g^{CU}_{ij}\right) + v_j\left(\tau_i, \tau_j, \tau_k, g^{CU}_{ij}\right)$$
$$\text{s.t.} \quad \tau_i = \tau_j,$$

which yields

$$\tau_i\left(g^{CU}_{ij}\right) = \tau_j\left(g^{CU}_{ij}\right) = \frac{5\left(\alpha_i + \alpha_j\right)}{38}. \tag{6}$$

Comparing (5) and (6) with (4) reveals the well-known phenomenon of "tariff complementarity" whereby, as in various other economic settings, PTA formation induces members to lower their external tariff on non-members (e.g., $\tau_i(g^{CU}_{ij}) < \tau_i(g_\varnothing)$). Intuitively, in the oligopoly model, imperfect competition motivates governments to shift home market profits from foreign firms to domestic firms by raising tariffs. Indeed, this incentive strengthens with the home country's market size. But, by increasing competition in the home market, FTA formation reduces the home firm's markup in the home market. Thus, the home country's profit shifting motivation weakens and delivers tariff complementarity.

Importantly, the lower post-FTA tariff on the non-member shifts not only home market profits from the home firm to the non-member firm but also from the foreign firm of the new FTA partner country to the foreign non-member firm. Thus, tariff complementarity creates a negative externality between FTA members.[15] However, CU formation allows members to internalize the negative externality via a common external tariff. This coordination benefit underlies why the CU optimal tariff exceeds the FTA optimal tariff: $\frac{5(\alpha_i+\alpha_j)}{38} > \frac{\alpha_i}{7}$.[16] Nevertheless, CU members' ability to exploit the coordination benefit is limited because WTO rules prevent CU members raising external tariffs after CU formation. In the current oligopoly model, this constraint can bind only for the smaller CU insider j and does so when $\frac{\alpha_i}{\alpha_j} > \frac{32}{25} = 1.28$. As such, this consideration places an upper bound on the degree of asymmetry allowed.[17] Denoting the largest country by l and normalizing the market size of the smallest country to 1, I denote this threshold $\bar{\alpha}_l$ and hereafter impose $\alpha_l < \bar{\alpha}_l$.

Naturally, the equilibrium path of PTA networks depends on PTA formation incentives and these depend on MFN tariffs. For members, country i faces a benefit and cost when forming a bilateral PTA. On the one hand, country i benefits from tariff free access to country j's market. If the non-member k has no pre-existing PTA with country j, this tariff free access represents preferential access. If the non-member k has a pre-existing PTA with country j, this tariff free access eliminates pre-existing discrimination. On the other hand, the tariff free access that country i grants country j in country i's market represents the cost of a bilateral PTA for country i. In general, PTA formation also confers a benefit and cost on the non-member. While the non-member benefits from any tariff complementarity, it also suffers from either discrimination or elimination of preferential access. Given these principles, five key properties drive the equilibrium structure.

15 Estevadeordal et al. (2008) provide empirical evidence for tariff complementarity.

16 Formally, this inequality holds if and only if $\frac{\alpha_i}{\alpha_j} \in (\frac{3}{35}, \frac{35}{3})$. The following analysis respects this constraint.

17 Like Missios et al. (2016), the CU external tariff constraint plays little role here. Indeed, slightly relaxing this constraint (and imposing $\tau_i(g_{ij}^{CU}) = \tau_i(g_\varnothing)$), would leave the "large world" equilibrium structure in figure 2 unaffected and the "small world" equilibrium structure in figure 3 would change only in that the $\underline{\delta}_l^{Flex}(\alpha_l)$ and $\bar{\delta}_l^{Flex}(\alpha_l)$ curves would kink at $\alpha_l = \bar{\alpha}_l$. In contrast, see Mrázová et al. (2012) for an economic environment where the constraint can have non-trivial implications.

Lemma 1 summarizes these five properties noting that $v_i(\tau_i, \tau_j, \tau_k, g)$ merely reduces to $v_i(g)$ given optimal MFN tariffs themselves depend on the network g.

Lemma 1 *The following properties characterize the myopic preferences of countries in the oligopoly model:*

(i) Bilateral PTA formation is more attractive with a larger partner: $v_i(g + ij^{FTA}) > v_i(g + ik^{FTA})$ *and* $v_i(g_{ij}^{CU}) > v_i(g_{jk}^{CU})$ *if* $\alpha_j > \alpha_k$.

(ii) Except as an FTA outsider, all bilateral PTAs are mutually beneficial for members: $v_i(g + ij^{FTA}) > v_i(g)$ *for* $g \neq g_{jk}^{FTA}$ *and* $v_i(g_{ij}^{CU}) > v_i(g_\varnothing)$. *Further, the CU outsider benefits from CU expansion:* $v_i(g^{FT}) > v_i(g_{jk}^{CU})$.

(iii) Countries have a myopic CU coordination benefit: $v_i(g_{ij}^{CU}) > v_i(g_{ij}^{FTA})$

(iv) Countries do not hold FTA exclusion incentives: $v_i(g^{FT}) > v_i(g_{ij}^{FTA})$. *But, a CU insider i may hold a CU exclusion incentive against a CU outsider k only if it is larger than the CU outsider and this incentive is stronger for larger CU insiders:* $v_i(g_{ij}^{CU}) - v_i(g^{FT}) > v_j(g_{ij}^{CU}) - v_j(g^{FT})$ *and* $v_i(g_{ik}^{CU}) - v_i(g^{FT}) > v_j(g_{jk}^{CU}) - v_j(g^{FT})$ *if* $\alpha_i > \alpha_j$ *but* $v_i(g_{ij}^{CU}) - v_i(g^{FT}) \geq 0$ *only if* $\alpha_i > \alpha_k$.

(v) Countries prefer being a CU insider than a CU outsider: $v_i(g_{ij}^{CU}) > v_i(g_{jk}^{CU})$. *Further, when a large country j is an FTA insider, another country i prefers being an FTA insider over an FTA outsider:* $v_i(g_{ij}^{FTA}) > v_i(g_{jk}^{FTA})$ *when* $\alpha_j \geq \max\{\alpha_i, \alpha_k\}$.

The first two properties (mostly) describe member PTA formation incentives. Part (i) says merely that bilateral PTA formation is myopically more attractive with a larger partner. Intuitively, larger partners levy higher MFN tariffs and thereby increase the value of tariff free access.

Despite the domestic market access given up, part (ii) says that bilateral PTA formation is myopically attractive with the only *possible* exception being FTA formation as an FTA outsider. Intuitively, an FTA outsider may refuse FTA formation with the FTA insiders because the FTA outsider has already extracted market access gains via tariff complementarity. Nevertheless, the FTA outsider myopically benefits from subsequent FTA formation with an FTA insider once the FTA insider is sufficiently larger than the FTA outsider. Additionally, part (ii) says CU expansion always benefits the CU non-member. Intuitively, given the high MFN tariffs imposed by CU insiders, the CU non-member benefits from eliminating the associated discrimination via CU expansion to global free trade.

The third property governs the myopic coordination benefit of CUs. Specifically, because the MFN tariffs of CU members internalize the negative externality associated with tariff complementarity, part (iii) says CU formation is myopically attractive relative to FTA formation.

The fourth property describes whether PTA insiders benefit from excluding the PTA outsider from expansion to global free trade. In general, each PTA insider would gain tariff free access to the non-member's market. However, such access is not preferential access because both PTA insiders gain access, thereby diluting the benefit. Moreover, through expansion, PTA insiders forego the reciprocal preferential access enjoyed as PTA insiders. Ultimately, part (iv) says that FTA insiders always benefit from direct expansion to global free trade. That is, they never hold an FTA exclusion incentive. Conversely, part (iv) says that a larger CU insider may hold a CU exclusion incentive over a smaller CU outsider and this incentive strengthens with the size of the larger CU member. Intuitively, the myopic CU coordination benefit strengthens the incentive of PTA insiders to benefit from excluding the PTA outsider and sufficiently so that a larger CU insider may benefit from permanently excluding a smaller CU outsider.

The fifth property governs the cost of being discriminated against as a PTA outsider. Because CU members internalize the negative externality associated with tariff complementarity, the CU outsider faces stronger discrimination than the FTA outsider. This intuition, coupled with the myopic CU coordination benefit, underlies part (v), which says a country prefers being a CU insider rather than a CU outsider. Despite tariff complementarity mitigating the cost of discrimination as an FTA outsider, the degree of this discrimination rises with the market size of FTA insiders. Indeed, part (v) says that, fixing the largest country as an FTA insider, the discrimination faced as an FTA outsider is high enough that a country prefers being an FTA insider with the largest country than an FTA outsider.

2.3. Strategies and equilibrium concept

My dynamic model closely resembles Seidmann (2009). As described in section 2.1, at most one agreement can form in any given period and agreements formed in previous periods are binding. Moreover, given a network at the end of the previous period g_{t-1}, I follow Seidmann (2009) and refer to the current period t as the subgame at g_{t-1}.

Seidmann (2009) assumes a stochastic protocol where a single "proposer" country can propose a trade agreement in a given period. However, I adopt a version of the deterministic protocol used by Lake and Yildiz (2016). Letting $\alpha_l \geq \alpha_m \geq \alpha_s$, two ideas underpin the protocol. First, like Aghion et al. (2007), country l is the largest country and the "leader country" who has the first opportunity to propose PTA formation in each period. Second, unlike Aghion et al. (2007), country m, who is the second largest country, becomes the proposer in a given period if country l does not have a proposal accepted by the "recipient" country or countries.

Formally, stages 1 and 2, below, govern the protocol in each period. Naturally, a proposer country can propose only an agreement to which it is a member and that represents a feasible transition (see table 1). To be clear, the proposer can propose no agreement and, following a proposal, a PTA forms if and only if all members of the proposed agreement accept.

TABLE 2
Proposer country's action space for each subgame

	$P_i(g)$	$P_j(g)$	$P_k(g)$
$g_{\varnothing}$	$\{\phi, ij^{FTA}, ik^{FTA}, ij^{CU}, ik^{CU}\}$	$\{\phi, ij^{FTA}, jk^{FTA}, ij^{CU}, jk^{CU}\}$	$\{\phi, ik^{FTA}, jk^{FTA}, ik^{CU}, jk^{CU}\}$
g_{ij}^{FTA}	$\{\phi, ik^{FTA}\}$	$\{\phi, jk^{FTA}\}$	$\{\phi, ik^{FTA}, jk^{FTA}\}$
g_{ij}^{CU}	$\{\phi, ijk^{CU}\}$	$\{\phi, ijk^{CU}\}$	$\{\phi, ijk^{CU}\}$
g_i^H	$\{\phi\}$	$\{\phi, jk^{FTA}\}$	$\{\phi, jk^{FTA}\}$
g^{FT}	$\{\phi\}$	$\{\phi\}$	$\{\phi\}$

Stage 1(a). Country l has the opportunity to propose a PTA. If an agreement forms then the period ends. If one recipient country rejects the proposal then the game moves to stage 1(b). If two recipient countries reject the proposal, or country l makes no proposal, then the game moves to stage 2.

Stage 1(b). Country l has the opportunity to propose a PTA with the country who did not reject its proposal in stage 1(a). If the agreement forms then the period ends. Otherwise, the game moves to stage 2.

Stage 2. Country m has the opportunity to propose a PTA.

Notice that the protocol implies that no further agreements form once no pair of countries want to form a subsequent agreement or upon attainment of the free trade network. Thus, no further agreements form after, at most, three periods.

As stated above, a proposer country can propose an agreement that has not yet formed and to which it will be a member. Table 2 illustrates the proposals available to each country in each possible subgame at network g; $P_i(g)$ represents this set of proposals and $\rho_i(g) \in P_i(g)$ represents a proposal. In table 2, ij^{FTA} and ij^{CU} denote the FTA and CU between i and j while ijk^{CU} denotes a three-country CU. ϕ denotes the proposer country's choice to make no proposal. Having received a proposal $\rho_i(g)$, each recipient country j (i.e., a country of the proposed agreement) responds by announcing $r_j(g, \rho_i(g)) \in \{Y, N\}$, where Y (N) denotes j accepts (does not accept) the proposal.

Given the protocol, country i's Markov strategy must do two things for every subgame at network g: (i) assign a proposal $\rho_i(g) \in P_i(g)$ for the stage where country i is the proposer and (ii) assign a response $r_i(g, \rho_j(g)) \in \{Y, N\}$ to any proposal country i may receive from another country j. I follow Seidmann (2009) and solve for a type of pure strategy Markov perfect equilibrium. Specifically, I use backward induction to solve for a pure strategy subgame perfect equilibrium where the proposal by the proposer and the response(s) by the respondent(s) in period t depend only on history via the network g in place at the end of the previous period.[18]

18 For convenience, I make two assumptions that restrict attention to certain Markov Perfect Equilibria. First, given the simultaneity of responses to a proposal for expansion of a CU to include the CU outsider, I assume countries

3. Equilibrium path of networks

I now analyze the equilibrium path of PTA networks among asymmetric countries. To illustrate the impact of asymmetry, I follow Saggi et al. (2013) and consider two separate cases. Section 3.1 considers the "large world" case of two large countries and one small country, $\alpha_l = \alpha_m > \alpha_s \equiv 1$. In this case, I relabel country l as country l_1, who is the leader country in stage 1 of the protocol, and country m as country l_2. Section 3.2 considers the "small world" case of one large country and two small countries, $\alpha_l > \alpha_m = \alpha_s$. In this case, I relabel country m as s_1, who is the proposer in stage 2 of the protocol, and country s as country s_2. Comparing these two cases helps shed light on real world implications of the trade-off between the FTA flexibility and CU coordination benefits (section 4.2 describes the additional insight from the general setting where $\alpha_m \in [\alpha_s, \alpha_l]$). Note, when distinguishing between multiple large or small countries is irrelevant, I merely use l (instead of l_1 and l_2) or s (instead of s_1 and s_2).[19]

A cost of not focusing on a more general asymmetric structure is that the remaining partial degree of symmetry creates multiple equilibria. To avoid this complication in the large world case of section 3.1, I assume country s derives some arbitrarily small non-economic benefit $\epsilon > 0$ when forming a bilateral PTA with country l_1. Thus, despite equal economic attractiveness, country s views country l_1 as a more attractive partner than l_2. Analogously in the small world case of section 3.2, I assume country l derives some arbitrarily small non-economic benefit $\epsilon > 0$ when forming a bilateral PTA with country s_1 so that country l views country s_1 a more attractive partner than s_2.[20] Indeed, these non-economic benefits can be motivated as explaining why country l_1 (s_1) moves before country l_2 (s_2) in the protocol of section 3.1 (section 3.2). Moreover, this approach would be essentially identical to saying that country l_1 (s_1) had a slightly larger market size than l_2 (s_2) in the large (small) world case of section 3.1 (section 3.2).

A corollary from taking this perspective is that the equilibrium outcome in the symmetric case where $\alpha_l = \alpha_m = \alpha_s$ is merely the limiting case of both the large world analysis and the small world analysis as $\alpha_l \to \alpha_s$. In the former case, this is achieved through l_1 and l_2 deriving some arbitrarily small non-economic benefit $\epsilon > 0$ when forming a bilateral PTA with each other so that

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respond to such proposals affirmatively if they prefer global free trade over the status quo. That is, $r_h(g_{ij}^{CU}, ijk^{CU}) = Y$ if and only if $v_h(g^{FT}) > v_h(g_{ij}^{CU})$. I also assume a recipient country i responds with $r_i(g, \rho_j(g)) = Y$ when responding with $r_i(g, \rho_j(g)) = N$ would merely delay formation of the proposed agreement to a later stage of the current period. This can be motivated by the presence of an arbitrarily small cost involved in making a response.

19 In the appendix, $\alpha \equiv (\alpha_l, \alpha_m, \alpha_s)$.

20 To be clear, the one-period payoffs $v_i(g)$ and the continuation payoffs $V_i(g)$ are defined *excluding* these non-economic benefits.

they view this PTA as more attractive than a PTA with s even though $\alpha_l = \alpha_s$. In the latter case, this is achieved through s_1 and s_2 deriving some arbitrarily small non-economic benefit $\epsilon > 0$ when forming a bilateral PTA with l so that they view the PTA with l as more attractive than a PTA between themselves even though $\alpha_l = \alpha_s$. Indeed, the y-axis of figures 2–4 in sections 3.1–3.3 depict the equilibrium path of networks for a symmetric three-country world.

The subsequent analysis in the "large world" and "small world" cases proceeds by backward induction. Remember, global free trade remains forever once attained. Thus, the backward induction begins by considering the equilibrium outcome in subgames at hub–spoke networks. Given the equilibrium transitions from hub–spoke networks, the analysis then rolls backward and considers the equilibrium outcome in subgames at FTA insider–outsider networks. Before rolling back to consider the equilibrium outcome in the subgame at the empty network, the analysis considers the equilibrium outcome of subgames at CU insider–outsider networks. Given the equilibrium transitions from the FTA and CU insider–outsider networks, the analysis then rolls back and considers the equilibrium outcome at the empty network. The equilibrium transition from the empty network together with the subsequent equilibrium transitions reveals the equilibrium path of networks.

3.1. A "large" world: Two large countries and one small country

To illustrate how the structure of asymmetry affects whether FTAs or CUs emerge in equilibrium, I begin by considering the "large world" case with two large countries and one large country. That is, $\alpha_s < \alpha_{l_1} = \alpha_{l_2} < \bar{\alpha}_l$. With the equilibrium transitions in place from hub–spoke as well as CU and FTA insider–outsider networks (sections 3.1.1–3.1.2), the key trade-off underlying the equilibrium path of networks emerges, which is the trade-off between the CU coordination benefits and the FTA flexibility benefit (section 3.1.3).

3.1.1. Subgames at hub–spoke networks

To begin, consider the subgame at a hub–spoke network g_i^H. As described in section 2.2, spokes always benefit from exchanging reciprocal preferential access and forming the final FTA that leads to global free trade. Thus, from any hub–spoke network g_i^H, the equilibrium transition is $g_i^H \to g^{FT}$.

3.1.2. Subgames at FTA and CU insider–outsider networks

Now roll back to the subgame at an FTA insider–outsider network g_{ij}^{FTA}. While an FTA insider always wants to become the hub, an FTA outsider may refuse an FTA with either FTA insider, which leaves the FTA insider–outsider network g_{ij}^{FTA} in place permanently.

Myopic and farsighted incentives motivate an FTA insider's desire to become the hub. As described in section 2.2, preferential market access to the FTA outsider's market makes becoming the hub myopically attractive: $v_i(g_i^H) > v_i(g_{ij}^{FTA})$. In principle, an FTA insider may have a farsighted incentive to refuse becoming the hub because it subsequently loses preferential access in both spoke markets when the spokes form their own FTA. However, as described in section 2.2, FTA insiders do not hold FTA exclusion incentives: $v_i(g^{FT}) > v_i(g_{ij}^{FTA})$. Thus, from myopic and farsighted perspectives, FTA insiders want to become the hub. Further, as described in section 2.2, the FTA outsider prefers FTA formation with the larger FTA insider. Thus, in equilibrium, the more attractive FTA insider becomes the hub whenever the FTA outsider willingly participates in FTA formation.

Unlike FTA insiders, the FTA outsider may face a tension between myopic and farsighted incentives for subsequent FTA formation. As discussed in section 2.2, the FTA outsider benefits from tariff complementarity whereby FTA insiders lower their MFN tariffs upon FTA formation. Thus, despite the discrimination faced because FTA insiders enjoy reciprocal tariff free access, the FTA outsider has already gained tariff concessions from FTA members. As such, the FTA outsider may not benefit myopically from becoming a spoke: $v_i(g_{jk}^{FTA}) > v_i(g_j^H)$ can hold. Nevertheless, even in this case, an FTA outsider can benefit from removing the discrimination faced in *both* FTA insider markets: $v_i(g^{FT}) > v_i(g_{jk}^{FTA})$. Thus, given spokes always form spoke–spoke FTAs, an FTA outsider can have a farsighted incentive to become a spoke even though it may not have a myopic incentive.

Naturally, the discount factor mediates the myopic and farsighted incentives of the FTA outsider's decision regarding subsequent FTA formation. An FTA outsider i wants to become a spoke with the more attractive FTA insider j if and only if

$$v_i\left(g_j^H\right) + \frac{\delta}{1-\delta} v_i\left(g^{FT}\right) > \frac{1}{1-\delta} v_i\left(g_{jk}^{FTA}\right)$$

$$\Leftrightarrow \delta > \bar{\delta}_{i,j}^{OUT}\left(\alpha_l\right) \equiv \frac{v_i\left(g_{jk}^{FTA}\right) - v_i\left(g_j^H\right)}{v_i\left(g^{FT}\right) - v_i\left(g_j^H\right)}.$$

Thus, an FTA outsider wants to become the spoke only when it is sufficiently patient that the farsighted incentive to become the spoke outweighs the myopic incentive to remain an FTA outsider. Because FTA insiders always want to become the hub and spokes always form their own FTA, this tradeoff for the FTA outsider determines whether an FTA insider–outsider remains permanently or leads to global free trade via the hub–spoke network.

In contrast to subsequent FTA formation at an FTA insider–outsider network, subsequent CU formation at a CU insider–outsider network does not depend on a tension between myopic and farsighted incentives. As described in section 2.2, a CU outsider faces strong discrimination given CU insiders internalize the negative externality associated with tariff complementarity. Thus, a CU outsider always favours CU expansion, which, by construction, leads directly to global free trade. But, as described in section 2.2, a large country may benefit from permanently excluding the CU outsider from CU expansion. Indeed, a large country holds a CU exclusion incentive against the smallest country under sufficient asymmetry: $v_l(g_{ll}^{CU}) \geq v_l(g^{FT})$ once $\alpha_l \geq \bar{\alpha}_l^{CU}$. In this case, the relatively large market size of the CU insiders raises their MFN tariffs sufficiently that the market access provided by CU expansion with country s cannot compensate country $l_1(l_2)$ for its lost preferential market access with country $l_2(l_1)$. Thus, ultimately, CU expansion takes place after two large countries form a CU if and only if $\alpha_l < \bar{\alpha}_l^{CU}$.

Lemma 2 summarizes the discussion thus far. Importantly, lemma 2 applies not only for the large world case where $\alpha_l = \alpha_m > \alpha_s$ but also for the general case where $\alpha_l \geq \alpha_m \geq \alpha_s$.[21]

Lemma 2 *Let* $\bar{\alpha}_l > \alpha_l \geq \alpha_m \geq \alpha_s$.

(i) Consider an FTA insider–outsider network g_{ij}^{FTA} *where country* i *is more attractive than country* j. *Then, FTA expansion to global free trade via the hub–spoke network* g_i^H *takes place if* $\delta > \bar{\delta}_{k,i}^{OUT}(\alpha_l)$. *Otherwise, the FTA insider–outsider network* g_{ij}^{FTA} *remains permanently.*

(ii) Consider a CU insider–outsider network g_{ij}^{CU}. *This CU insider–outsider network does not expand, and thereby remains permanently, if it involves the largest country and the largest country holds a CU exclusion incentive against the CU outsider. Otherwise, the CU insider–outsider network expands to include the third country (which is equivalent to global free trade).*

3.1.3. Subgame at empty network

Now, roll back to the empty network. Keeping in mind the equilibrium transitions from PTA insider–outsider networks described in lemma 2, knowing the PTA outcome at the empty network reveals the equilibrium path of networks. Given the attractiveness of the large leader country l_1, the equilibrium path of networks revolves around its preference for exploiting the FTA flexibility or CU coordination benefit.

Nevertheless, l_1 cannot merely impose its will on others. Given l_2 cannot become the hub after FTA formation with l_1, the coordination benefits of CU formation imply l_2 prefers a CU rather than an FTA with l_1. But, suppose l_1 wants to form an FTA with country l_2 to exploit the FTA flexibility benefit whereby l_1 then becomes the hub on the path to global free trade. The protocol says that l_2 can reject l_1's FTA proposal and thereby force l_1 to propose PTA formation with country s (and, if that fails, l_2 can then propose PTA formation itself). Thus, to induce l_2's acceptance of its FTA proposal, l_1 must be able

21 I assume: (i) a recipient country i responds with $r_i(g, \rho_j(g)) = N$ when indifferent between $r_i(g, \rho_j(g)) = Y$ and $r_i(g, \rho_j(g)) = N$ and (ii) a proposer country i proposes CU formation rather than FTA formation when indifferent between CU and FTA formation.

to threaten l_2 that it would prefer an FTA with s over a CU with l_2.[22] In this case, l_2 will accept an FTA proposal from l_1 to avoid being an FTA outsider on the path to global free trade. Otherwise, facing a credible threat of l_2 rejecting its FTA proposal, l_1 cedes and proposes a CU with l_2.

Formally, l_1 prefers FTA formation with s over CU formation with l_2 when

$$V_{l_1}\left(g_{sl_1}^{FTA}\right)=v_{l_1}\left(g_{sl_1}^{FTA}\right)+\delta v_{l_1}\left(g_{l_1}^{H}\right)+\frac{\delta^2}{1-\delta}v_{l_1}\left(g^{FT}\right)>V_{l_1}\left(g_{ll}^{CU}\right). \quad (7)$$

If the large countries do not hold a CU exclusion incentive, their CU expands directly to global free trade. Then, (7) says the FTA flexibility benefit for a large country of being an FTA insider with country s outweighs the CU coordination benefit from being a CU insider with the other large country when

$$\begin{aligned}&\underbrace{\delta\left[v_{l_1}\left(g_{l_1}^{H}\right)-v_{l_1}\left(g^{FT}\right)\right]}_{\text{FTA flexibility benefit}} > \underbrace{v_{l_1}\left(g_{ll}^{CU}\right)-v_{l_1}\left(g_{sl_1}^{FTA}\right)}_{\text{Myopic CU coordination benefit}} \\ &\Leftrightarrow \delta>\underline{\delta}_l^{Flex}\left(\alpha_l\right)\equiv\frac{v_{l_1}\left(g_{ll}^{CU}\right)-v_{l_1}\left(g_{sl_1}^{FTA}\right)}{v_{l_1}\left(g_{l_1}^{H}\right)-v_{l_1}\left(g^{FT}\right)}\end{aligned}. \quad (8)$$

Because CU and FTA formation eventually yield global free trade, the myopic CU coordination and FTA flexibility benefits derive from the different paths to global free trade. With a sufficiently high discount factor, the FTA flexibility benefit outweighs the myopic CU coordination benefit and l_1 prefers FTA formation with s over CU formation with l_2.

The FTA flexibility benefit for l_1 is that it becomes the hub after being an FTA insider rather than moving directly to global free trade as would happen from CU expansion after being a CU insider. That is, the FTA flexibility benefit captures the ability of FTA insiders to subsequently form their own individual FTAs. Moreover, this flexibility is valuable, $v_{l_1}(g_{l_1}^{H})-v_{l_1}(g^{FT})>0$, because the hub enjoys reciprocal tariff free preferential market access with both spoke countries while the spokes face MFN tariffs with each other. The myopic CU coordination benefit is merely the one-period benefit l_1 derives from CU formation with l_2 over FTA formation with s. Noting that $v_{l_1}(g_{ll}^{CU})-v_{l_1}(g_{sl_1}^{FTA})=[v_{l_1}(g_{ll}^{CU})-v_{l_1}(g_{ll}^{FTA})]+[v_{l_1}(g_{ll}^{FTA})-v_{l_1}(g_{sl_1}^{FTA})]$ this myopic CU coordination benefit derives from: (i) the ability of large CU members to coordinate external trade policy and thereby internalize the negative externality associated with tariff complementarity, $v_{l_1}(g_{ll}^{CU})-v_{l_1}(g_{ll}^{FTA})>0$, and (ii) the ability to engage in PTA formation with a larger partner, $v_{l_1}(g_{ll}^{FTA})-v_{l_1}(g_{sl_1}^{FTA})>0$.

A CU exclusion incentive between the large countries modifies the trade-off between the FTA flexibility and CU coordination benefits. Now (7) says

22 Note, l_1 always prefers CU formation with l_2 over CU formation with s.

the FTA flexibility benefit for a large country of being an FTA insider with country s outweighs the CU coordination benefit from being a CU insider with the other large country when

$$\begin{aligned}
&\underbrace{\delta\left[v_{l_1}(g^{H}_{l_1}) - v_{l_1}(g^{FT})\right]}_{\text{FTA flexibility benefit}} \\
&> \underbrace{\underbrace{\left[v_{l_1}(g^{CU}_{ll}) - v_{l_1}(g^{FTA}_{sl_1})\right]}_{\text{Myopic CU coordination benefit}} + \frac{\delta}{1-\delta}\underbrace{\left[v_{l_1}(g^{CU}_{ll}) - v_{l_1}(g^{FT})\right]}_{\text{Joint authority motive}}}_{\text{CU coordination benefit}} \\
&\Leftrightarrow \delta \in \left(\underline{\delta}^{Flex}_{l}(\alpha_l), \bar{\delta}^{Flex}_{l}(\alpha_l)\right).
\end{aligned} \tag{9}$$

Now, the CU coordination benefit consists of a myopic and farsighted component. This farsighted component is the joint authority motive and represents the benefit of eliminating the possibility that either CU insider can become the hub and precipitate global free trade, which is what would happen if the countries engaged in FTA formation. Thus, when the large countries hold a CU exclusion incentive, the CU coordination benefit outweighs the FTA flexibility benefit for sufficiently myopic or sufficiently farsighted countries.

With the trade-off between the FTA flexibility benefit and CU coordination benefits in place, proposition 1 now describes the equilibrium path of networks in the large world of two large countries and one small country. Note that, for compactness, one can rewrite $\delta > \underline{\delta}^{Flex}_{l}(\alpha_l)$ in (8) as $\delta \in (\underline{\delta}^{Flex}_{l}(\alpha_l), \bar{\delta}^{Flex}_{l}(\alpha_l))$ by letting $\bar{\delta}^{Flex}_{l}(\alpha_l) \equiv 1$.

PROPOSITION 1 *Consider a "large world" with two large countries and one small country, $\alpha_s < \alpha_{l_2} = \alpha_{l_1} \equiv \alpha_l < \bar{\alpha}_l$. If $\delta \in (\underline{\delta}^{Flex}_{l}(\alpha_l), \bar{\delta}^{Flex}_{l}(\alpha_l))$, the equilibrium path of networks is that the large countries form an FTA and then country l_1 becomes the hub on the path to global free trade. If $\delta \notin (\underline{\delta}^{Flex}_{l}(\alpha_l), \bar{\delta}^{Flex}_{l}(\alpha_l))$, the equilibrium path of networks is that the large countries form a CU, which then expands to global free trade if and only if the large countries do not hold a CU exclusion incentive.*

Figure 2 illustrates proposition 1. First, suppose $\alpha_l < \bar{\alpha}^{CU}_{l} \approx 1.14\alpha_s$ so that the large countries do not hold a CU exclusion incentive. As such, a CU between the large countries expands to global free trade. When $\delta > \underline{\delta}^{Flex}_{l}(\alpha_l)$, *both* large countries prefer an FTA with country s over a CU with each other. In this case, the future flexibility benefit for a large country of becoming the hub after being an FTA insider with s outweighs the myopic CU coordination benefit of internalizing the tariff complementarity negative externality via CU formation with the other large country. Thus, l_2 cannot credibly threaten to reject an FTA with l_1 (in stage 1(a)) because l_1 would then form an FTA with s (in stage 1(b)) rather than witness an FTA between l_2 and s (in stage 2). Indeed, given the market size of l_2 makes it a more attractive FTA partner

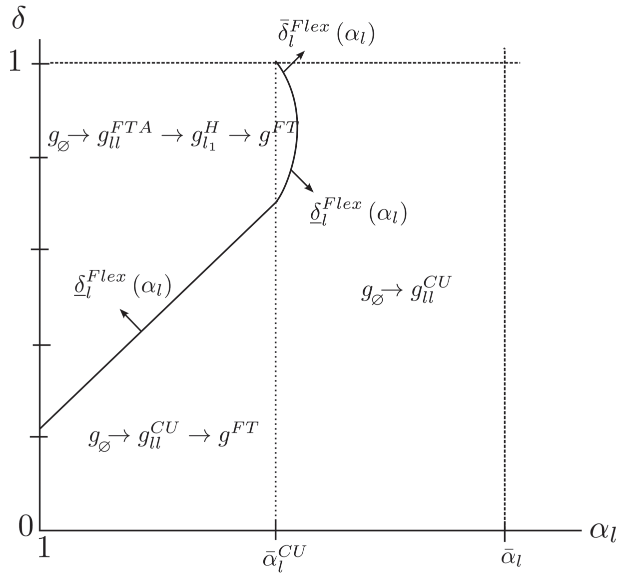

FIGURE 2 Equilibrium path of networks in a large world

than s, l_1 proposes an FTA with l_2 when $\delta > \underline{\delta}_l^{Flex}(\alpha_l)$ and l_2 accepts.[23] Thus, the equilibrium path of networks is $g_\varnothing \to g_{ll}^{FTA} \to g_{l_1}^{H} \to g^{FT}$.

However, once $\delta < \underline{\delta}_l^{Flex}(\alpha_l)$ then *both* large countries prefer CU formation with each other over FTA formation with s. Thus, even if l_1 would prefer FTA over CU formation with l_2, l_2 can credibly threaten to refuse an FTA with l_1 (in stage 1(a)) because l_1 would prefer to wait for a CU proposal from l_2 (in stage 2) rather than form an FTA with s (in stage 1(b)). Hence, the equilibrium path of networks is $g_\varnothing \to g_{ll}^{CU} \to g^{FT}$.

Second, suppose $\alpha_l \geq \bar{\alpha}_l^{CU}$ so that a CU between the large countries does not expand to include the small country because of their CU exclusion incentive. Similar intuition again explains the equilibrium. The main difference is that the CU exclusion incentive provides a farsighted component to the CU coordination benefit. The CU exclusion incentive, i.e., $v_l(g_{ll}^{CU}) \geq v_l(g^{FT})$, implies countries value the joint authority motive of CUs whereby CU formation eliminates the possibility that either FTA insider can become the hub and precipitate global free trade. Thus, l_1 prefers an FTA with s over a CU with l_2 only when $\delta \in (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$ where, now, $\bar{\delta}_l^{Flex}(\alpha_l) < 1$. As such, the equilibrium path of networks is $g_\varnothing \to g_{ll}^{FTA} \to g_{l_1}^{H} \to g^{FT}$ when $\delta \in (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$ but $g_\varnothing \to g_{ll}^{CU}$ when $\delta \notin (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$.

23 Note that $\max\{\bar{\delta}_{s,l}^{OUT}(\alpha_l), \bar{\delta}_{l_2,l_1}^{OUT}(\alpha_l)\} < \underline{\delta}_l^{Flex}(\alpha_l)$. Thus, $g_{sl}^{FTA} \to g_l^{H} \to g^{FT}$ and $g_{ll}^{FTA} \to g_{l_1}^{H} \to g^{FT}$, respectively, from the subgames at g_{sl} and g_{ll} once $\delta > \underline{\delta}_l^{Flex}(\alpha_l)$.

Figure 2 describes not only whether PTA formation takes the form of FTAs or CUs for a given value of asymmetry α_l but also how the type of PTA formation changes as asymmetry grows. Indeed, rising asymmetry reduces the range of the discount factor where FTA formation takes place. When the large countries have no CU exclusion incentive, i.e., $\alpha_l < \bar{\alpha}_l^{CU}$, this is because the myopic CU coordination benefit strengthens relative to the FTA flexibility benefit. On the one hand, the FTA flexibility benefit, i.e., $v_{l_1}(g_{l_1}^{H}) - v_{l_1}(g^{FT})$, strengthens because, as the hub, l_1 has sole preferential access with l_2 and this becomes more valuable as α_l rises. But, on the other hand, the myopic CU coordination benefit, i.e., $v_{l_1}(g_{ll}^{CU}) - v_{l_1}(g_{sl_1}^{FTA})$, strengthens even more as α_l rises. First, the benefit of forming a PTA with l_2 rather than s becomes more valuable. Second, the benefit l_1 and l_2 derive from their CU internalizing the negative externality of tariff complementarity becomes more valuable. Thus, $\underline{\delta}_l^{Flex}(\alpha_l)$ slopes upward in figure 2.

Once the large countries have a CU exclusion incentive, an additional force reduces the extent of FTA formation. The CU exclusion incentive strengthens as α_l rises because the higher degree of preferential access protected as CU insiders makes giving further tariff free access more costly. In turn, this adds further incentive for CU formation over FTA formation for the large country l_1 and and $\bar{\delta}_l^{Flex}(\alpha_l)$ slopes downward. Ultimately, FTA formation no longer exists shortly after α_l exceeds $\bar{\alpha}_l^{CU}$.

3.2. A "small" world: Two small countries and one large country

To illustrate how the structure of asymmetry affects whether FTAs or CUs emerge in equilibrium, I now consider the "small world" case with two small countries and one large country. That is, $\alpha_{s_2} = \alpha_{s_1} < \alpha_l < \bar{\alpha}_l$.

3.2.1. Subgames at hub–spoke networks and FTA and CU insider–outsider networks

As noted immediately prior to its presentation, lemma 2 describes the equilibrium transitions conditional on an initial PTA in both the large world and the small world case. First, spokes form the final FTA leading to global free trade. Second, an FTA insider–outsider network g_{ij}^{FTA} expands to global free trade via the hub–spoke network with the more attractive FTA insider i as the hub when $\delta > \bar{\delta}_{k,i}^{OUT}(\alpha_l)$ but, otherwise, the FTA outsider rejects subsequent FTA formation. Third, a CU insider–outsider network g_{ij}^{CU} expands to include the CU outsider unless the large country holds a CU exclusion incentive, which it does once $\alpha_l \geq \bar{\alpha}_l^{CU}$.

3.2.2. Subgame at empty network

Rolling back to the subgame at the empty network, the FTA flexibility and CU coordination benefits for the large country l still drive the equilibrium structure. Similar to before, inducing s_1's acceptance of its FTA proposal requires l threaten s_1 that it prefers an FTA with s_2 over a CU with s_1.[24]

24 Note, l always prefers CU formation with s_1 over CU formation with s_2 given the non-economic benefit of PTA formation with s_1.

In this case, s_1 will accept the FTA proposal from l to avoid being an FTA outsider on the path to global free trade. Otherwise, facing a credible threat of s_1 rejecting its FTA proposal, l cedes and proposes a CU with s_1.

Formally, l prefers an FTA with s_2 over a CU with s_1 when $V_l(g^{FTA}_{s_2l}) > V_l(g^{CU}_{s_1l})$. When the large country does not have a CU exclusion incentive then CU expansion takes place and $V_l(g^{FTA}_{s_2l}) > V_l(g^{CU}_{s_1l})$ reduces to

$$\underbrace{\delta\left[v_l\left(g^H_l\right) - v_l\left(g^{FT}\right)\right]}_{\text{FTA flexibility benefit}} > \underbrace{v_l\left(g^{CU}_{s_1l}\right) - v_l\left(g^{FTA}_{s_2l}\right)}_{\text{Myopic CU coordination benefit}}$$
$$\Leftrightarrow \delta > \frac{v_l\left(g^{CU}_{s_1l}\right) - v_l\left(g^{FTA}_{s_2l}\right)}{v_l\left(g^H_l\right) - v_l\left(g^{FT}\right)} \equiv \underline{\delta}^{Flex}_l(\alpha_l). \tag{10}$$

When the large country holds a CU exclusion incentive, $V_l(g^{FTA}_{s_2l}) > V_l(g^{CU}_{s_1l})$ reduces to

$$\underbrace{\delta\left[v_l\left(g^H_l\right) - v_l\left(g^{FT}\right)\right]}_{\text{FTA flexibility benefit}}$$
$$> \underbrace{\underbrace{\left[v_l\left(g^{CU}_{sl}\right) - v_l\left(g^{FTA}_{sl}\right)\right]}_{\text{Myopic CU coordination benefit}} + \frac{\delta}{1-\delta}\underbrace{\left[v_l\left(g^{CU}_{sl}\right) - v_i\left(g^{FT}\right)\right]}_{\text{Joint authority motive}}}_{\text{CU coordination benefit}} \tag{11}$$
$$\Leftrightarrow \delta \in \left(\underline{\delta}^{Flex}_l(\alpha_l), \bar{\delta}^{Flex}_l(\alpha_l)\right).$$

Again, the trade-off depends on the FTA flexibility benefit versus the CU coordination benefit with the CU coordination benefit consisting of a myopic component and, in the presence of a CU exclusion incentive, a farsighted component.

With the FTA flexibility and CU coordination benefits in place, proposition 2 describes the equilibrium. To streamline the analysis, proposition 2 restricts attention to discount factors below a threshold $\bar{\delta}(\alpha_l)$ once $\alpha_l \geq \bar{\alpha}^{CU}_l$. This condition ensures that, when the large country has a CU exclusion incentive, the small country s_1 prefers a CU with the large country l rather than an FTA with l or a CU with the other small country s_2.[25] Nevertheless, I discuss the equilibrium path of networks when $\delta > \bar{\delta}(\alpha_l)$ and $\alpha \geq \bar{\alpha}^{CU}_l$ before moving on to the next subsection.

PROPOSITION 2 *Consider a "small world" with two small countries and one large country,* $\alpha_{s_2} = \alpha_{s_1} \equiv \alpha_s < \alpha_l < \bar{\alpha}_l$. *Further, suppose that* $\delta \leq \bar{\delta}(\alpha_l)$

25 That is, in general, $\delta \leq \bar{\delta}(\cdot)$ and $\alpha_l \geq \bar{\alpha}^{CU}_l$ imply $V_m(g^{CU}_{ml}) \geq \max\{V_m(g^{CU}_{sm}), V_m(g^{FTA}_{ml})\}$. As shown in figure 3, $\bar{\delta}(\alpha_l)$ increases from 0.89 when $\alpha_l = \bar{\alpha}^{CU}_l$ to 0.97 when $\alpha_l = \bar{\alpha}_l$. In the general case where $\alpha_m \in [\alpha_s, \alpha_l]$, the restriction imposed by $\delta < \bar{\delta}(\alpha_l)$ is indeed tightest in the small world case of $\alpha_m = \alpha_s$.

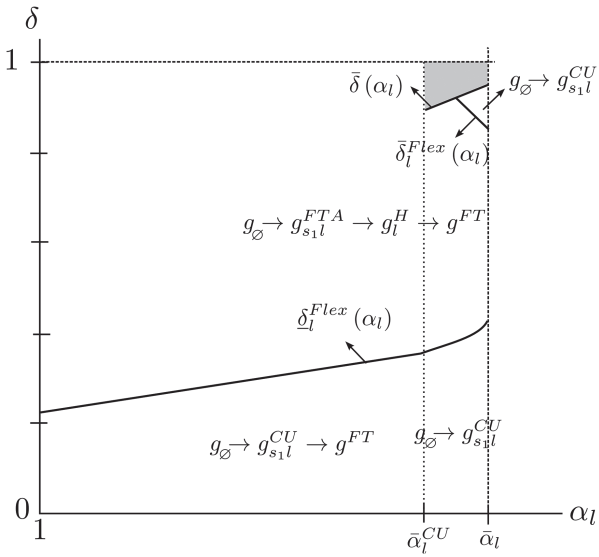

FIGURE 3 Equilibrium path of networks in a small world

once $\alpha_l \geq \bar{\alpha}_l^{CU}$. If $\delta \in (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$, the equilibrium path of networks is that the large country and the small country s_1 form an FTA and then the large country becomes the hub on the path to global free trade. If $\delta \notin (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$, the equilibrium path of networks is that the large country and the small country s_1 form a CU, which then expands to global free trade if and only if the large country does not hold a CU exclusion incentive.

Figure 3 illustrates proposition 2. First, suppose $\alpha_l < \bar{\alpha}_l^{CU} \approx 1.21\alpha_s$ so that the large country does not hold a CU exclusion incentive. Then, the CU between the large country l and the small country s_1 expands to global free trade. But, when $\delta > \underline{\delta}_l^{Flex}(\alpha_l)$, l prefers an FTA with s_2 over a CU with s_1 because the future flexibility benefit of FTA formation that allows l_1 to become the hub outweighs the myopic CU coordination benefit that allows l and s_1 to internalize the negative externality from tariff complementarity. Thus, l can threaten an FTA with s_2 to induce s_1's acceptance of an FTA proposal. In turn, l proposes an FTA with s_1 when $\delta > \underline{\delta}_l^{Flex}(\alpha_l)$ and s_1 accepts.[26] Thus, the equilibrium path of networks is $g_\varnothing \to g_{s_1 l}^{FTA} \to g_l^H \to g^{FT}$. However, once $\delta < \underline{\delta}_l^{Flex}(\alpha_l)$ then l prefers CU formation over FTA formation and the equilibrium path of networks is $g_\varnothing \to g_{s_1 l}^{CU} \to g^{FT}$.

Second, suppose $\alpha_l \geq \bar{\alpha}_l^{CU}$ so that a CU involving the large country does not expand to include the small CU outsider because of the large country's CU exclusion incentive. This CU exclusion incentive, i.e., $v_l(g_{sl}^{CU}) > v_l(g^{FT})$, provides a farsighted component to the CU coordination benefit because CU

26 Note that $\bar{\delta}_{s,l}^{OUT}(\alpha_l) < \underline{\delta}_l^{Flex}(\alpha_l)$. Thus, $g_{sl}^{FTA} \to g_l^H \to g^{FT}$ from the subgame at g_{sl}^{FTA} once $\delta > \underline{\delta}_l^{Flex}(\alpha_l)$.

formation eliminates the possibility that either FTA insider can become the hub and precipitate global free trade. Thus, l prefers FTA formation over CU formation only when $\delta \in (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$ where, now, $\bar{\delta}_l^{Flex}(\alpha_l) < 1$. As such, the equilibrium path of networks is $g_\varnothing \rightarrow g_{s_1 l}^{FTA} \rightarrow g_l^H \rightarrow g^{FT}$ when $\delta \in (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$ but $g_\varnothing \rightarrow g_{s_1 l}^{CU}$ when $\delta \notin (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$.

Figure 3 describes not only whether PTA formation takes the form of FTAs or CUs for a given value of asymmetry α_l but also how the type of PTA formation changes as asymmetry grows. Like figure 2, rising asymmetry reduces the range of the discount factor where FTA formation takes place although for slightly different reasons. Because the large country's benefit of being the hub stems from sole preferential access to each of the small spoke countries, this benefit is independent of α_l. However, the myopic CU coordination benefit still rises with α_l. Nevertheless, this benefit no longer consists of a part stemming from PTA formation with a larger partner as in figure 2. Rather, it entirely revolves around tariff complementarity. Because CU members set a common MFN tariff that partly reflects each country's tariff preference, the common MFN tariff depends on the market size of both countries. This contrasts with FTA formation where the MFN tariff depends only on a country's own market size. In turn, as α_l rises, the degree of tariff complementarity practiced by s_1 (l) falls (rises) under a CU relative to an FTA. As such, the myopic CU coordination benefit for l rises with α_l and $\underline{\delta}_l^{Flex}(\alpha_l)$ slopes upward.

Once the large country has a CU exclusion incentive, an additional force reduces the extent of FTA formation. By increasing the cost of giving further tariff free access, the CU exclusion incentive strengthens as α_l rises. In turn, this adds further incentive for CU formation over FTA formation for the large country and $\bar{\delta}_l^{Flex}(\alpha_l)$ slopes downward.

In the following subsection, I discuss the important differences in the equilibrium structure between the small world case of figure 3 and the large world case of figure 2 and describe how this sheds some light on real world PTA negotiations. But, before doing so, I discuss the equilibrium path of networks in the shaded area of figure 3 where $\delta > \bar{\delta}(\alpha_l)$ and $\alpha \geq \bar{\alpha}_l^{CU}$ that was ignored in proposition 2.

Once $\alpha_l \geq \bar{\alpha}_l^{CU}$, the large country has a CU exclusion incentive and a CU involving the large country will not expand to global free trade. Here, the equilibrium becomes tedious once $\delta > \bar{\delta}(\alpha_l)$. First, consider δ sufficiently high and α_l only somewhat above $\bar{\alpha}_l^{CU}$. Then, the small countries prefer a CU with each other over any other PTA as a means to attain tariff free access to the large country via CU expansion to global free trade *and* do so without facing discrimination as a spoke. As such, the equilibrium path of networks would be $g_\varnothing \rightarrow g_{ss}^{CU} \rightarrow g^{FT}$. Second, for δ sufficiently high and α_l sufficiently above $\bar{\alpha}_l^{CU}$, s_1 prefers an FTA with l over any other PTA because: (i) preferential access to l's market is quite valuable and (ii) FTA formation eventually yields global free trade and it does not hold a CU exclusion incentive. If l also prefers

FTA over CU formation with s_1, i.e., $\delta \in (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$, the equilibrium path of networks is $g_\varnothing \to g_{s_1 l}^{FTA} \to g_l^H \to g^{FT}$. But, l prefers CU formation when $\delta \notin (\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l))$. Now, the equilibrium outcome depends on whether s_2 prefers being a permanent CU insider with l or being discriminated against as an FTA outsider and a spoke on the path to global free trade. Because s_2 does not hold a CU exclusion incentive, the answer is the latter when δ is sufficiently high, leading to $g_\varnothing \to g_{s_1 l}^{FTA} \to g_l^H \to g^{FT}$ in equilibrium, but the answer is the former when δ is sufficiently low, leading to $g_\varnothing \to g_{s_1 l}^{CU}$ in equilibrium.[27]

3.3. Real world implications

Given the equilibrium characterization illustrated in figures 2 and 3, figure 4 compares whether FTA or CU formation takes place. For example, in the upper left region, "2L: FTA" denotes that FTA formation takes place in the large world case with two large countries and one small country while "2S: FTA" denotes that FTA formation takes place in the small world case with two small countries and one large country.

Figure 4 shows that, indeed, the type of PTA takes the same form across three of the four regions of the parameter space. However, PTAs take different forms across the small and large worlds in the middle shaded area: FTA formation in the small world but CU formation in the large world. Moreover, for the most part, once α_l lies between the threshold values of $\bar{\alpha}_l^{CU}$ for the two worlds, CU formation emerges regardless of the discount factor in the large world whereas FTA formation emerges in the small world once δ exceeds $\underline{\delta}_l^{Flex}(\alpha_l)$. Here, the FTA flexibility benefit cannot outweigh the CU coordination benefits in the large world but does outweigh the CU coordination benefit in the small world. Thus, the trade-off between the FTA flexibility and CU coordination benefits drives the prevalence of FTAs in the small world relative to the large world.

Naturally, given the stylized nature of the model, real world implications should be interpreted with care. Nevertheless, with this in mind, I now describe how these insights could potentially help rationalize that MERCOSUR is a CU (consisting of Brazil, Argentina, Uruguay, Paraguay and, now, Venezuela) while the Andean Community is an FTA (consisting of Colombia, Peru, Ecuador and Bolivia). For this purpose, I view the decision whether MERCOSUR should be an FTA or CU as decided by the dominant and largest members Brazil and Argentina and the analogous decision for the Andean Community as one decided by the dominant and largest members Colombia and Peru.

Two observations immediately jump out when looking at MERCOSUR. First, the only agreement notified to the WTO by MERCOSUR is an agree-

27 s_1 rather than s_2 becomes the PTA insider in equilibrium because l prefers s_1 as its PTA insider partner and s_1 accepts anticipating that s_2 would accept if s_1 rejected.

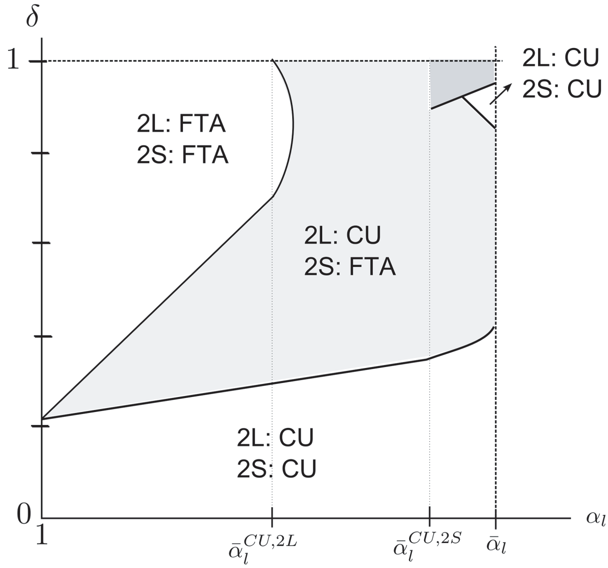

FIGURE 4 Comparing equilibrum type of PTA in small and large worlds

ment with India, and this agreement actually falls outside the scope of Article XXIV (formed under the Enabling Clause of GATT). That is, according to the WTO, MERCOSUR has not formed any Article XXIV FTAs or CUs with other countries. Second, given their economic size and strong bilateral trade linkages, Brazil and Argentina likely view each other as relatively attractive partners vis-à-vis non-MERCOSUR countries. These observations suggest two possible reasons for the CU nature of MERCOSUR. First, even if Argentina or Brazil wanted MERCOSUR as an FTA, the threat of this FTA proponent forming an FTA with a non-MERCOSUR country so the other would accept a MERCOSUR FTA would likely be non-credible. Second, Argentina and Brazil could hold a CU exclusion incentive and are sufficiently farsighted that the joint authority motive of a CU outweighs any possible FTA flexibility benefit. Indeed, anecdotal evidence suggests that, at various points in time, Brazil or Argentina have exploited their joint authority motive to halt possible FTA negotiations desired by the other that could have plausibly moved ahead on a bilateral basis if MERCOSUR was an FTA.[28]

Looking at the Andean Community (CAN), two contrasting observations immediately jump out. First, apart from CAN itself, Colombia and Peru have notified the WTO of, respectively, eight and 12 FTAs under Article XXIV. Thus, the flexibility benefit of FTAs appears rather valuable for Colombia and/or Peru. Second, given their size and far weaker bilateral trade linkages

28 See Klom (2003, p. 362), Osthus (2013, pp. 36–41, 49–64) and `en.mercopress.com/2010/04/21/brazil-s-main-presidential-candidate-considers-mercosur-a-farce-and-a-barrier`.

than between Brazil and Argentina, Colombia and Peru plausibly view each other as not much more attractive partners than many non-CAN countries.[29] Thus, even if Colombia or Peru would prefer CAN as a CU, it is likely the other could credibly threaten to begin FTA formation with non-CAN countries as a way to insist on CAN as an FTA.

Similar reasoning helps explain the CU nature of the EU versus the FTA nature of EFTA (consisting of Switzerland, Norway, Iceland and Liechtenstein). Like the large dominant members of MERCOSUR, the large dominant and original members of the EU likely viewed each other as very attractive partners relative to non-EU countries. Thus, like MERCOSUR, if some large dominant members wanted an EU CU then it is unlikely that other large dominant members could credibly threaten to form FTAs with non-EU countries to force an EU FTA. However, strikingly different from MERCOSUR, the EU has notified the WTO of 32 separate FTAs under GATT Article XXIV. Thus, unlike MERCOSUR, the rationale for an EU CU should recognize the value placed on subsequent FTA formation. Nevertheless, the CU joint authority motive remains important. Under a hypothetical EU FTA, each EU member could have started forming their own FTAs with various partners, triggering a complicated web of differential rates of bilateral preferential access between EU members and FTA partners. Further, it could have vastly slowed the rate of aggregate FTA formation given the time and diplomatic resources needed to negotiate individual FTAs. These problems could have plausibly generated an EU CU preference among the large dominant members.

Like CAN, EFTA consists of relatively smaller countries on the continent with relatively weak bilateral trade linkages.[30] Thus, if one EFTA member

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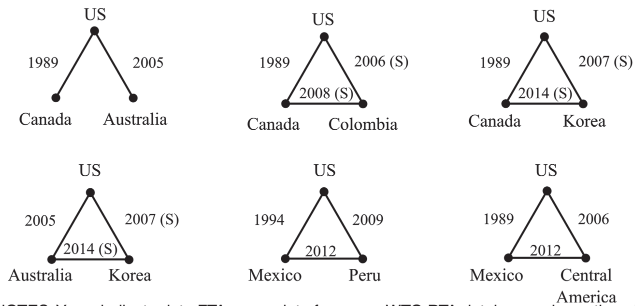
29 According to the Observatory of Economic Complexity (`atlas.media.mit.edu/en/`: `https://bit.ly/2Fmyji3`; `https://bit.ly/2Cde9TG`; `https://bit.ly/2CcmEyi`; `https://bit.ly/2M4bPD4`; `https://bit.ly/2D3QBCa`; `https://bit.ly/2FpcPRR`; `https://bit.ly/2VMxcgo` and `https://bit.ly/2RNPZZW`), in 1995, Brazil's (Argentina's) share of exports to Argentina (Brazil) and Brazil's (Argentina's) share of imports from Argentina (Brazil) range between 7% and 27%. The corresponding shares between Colombia and Peru range from below 1% to 8%.

30 Switzerland and Norway are the two largest members of EFTA. According to the Observatory of Economic Complexity (`atlas.media.mit.edu/en/`: `https://bit.ly/2TDuR5y`; `https://bit.ly/2M30X8v`; `https://bit.ly/2SNBT80`; `https://bit.ly/2RoUBpC`; `https://bit.ly/2FsBvYD`; `https://bit.ly/2TKEuzD`; `https://bit.ly/2Cg1TSi` and `https://bit.ly/2smfK4U`), Switzerlands's (Norway's) share of exports to Norway (Switzerland) in 1995 and Switzerland's (Norway's) share of imports from Norway (Switzerland) in 1995 do not exceed 1.5%. The corresponding shares between Germany and France range between 11% and 20%.



NOTES: Years indicate date FTA comes into force, per WTO RTA database unless otherwise noted. (S) denotes date signed per sice.oas.org/agreements_e.asp, except for Australia–Korea FTA per dfat.gov.au/trade/agreements/Pages/status-of-fta-negotiations.aspx. Central America includes El Salvador, Costa Rica, Guatemala, Honduras and Nicaragua.

FIGURE 5 Evolution of US FTAs

wanted EFTA as a CU then it is likely that other EFTA members could plausibly threaten to form FTAs with non-EFTA countries to force the FTA nature of EFTA. Further, EFTA has notified the WTO of 24 GATT Article XXIV FTAs. While EFTA usually negotiates FTAs as a bloc, this is not always so. Indeed, the largest EFTA member, Switzerland, unlike the second largest member Norway, has formed FTAs with the global powers China and Japan. Further, the Swiss State Secretariat for Economic Affairs, the government entity responsible for foreign trade, emphasizes their sovereign ability to form FTAs and that the prevention of other countries gaining meaningful preferential access vis-à-vis Switzerland guides FTA partner choice.[31] Thus, the Swiss desire for the flexibility benefits of FTAs combined with a plausibly credible threat of abandoning EFTA and pursuing FTAs with non-EFTA states could help rationalize the FTA nature of EFTA.

Finally, how does the trade-off between the FTA flexibility and CU coordination benefits inform the fact that the 1989 US–Canada bilateral FTA set the US on a path devoid of CUs? Given the sheer economic size of the US relative to Canada, the US–Canada relationship fits closer to the small world case of one large and two small countries rather than the large world case of two large and one small country. Thus, as the leader country, it is likely the US could credibly commit to begin FTA formation with other countries if Canada insisted on a bilateral CU. Thus, the bilateral US–Canada FTA could indicate the value placed on the FTA flexibility benefit by the US. Indeed, figure 5 shows that the US became the hub when thinking of the third small country as either Australia, Colombia or Korea. And, in the latter two cases, the spoke countries then formed their own FTA. The figure also shows a

31 See www.seco.admin.ch/seco/en/home/Aussenwirtschaftspolitik_Wirtschaftliche_Zusammenarbeit/Wirtschaftsbeziehungen/Freihandelsabkommen.html.

similar story with respect to either the US and Australia being FTA insiders and Korea being the third country or the US and Mexico being FTA insiders and Peru or "Central America" being the third country.

4. Discussion

4.1. An alternative model of trade

So far, the results were based on an intra-industry model of trade in imperfectly competitive markets. In contrast, an alternative class of trade models emphasize trade arising from supply side comparative advantage forces in competitive markets. One example is the well-known competing exporters model.[32]

Three countries $i=s,m,l$ have endowments of three (non-numeraire) goods $Z=S,M,L$. Like earlier, demand in country i for each non-numeraire good Z is $d_i^Z(p_i)=\alpha_i - p_i^Z$. Each country i has an endowment $e_i^Z=0$ of good $Z=I$ and an endowment $e_i^Z \equiv e>0$ of goods $Z \neq I$. Thus, countries j and k have a "comparative advantage" in good I and, in equilibrium, compete with each other when exporting good I to country i.

No-arbitrage conditions link the equilibrium price of good I across countries and international market clearing conditions deliver equilibrium prices. The no arbitrage conditions imply $p_i^I=p_j^I+\tau_{ij}=p_k^I+\tau_{ik}$ and market clearing in good Z requires $\sum_i x_i^Z=0$, where country i's *net* exports of good Z are $x_i^Z=e_i^Z-d_i(p_i^Z)$. Thus, in equilibrium, $p_i^I=\frac{1}{3}[\sum_h \alpha_h - 2e+\tau_{ij}+\tau_{ik}]$ and $p_j^I=\frac{1}{3}[\sum_h \alpha_h - 2e+\tau_{ik}-2\tau_{ij}]$ for $j \neq i$.[33]

I now show the results of the previous section hold in this alternative trade model, thereby demonstrating the robustness of the trade-off between the FTA flexibility and CU coordination benefits for explaining the type of PTA.

The first important observation is that the myopic PTA formation incentives described in section 2.2 under the oligopoly model also hold in the competing exporters model with symmetric market size (see lemma 4 in the appendix). In turn, these properties also hold with sufficiently small degrees of asymmetric market size. This is *not* to say that a sufficiently small degree of asymmetry is a necessary condition for the myopic PTA formation incentives, only that it is a sufficient condition. Thus, propositions 1 and 2 describe the equilibrium path of networks in the large and small world case for sufficiently small α_l.[34]

The key difference between figures 2 and 3 highlighted by figure 4 is that the extent of FTA formation is larger in the small world case than the large

32 This model dates back to Bagwell and Staiger (1999) and has been used in the PTA literature by, e.g., Saggi and Yildiz (2011).

33 See the appendix for welfare expressions and optimal MFN tariffs.

34 In the oligopoly model, propositions 1 and 2 rely on lemmas 1, 2 and 3 in the appendix. For the competing exporters model, lemma 4 verifies lemmas 1, 2 and 3.

world case. Indeed, the second important observation is that this remains true in the competing exporters model as one moves away from symmetry. In terms of figures 2 and 3, $\underline{\delta}_l^{Flex}(\alpha_l)$ still slopes upward in the large world case but $\underline{\delta}_l^{Flex}(\alpha_l)$ now slopes downward in the small world case. Thus, the difference between the large and small world cases actually becomes even starker.

Two observations explain the greater extent of FTA formation in the small world case relative to the large world case. First, as in the oligopoly model when the leader country i is negotiating initial PTA formation with the second most attractive country j and pushing for FTA rather than CU formation, the small world with $j = s_1$ and s_2 as small countries lends added credibility to l's threat of forming an FTA with s_2. Second, the impact of a rising α_l on the relative degree of tariff complementarity under a small-large CU versus a small-large FTA is opposite to that in the oligopoly model small world case. There, a rising α_l benefitted the large country by increasing the degree of tariff complementarity practised by itself relative to the small country. However, here, the opposite holds. Now, a higher α_l increases the value for s_1 of mitigating tariff complementarity practised by l. Thus, given no domestic production by l, the optimal CU tariff of l rises and hurts l by moving further from its individually optimal FTA tariff. Moreover, a higher α_l now reduces l's exports to s_1 and thereby reduces the value for l of mitigating tariff complementarity practised by s_1. By lowering the optimal CU tariff of s_1 and the preferential margin, this hurts l. Together, these two observations not only flatten $\underline{\delta}_l^{Flex}(\alpha_l)$ in the small world relative to the large world but actually change its shape from upward to downward sloping as well.

4.2. Generalizing beyond “large” and “small” worlds

Despite the parameter α_l capturing the relative size of the largest to the smallest country, the small and large world cases are two extremes where the market size of the “medium” country equals that of either the large or small country (i.e., $\alpha_m = \alpha_l$ or $\alpha_m = \alpha_s$).

Nevertheless, the proof for the equilibrium path of networks in the large and small worlds, i.e., propositions 1 and 2, are merely special cases of the more general proofs, contained in propositions 3 and 4 of the appendix, for the equilibrium path of networks where $\alpha_m \in [\alpha_s, \alpha_l]$. Intuitively, one would expect the upper left region of figure 4, where FTAs emerge in either the small or large world, to expand out as α_m falls from $\alpha_m = \alpha_l$ and fully engulf the shaded middle area once $\alpha_m = \alpha_s$. Indeed, despite one complication, the logic of the baseline analysis validates this intuition.

The additional complication in the general asymmetric world stems from the following situation. Suppose country l holds a CU exclusion incentive when country s is the CU outsider, so that the CU between countries m and l does not expand. On the one hand, relative to a CU with m, l may not want to form an FTA with s even though it wants to form an FTA with country m. On the other hand, m may prefer an FTA with s rather than a CU with l.

This latter observation implies m cannot credibly reject an FTA with l (in stage 1(a)) because l will then propose an FTA with s (in stage 1(b)) rather than witness an FTA between s and m (in stage 2). As such, m will accept an FTA from l (in stage 1(a)) even though l does not prefer FTA formation with s over CU formation with m (i.e., $\delta < \underline{\delta}_l^{Flex}(\alpha_l)$). In the large world case, m would not accept such an FTA. But this was because m could credibly commit to proposing a CU with l rather than an FTA with s (in stage 2) and it cannot do so in the situation described here. Ultimately, the constraint for l to impose FTA formation on m in the general asymmetric world is slightly relaxed in this particular situation.

Nevertheless, the key idea conveyed in the earlier analysis of the large and small worlds applies in the general asymmetric world. Specifically, the large country's ability to exploit the FTA flexibility benefit as the hub with the "medium" country increases as the medium country becomes smaller. Intuitively, this shrinks the relative attractiveness of the medium country and increases the credibility of the large country threatening an FTA with the small country as a means to induce the medium country's acceptance of FTA formation.

4.3. Incorporating multilateral negotiations

To focus on the trade-off between the FTA flexibility and CU coordination benefits, the possibility of multilateral negotiations, including a direct move to global free trade via zero tariffs, was assumed away. Indeed, this matches the contrast between the extraordinary proliferation of PTAs since the mid 1990s and the complete failure of the current Doha round of multilateral negotiations. Nevertheless, with some minor modifications, my main results are quite robust to allowing multilateral negotiations. Moreover, doing so helps link the analysis to the recent literature on the role of PTAs as building blocs or stumbling blocs to global free trade (e.g., Saggi and Yildiz 2010 and Lake 2017).

To model multilateral negotiations, suppose each period has a stage 0, where countries sequentially announce whether they want to participate in multilateral negotiations. If all countries announce in favour, multilateral negotiations take place with the outcome being the tariff vector that maximizes the three-country joint government payoff subject to any zero tariffs associated with pre-existing PTAs.[35,36] That is, multilateral negotiations determine MFN tariffs. Regardless of whether multilateral negotiations take

35 When a country is indifferent between announcing in favour or against multilateral negotiations, I assume it announces against. This can be motivated by an arbitrarily small cost cost involved with participating in multilateral negotiations.

36 The sequential nature here merely removes the multiple equilibria problem that would arise with simultaneous announcements. The sequence in which players make announcements is completely irrelevant.

place in stage 0, countries then have the opportunity to form PTAs in stages 1 and 2, as in earlier sections.

Nevertheless, in equilibrium, multilateral negotiations play no meaningful role after an initial PTA. Note that, whenever they take place, multilateral negotiations yield global free trade because this maximizes world welfare. But, regardless of multilateral negotiations, any CU expansion leads directly to global free trade. Further, the FTA insider-turned-hub would block multilateral negotiations either at the FTA insider–outsider network or the hub–spoke network to protect the sole preferential access it enjoys, albeit temporarily, as the hub.

Do multilateral negotiations take place prior to any PTAs having formed? If there exists a CU exclusion incentive, the answer is no. When the CU coordination benefit dominates the FTA flexibility benefit, CU insiders block multilateral negotiations, becoming permanent CU insiders. When the FTA flexibility benefit dominates the CU coordination benefit, the FTA insider-turned-hub blocks multilateral negotiations, becoming the hub on the path to global free trade. However, multilateral negotiations take place in the absence of a CU exclusion incentive if $V_l(g^{FT}) > V_l(g_{ml})$, which reduces to

$$\frac{1}{1-\delta} v_l\left(g^{FT}\right) > v_l\left(g_{ml}^{FTA}\right) + \delta v_l\left(g_l^{H}\right) + \frac{\delta^2}{1-\delta} v_l\left(g^{FT}\right)$$
$$\Leftrightarrow \delta < \tilde{\delta}\left(\alpha_l\right) \equiv \frac{v_l\left(g^{FT}\right) - v_l\left(g_{ml}^{FTA}\right)}{v_l\left(g_l^{H}\right) - v_l\left(g^{FT}\right)}.$$

When $\delta > \tilde{\delta}(\alpha_l)$, there is sufficient weight on the FTA flexibility benefit, and the sole preferential access to each spoke country as the hub, that the FTA insider-turned-hub blocks multilateral negotiations and becomes the FTA insider-turned-hub on the path to global free trade. But, multilateral negotiations take place when $\delta < \tilde{\delta}(\alpha_l)$, generating global free trade.

Unlike CU expansion, which leads directly to global free trade, FTA expansion in earlier sections had to proceed via a hub–spoke network even though, in principle, FTA insiders and the FTA outsider could form a trilateral FTA leading directly to global free trade. But, above, multilateral negotiations always lead to global free trade and were allowed to take place in every period, including at the FTA insider–outsider network. That is, the modelling of multilateral negotiations allowed countries to move directly from an FTA insider–outsider network to global free trade. This move is equivalent to the FTA insiders and the FTA outsider forming a trilateral FTA. Nevertheless, as described above, the insider-turned-hub would always block such trilateral FTA negotiations. Further, the veto power wielded by each country, and the insider-turned-hub in particular, in these trilateral FTA negotiations matches the situation of CU expansion where such expansion takes place if and only if all countries agree. Thus, the main results in earlier sections remain when allowing trilateral FTA negotiations that require the consent of all countries.

4.4. A many-country world

As with nearly all of the PTA literature, my analysis considered three countries.[37] Nevertheless, how would the insights discussed above materialize in a many country world?

In a three-country world, the insider-turned-spoke did not benefit from the FTA flexibility benefit. Rather, it suffered from the flexibility of FTAs. However, this would not necessarily happen in a many country world. While figure 5 highlights how, in a many-country world, the US has emerged as the hub in various different contexts, this has not happened exclusively. Indeed, one would expect that certain countries make "natural" trading partners for various economic and non-economic reasons. For example, many Asian nations could make natural trading partners for Australia. Indeed, Australia implemented FTAs with China and Japan in 2015 making Australia the "hub" country between these Asian powers and the US. Further, Australia is currently negotiating FTAs with Asian developing country powerhouses Indonesia and India. Similarly, Canada has an FTA with EFTA, has signed an FTA with the EU and is currently in negotiations with Japan. In all these cases, Canada would be the "hub" between these countries and the US. Ultimately, the FTA flexibility benefit can be shared between FTA partners in a many country world.

A many country world can also make the joint authority motive of CU more valuable. In the formal analysis earlier, the CU coordination and FTA flexibility benefits were distinct. But, as alluded to in section 3.3, the FTA flexibility and CU coordination benefits can interact in a many country world. There, I discussed how the joint authority motive potentially made the EU CU attractive given the complex web of bilateral rates of preferential access that could have emerged if EU members started forming their own individual FTAs with non-EU countries. Nevertheless, most of the EUs subsequent PTAs have been FTAs (e.g., EFTA, Canada, Mexico and Korea).[38] Indeed, from a purely economic perspective, having the flexibility to form further PTAs without requiring the consent of these FTA partners probably meant having these various PTAs as CUs was never seriously considered. Thus, a many

37 The main exception to thee-country PTA models are models relying on network stability solution concepts (e.g., Goyal and Joshi 2006 and Furusawa and Konishi 2007 use pairwise stability) rather than non-coperative game theoretic solution concepts (e.g., Saggi and Yildiz 2011 and Missios et al. 2016 use coalition proof Nash equilibrium).

38 Apart from the microstates of Andorra and San Marino, the only CU partner of the EU is Turkey. However, as mentioned in the introduction, Turkey agreed to extend external tariff concessions to all countries who negotiate an FTA with the EU in order to preserve the common external tariff. Given EU FTA partners do not extend tariff preferences to Turkey as part of their EU FTA, this is an unusual and extreme type of CU that I do not model.

country world creates interesting interactions between the CU coordination and FTA flexibility benefits.

4.5. Length of FTA negotiations

An important presumption underlying typical dynamic models of PTA formation is an exogenous time lag between beginning PTA negotiations and PTA implementation. Absent such a time lag, countries should form PTAs immediately upon the opportunity arising rather than waiting. For example, given spokes always benefit from FTA formation in my model, spokes would form their FTA immediately upon the emergence of the hub–spoke network, which, in turn, would wipe away the FTA flexibility benefit.

Nevertheless, academic empirical evidence and real world policy discussions recognize the substantial time requirement surrounding PTA formation. For US FTAs, Freund and McDaniel (2016) document an average of 1.5 years from launching negotiations to signing an FTA and 3.75 years from launching negotiations to PTA implementation. Looking at over 120 FTAs, Mölders (2012) and Mölders (2015) document an average of 3.6 years from beginning negotiations to PTA implementation (3.25 years for bilateral FTAs). Thus, considerable time elapses between the start of PTA negotiations and PTA implementation.

Successful PTA formation requires substantial diplomatic resources. Real world PTAs involve negotiations over phase-out periods for tariffs and non-tariff barriers at the product-level as well as product-level rules of origin. Typically, they also involve negotiations over other complex issues including labour and environmental provisions, public procurement, services, state aid, competition policy, intellectual property rights and investment (Kohl et al. 2016). Thus, countries require skilled and experienced negotiators familiar with the specific wants and concerns of domestic interest groups and bureaucrats who understand how to implement and follow the PTA. This can be challenging not only for developing countries (Dent 2006) but also for developed countries like the US. Indeed, US Government Accountability Office (2004, p. 3, p. 27) document that, due to their high diplomatic-resource intensity, FTA negotiations strain the Office of the United States Trade Representative (USTR) and other agencies' resources and these resource constraints actually influence FTA partner selection.

5. Conclusion

Since the early 1990s, the number of PTAs has expanded exponentially. However, while some influential PTAs are CUs, the vast majority are FTAs. This is surprising given that CU members coordinate on common external tariffs. Indeed, dating back to Kennan and Riezman (1990), the literature recognizes this coordination benefit of CUs with Facchini et al. (2012, p. 136) stating, "...the existing literature has indicated that CUs are...the optimal form of preferential agreements [for members]" and Melatos and Woodland (2007a, p. 904) stating, "...the apparent inconsistency between the observed popularity of free trade areas [FTAs] and the theoretical primacy of customs unions..." remains an unresolved issue.

Recent papers have examined broad notions of flexibility and coordination. For those endogenizing the choice between FTAs and CUs when either can emerge in equilibrium, the coordination-flexibility trade-off tension relied on: (i) the impact of uncertainty on static tariff setting motivations, (ii) countries entering or leaving the world trading system or (iii) transfers. My dynamic model has none of these features. In my model, the FTA flexibility benefit emerges because individual FTA members have the flexibility to form their own subsequent agreements whereas, due to CU common external tariffs, CU members must jointly engage in future agreements. Nevertheless, the joint approval required from members for CU expansion creates a valuable joint authority motive for CUs when CU members benefit from permanently excluding the non-member. Further, the coordination of external tariffs by CU members provides a myopic coordination benefit. The trade-off between the FTA and CU coordination benefits, which consists of a myopic CU coordination benefit and a forward-looking joint authority motive, shape the equilibrium type of PTA.

While a large leader country has the first opportunity to propose PTAs in each period, it cannot impose FTA formation on the second largest country who, unable to exploit the FTA flexibility benefit, prefers CU formation. Rather, inducing the second largest country's acceptance of an FTA proposal requires that the large leader country threaten it prefers an FTA with the smallest country over a CU with the second largest country. In turn, market size asymmetry between the large leader country's potential partners impacts its ability to force FTA formation. As the second largest and smallest countries become closer in market size, the second largest country recognizes the stronger threat of the large leader country forming an FTA with the smallest country and becomes more amenable to FTA formation. Thus, the relative prevalence of FTA versus CU formation is higher in a small world of two small countries and one large country than a large world of two large countries and one small country. The insights stemming from the trade-off between the FTA flexibility and CU coordination benefits, and how they depend on market size asymmetry, appear useful in shedding some light on PTA formation in Europe and South America.

Moving forward, these insights can motivate subsequent investigation of the real world determinants of FTAs versus CUs. Building on the framework in this paper, Lake and Yildiz (2016) introduce geographic asymmetry so that certain country pairs are closer than other pairs. They show that in equilibrium, consistent with casual observation, CUs are intra-regional while FTAs are inter and intra-regional. Indeed, as part of a broader analysis investigating the empirical determinants of FTAs versus CUs that builds on their earlier work, Facchini et al. (2017, p. 904) verify this systematic importance of distance.

Apart from distance, the steady long term decline in globally negotiated tariff bindings (which cap the MFN tariffs that countries can set) represent another prominent feature of the world trading system. Indeed, by influencing countries' MFN tariffs, this decline may have interesting implications for the type of PTA countries choose.

Appendix

A. Welfare expressions and optimal tariffs

For the oligopoly and competing exporters model, I present consumer surplus, producer surplus and firm profits for arbitrary tariffs and network dependent optimal MFN tariffs.

Oligopoly model with market size asymmetry

$CS_i = (1/32)(3\alpha_i - \tau_{ij} - \tau_{ik})^2$,
$PS_i = (1/16)[(\alpha_i + \tau_{ij} + \tau_{ik})^2 + \sum_{h \neq i, h \neq h'} (\alpha_h + \tau_{hh'} - 3\tau_{hi})^2]$,
$TR_i = (1/4)[\alpha_i(\tau_{ij} + \tau_{ik}) + 2\tau_{ij}\tau_{ik} - 3(\tau_{ij}^2 + \tau_{ik}^2)]$. The optimal MFN tariffs are $\tau_i(g_\varnothing) = \tau_i(g_{jk}^{FTA}) = \tau_i(g_{jk}^{CU}) = 3\alpha_i/10$, $\tau_i(g_{ij}^{FTA}) = \tau_i(g_j^H) = \alpha_i/7$ and $\tau_i(g_{ij}^{CU}) = 5(\alpha_i + \alpha_j)/38$.

Competing exporters model with market size asymmetry

$CS_i = (1/6)\{[2e + 2\alpha_i - \alpha_h - \alpha_{h'} - (\tau_{ih} + \tau_{ih'})]^2 + \sum_{h \neq i, h \neq h'} [2e + 2\alpha_i - \alpha_h - \alpha_{h'} - (\tau_{hh'} - 2\tau_{hi})]^2\}$,
$PS_i = (1/3)e \sum_{h \neq i,\, h \neq h'} [\alpha_i + \alpha_j + \alpha_k - 2e + \tau_{hh'} - 2\tau_{hi}]$,
$TR_i = (1/3) \sum_{h \neq i, h \neq h'} \tau_{ih}(e + \alpha_i + \alpha_{h'} - 2\alpha_h - 2\tau_{ih} + \tau_{ih'})$.
The optimal MFN tariffs are: $\tau_i(g_\varnothing) = \tau_i(g_{jk}^{FTA}) = \tau_i(g_{jk}^{CU}) = (1/8)[2e + 2\alpha_i - (\alpha_j + \alpha_k)]$, $\tau_i(g_{ij}^{FTA}) = \tau_i(g_j^H) = (1/11)[e + \alpha_i + 4\alpha_j - 5\alpha_k]$ and $\tau_i(g_{ij}^{CU}) = (1/5)[e + \alpha_i + \alpha_j - 2\alpha_k]$.

B. Proofs

The proofs begin with presentation and proof of lemmas 3 and 4 and propositions 3 and 4 that were not presented in the main text. After that, the proofs of lemmas 1 and 2 and propositions 1 and 2 from the main text follow. Notation wise, $\boldsymbol{\alpha} \equiv (\alpha_i, \alpha_j, \alpha_k)$.

LEMMA 3 *Let $\alpha_i < 1.28\alpha_j$ for any countries i and j. Then, the following properties characterize the continuation payoffs of countries in the oligopoly model:*

(i) $V_k(g_{ik}^{FTA}) > V_k(g_{ij}^{CU})$ *when* $\alpha_i \geq \alpha_k$ *and* $g_{ik}^{FTA} \to g_i^H \to g^{FT}$.
(ii) $V_k(g_{jk}^{FTA}) > V_k(g_\varnothing)$ *when* $\alpha_i \geq \alpha_j \geq \alpha_k$ *and* $g_{jk}^{FTA} \to g_j^H \to g^{FT}$.
(iii) $\bar{\delta}_{k,i}^{OUT}(\boldsymbol{\alpha}) \leq \underline{\delta}_{i,j}^{Flex}(\boldsymbol{\alpha})$ *when* $\alpha_i \geq \max\{\alpha_j, \alpha_k\}$ *and* $\underline{\delta}_{i,j}^{Flex}(\boldsymbol{\alpha}) > 0$.
(iv) $V_i(g_{ij}^{CU}) > V_i(g_{jk}^{FTA})$ *when* $\alpha_i \geq \alpha_j \geq \alpha_k$ *and* $\bar{\delta}_{i,j}^{OUT}(\boldsymbol{\alpha}) < 1$.

(v) $V_i(g_{ik}^{FTA}) > V_i(g_{jk}^{FTA})$ *when* $\alpha_i \geq \alpha_j \geq \alpha_k$, $\delta > \underline{\delta}_{j,k}^{Flex}(\boldsymbol{\alpha})$ *and* $g_{hk}^{FTA} \to g_h^H \to g^{FT}$ *for* $h = i, j$.

(vi) $\bar{\delta}_{i,j}^{OUT}(\boldsymbol{\alpha}) \geq \bar{\delta}_{j,i}^{OUT}(\boldsymbol{\alpha})$ *and, if* $v_i(g^{FT}) > v_i(g_{ij}^{CU})$, $\underline{\delta}_{i,k}^{Flex}(\boldsymbol{\alpha}) \leq \underline{\delta}_{j,k}^{Flex}(\boldsymbol{\alpha})$ *for* $\alpha_i \geq \alpha_j \geq \alpha_k$.

Proof.

(i) Let $g_{ij}^{CU} \to g^{FT}$ given lemma 1(ii) implies $V_k(g_{ij}^{CU})$ maximized when $g_{ij}^{CU} \to g^{FT}$. Then, $V_k(g_{ik}^{FTA}) > V_k(g_{ij}^{CU})$ reduces to $\delta < \tilde{\delta}_k \equiv [-.043\alpha_k^2 + .049\alpha_i^2 - .023\alpha_j^2 + .060\alpha_i\alpha_j][-.013\alpha_k^2 + .042\alpha_j^2]^{-1} > 1$ when $\alpha_i \geq \alpha_k$.

(ii) Given $v_k(g) - v_k(g_\varnothing)$ is increasing in α_j for $g = g_{jk}^{FTA}, g_j^H, g^{FT}$ then $V_k(g_{jk}^{FTA}) - V_k(g_\varnothing)$ minimized when $\alpha_j = \alpha_k$. Then, $V_k(g_{jk}^{FTA}) - V_k(g_\varnothing) = .029\alpha_k^2 + \delta(.010\alpha_i^2 - .019\alpha_k^2) + \delta^2(.042\alpha_i^2 - .013\alpha_k^2) > 0$ for all $\delta \geq 0$.

(iii) Note that $v_k(g_{ij}^{FTA}) - v_k(g_i^H)$ is increasing in α_k and $v_k(g^{FT}) - v_k(g_i^H)$ is decreasing in α_k. Thus, $\bar{\delta}_{j,i}^{OUT}(\boldsymbol{\alpha}) > \bar{\delta}_{k,i}^{OUT}(\boldsymbol{\alpha})$ when $\alpha_j > \alpha_k$. Further, lemma 1(i) implies $\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}) \leq \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$ where $g_{hl}^{FTA} \to g_l^H \to g^{FT}$ for $h = s, m$ and

$$V_l\left(g_{ml}^{FTA}\right) > V_l\left(g_{ml}^{CU}\right) \text{ if and only if } \delta \in \left(\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha})\right) \tag{A1}$$

$$V_l\left(g_{sl}^{FTA}\right) > V_l\left(g_{ml}^{CU}\right) \text{ if and only if } \delta \in \left(\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})\right). \tag{A2}$$

Thus, consider whether $\bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha}) \leq \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$. Given $\bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha})$ maximized by $\alpha_l = \alpha_m$ and $\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$ minimized by $\alpha_l = \alpha_m$, then $\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}) - \bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha})$ minimized by $\alpha_l = \alpha_m$. Moreover, $\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}) - \bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha}) > 0$ for any $\alpha_l = \alpha_m$ when $\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}) > 0$.

(iv) Note that $\bar{\delta}_{i,j}^{OUT}(\boldsymbol{\alpha}) < 1$ if and only if $v_i(g^{FT}) > v_i(g_{jk}^{FTA})$ and that, using lemma 1(iv), $g_{ij}^{CU} \to g^{FT}$ if and only if $v_i(g^{FT}) > v_i(g_{ij}^{CU})$. Thus, using lemma 1(ii), a sufficient condition for $V_i(g_{ij}^{CU}) > V_i(g_{jk}^{FTA})$ when $\bar{\delta}_{i,j}^{OUT}(\boldsymbol{\alpha}) < 1$ is that $v_i(g_{ij}^{CU}) > v_i(g_{jk}^{FTA})$ when $v_i(g^{FT}) > v_i(g_{jk}^{FTA})$. Define $\tilde{\alpha}_i(\alpha_j)$ such that $v_i(g_{ij}^{CU}) \geq v_i(g_{jk}^{FTA}) \Leftrightarrow \alpha_i \leq \tilde{\alpha}_i(\alpha_j)$ and define $\hat{\alpha}_i(\alpha_j)$ such that $v_i(g^{FT}) \geq v_i(g_{jk}^{FTA}) \Leftrightarrow \alpha_i \leq \hat{\alpha}_i(\alpha_j)$. Then, $\tilde{\alpha}_i(\alpha_j) - \hat{\alpha}_i(\alpha_j)$ is minimized when $\alpha_j = 1$ and, in this case, $\tilde{\alpha}_i(\alpha_j) - \hat{\alpha}_i(\alpha_j) > 0$. Thus, $v_i(g_{ij}^{CU}) > v_i(g_{jk}^{FTA})$ when $v_i(g^{FT}) > v_i(g_{jk}^{FTA})$.

(v) $V_i(g_{ik}^{FTA}) > V_i(g_{jk}^{FTA})$ reduces to $\delta > \tilde{\delta}_i \equiv [.043\alpha_i^2 - .061\alpha_j^2 + .010\alpha_k^2][-.013\alpha_i^2 + .019\alpha_j^2 + .061\alpha_k^2]^{-1}$. Let $g_{sm}^{FTA} \to g_m^H \to g^{FT}$ and define $V_m(g_{sm}^{FTA}) > V_m(g_m^{CU})$ if and only if $\delta \in (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$. Then, it is simple to verify numerically that $\tilde{\delta}_i < \underline{\delta}_{j,k}^{Flex}(\boldsymbol{\alpha})$ so that $\delta > \underline{\delta}_{j,k}^{Flex}(\boldsymbol{\alpha})$ implies $V_i(g_{ij}^{FTA}) > V_i(g_{jk}^{FTA})$.

(vi) First, $\bar{\delta}_{l,m}^{OUT}(\boldsymbol{\alpha}) - \bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha}) \propto [222\alpha_s^2 - 35(\alpha_l^2 + \alpha_m^2)][(22\alpha_s^2 - 7\alpha_l^2)(22\alpha_s^2 - 7\alpha_m^2)]^{-1}$. Thus, a sufficient condition for $\bar{\delta}_{l,m}^{OUT}(\boldsymbol{\alpha}) - \bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha}) > 0$ is $22\alpha_s^2 -$

$7\alpha_l^2 > 0$, which holds given $\alpha_l \leq 1.28\alpha_s$. Second, a sufficient condition for $\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}) - \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}) \geq 0$ is $f(\boldsymbol{\alpha}) = 385,216\alpha_s^2 - 2,975(\alpha_l^2 + \alpha_m^2) - 61,250\alpha_m \alpha_l \geq 0$. In turn, $f(\boldsymbol{\alpha}) \geq f(\alpha_l = 1.28\alpha_s, \alpha_m = 1.28\alpha_s, \alpha_s) \propto \alpha_s^2 > 0$. ■

Lemma 4 *Consider the competing exporters model with symmetric endowments and either symmetric market size or an arbitrarily small degree of market size asymmetry. Then, countries do not hold CU exclusion incentives. Apart from properties regarding CU exclusion incentives, the myopic properties in lemma 1 and the continuation payoff properties in lemma 3 hold.*

Proof. First, consider lemma 1. Let $\alpha_l = \alpha_m = \alpha_s$. For (ii), $v_i(g_{ij}^{FTA}) - v_i(g_{\varnothing}) \propto e^2$, $v_i(g_i^H) - v_i(g_{ik}^{FTA}) \propto e^2$, $v_i(g^{FT}) - v_i(g_j^H) \propto e^2$, $v_i(g_{ij}^{CU}) - v_i(g_{\varnothing}) \propto e^2$ and $v_i(g^{FT}) - v_i(g_{jk}^{CU}) \propto e^2$. For (iii), $v_i(g_{ij}^{CU}) - v_i(g_{ij}^{FTA}) \propto e^2$. For (iv), $v_i(g^{FT}) - v_i(g) \propto e^2$ for $g = g_{ij}^{FTA}, g_{ij}^{CU}$. For (v), $v_i(g_{ik}^{CU}) - v_i(g_{jk}^{CU}) \propto e^2$ and $v_i(g_{ik}^{FTA}) - v_i(g_{jk}^{FTA}) \propto e^2$. Now, for some arbitrarily small $\epsilon > 0$, let $\alpha_l > \alpha_m > \alpha_s$ but $\alpha_l - \alpha_m < \epsilon$ and $\alpha_m - \alpha_s < \epsilon$. Further, let $\alpha_s \equiv 1 \gtrsim e$. Given the strict inequalities above, only part (i) needs verification. Here, let $\alpha_j > \alpha_k$ and note that $v_i(g) - v_i(g') \propto \alpha_j - \alpha_k > 0$ for either: (i) $g = g_{ij}^{FTA}$ and $g' = g_{ik}^{FTA}$ or (ii) $g = g_{ij}^{CU}$ and $g' = g_{ik}^{CU}$ or (iii) $g = g_j^H$ and $g = g_k^H$.

Second, consider lemma 3. Let $\alpha_l = \alpha_m = \alpha_s$. For (i), noting that $g_{ij}^{CU} \to g^{FT}$, $V_k(g_{ik}^{FTA}) > V_k(g_{ij}^{CU})$ if $v_k(g_{ik}^{FTA}) + \delta v_k(g_i^H) + \delta^2 v_k(g^{FT})/(1-\delta) > v_k(g_{ij}^{CU}) + \delta v_k(g^{FT})/(1-\delta) \Leftrightarrow \delta < \hat{\delta} \equiv 2.601$, which always holds. For (ii), $V_k(g_{jk}^{FTA}) > V_k(g_{\varnothing}) \Leftrightarrow v_k(g_{jk}^{FTA}) + \delta v_k(g_j^H) + \delta^2 v_k(g^{FT})/(1-\delta) > \delta v_k(g_{\varnothing})/(1-\delta) \Leftrightarrow 423 - 161\delta + 4,64\delta^2 > 0$, which always holds. For (iii), $\hat{\delta}_{h,i} \approx .328 > \underline{\delta}_i^{Flex} \approx .313$. But, for the leader country i, redefine $\underline{\delta}_i^{Flex}$ as $V_i(g_{ij}^{FTA}) > V_i(g_{ij}^{CU}) \Leftrightarrow \delta > \hat{\delta}_i^{Flex}$. Then, $\underline{\delta}_i^{Flex} \equiv \hat{\delta}_i^{Flex} = \hat{\delta}_{h,i}$ so that $\hat{\delta}_{h,i} \leq \underline{\delta}_i^{Flex}$ as required. For (iv), $v_i(g_{ij}^{CU}) - v_i(g_{jk}^{FTA}) \propto e^2$ so that $V_i(g_{ij}^{CU}) > V_i(g_{jk}^{FTA})$ given lemma 1(ii) and $g_{ij}^{CU} \to g^{FT}$. For (v), this follows from lemma 1(v) and $v_i(g_i^H) - v_i(g_j^H) \propto e^2$. For (vi), this holds by definition given $\alpha_l = \alpha_m = \alpha_s$. Now, for some arbitrarily small $\epsilon > 0$, let $\alpha_l \geq \alpha_m \geq \alpha_s$ but $\alpha_l - \alpha_m < \epsilon$ and $\alpha_m - \alpha_s < \epsilon$. Further, let $\alpha_s \equiv 1 \gtrsim e$. Given the strict inequalities above, only part (vi) needs verification. Here, $\bar{\delta}_{l,m}^{OUT}(\boldsymbol{\alpha}) - \bar{\delta}_{m,l}^{OUT}(\boldsymbol{\alpha}) \approx (41,949/1,682)(\alpha_l - 1) > 0$ and $\underline{\delta}_{m,l}^{Flex}(\boldsymbol{\alpha}) - \underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}) \approx (1,268,307/84,640)(\alpha_l - 1) > 0$. ■

Proposition 3 *Let $\alpha_l \geq \alpha_m \geq \alpha_s$. When $v_l(g^{FT}) > v_l(g_{ml}^{CU})$, the equilibrium path of networks is:*

(i) $g_{\varnothing} \to g_{ml}^{CU} \to g^{FT}$ if $\delta \leq \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$,
(ii) $g_{\varnothing} \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ if $\delta > \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$.

Proof. Throughout the proof, note that: (i) equations (A1) and (A2) define $\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha})$ and $\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$, (ii) when $g_{sm} \to g_m^H \to g^{FT}$, then $V_m(g_{sm}^{FTA}) > V_m(g_{ml}^{CU})$ if and only if $\delta > \underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha})$ and (iii) lemma 1(i) implies $\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}) \leq \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$. Moreover, the non-economic benefits $\epsilon > 0$ imply the one-period payoff for s is higher for a PTA with l rather than m even if $\alpha_l = \alpha_m$, and analogously for

m with respect to its PTA partners l and s when $\alpha_l = \alpha_s$, and analogously for l with respect to its PTA partners m and s when $\alpha_m = \alpha_s$.

Lemma 2 provides the equilibrium transitions conditional on an initial PTA. Given $v_l(g^{FT}) > v_l(g^{CU}_{ml})$ and lemma 1(i), $g^{CU}_{ij} \to g^{FT}$ from any insider–outsider network g^{CU}_{ij}. Moreover, lemma 3(iii) implies $g^{FTA}_{ml} \to g^H_l \to g^{FT}$ and $g^{FTA}_{sl} \to g^H_l \to g^{FT}$ when, respectively, $\delta > \underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha})$ and $\delta > \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$. Finally, given $\alpha_i \geq \alpha_j$ and the non-economic benefit $\epsilon > 0$ that k derives from PTA formation with i rather j, $g^{FTA}_{ij} \to g^H_i \to g^{FT}$ or $g^{FTA}_{ij} \to g^{FTA}_{ij}$.

Stage 2. Note that $V_m(g) \geq \max\{V_m(g^{CU}_{sm}), V_m(g^{FTA}_{ml}), V_m(g_{\varnothing})\}$ for some $g = g^{CU}_{ml}, g^{FTA}_{sm}$ because $V_m(g^{CU}_{ml}) \geq V_m(g^{CU}_{sm})$ by lemma 1(i), and $V_m(g^{CU}_{ml}) > V_m(g^{FTA}_{ml})$ by lemma 1(ii) and (iii), and $V_m(g^{CU}_{ml}) > V_m(g_{\varnothing})$ given $v_m(g^{FT}) > v_m(g^{CU}_{ml})$ and lemma 1(ii). Thus, m proposes either ml^{CU} or sm^{FTA}. A necessary condition for m proposing sm^{FTA} is $g^{FTA}_{sm} \to g^H_m \to g^{FT}$, which requires $\bar{\delta}^{OUT}_{l,m}(\boldsymbol{\alpha}) < 1$, because otherwise $g^{FTA}_{sm} \to g^{FTA}_{sm}$ and, in turn, $V_m(g^{CU}_{ml}) > V_m(g^{FTA}_{sm})$ by parts (i) and (iii)–(iv) of lemma 1. Note, l accepts ml^{CU} given $V_l(g^{CU}_{ml}) > V_l(g_{\varnothing})$ follows from lemma 1(ii) and $v_l(g^{FT}) > v_l(g^{CU}_{ml})$. And s will accept m's proposal of sm^{FTA} given lemma 3(ii) implies $V_s(g^{FTA}_{sm}) > V_s(g_{\varnothing})$.

Stage 1(b). First, suppose m rejected l's proposal in stage 1(a) so that l can now propose to s. Let $\delta \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$. Then, given parts (i) and (iii) of lemma 1, $V_l(g^{CU}_{ml}) \geq \max\{V_l(g^{FTA}_{sl}), V_l(g^{CU}_{sl})\}$. Further, using lemma 3(vi), $\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}) \leq \underline{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha})$ so that $\delta \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$ implies m proposes ml^{CU} in stage 2. Thus, l makes no proposal to s in stage 1(b) when $\delta \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$.

Let $\delta > \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$ so that, by lemma 3(iii), $g^{FTA}_{sl} \to g^H_l \to g^{FT}$. Then, given lemma 1(i), $V_l(g^{FTA}_{sl}) > \max\{V_l(g^{CU}_{sl}), V_l(g^{CU}_{ml})\}$. If m proposes ml^{CU} in stage 2, then l proposes sl^{FTA} to s who accepts by lemma 3(i). If m proposes sm^{FTA} in stage 2 then $\underline{\delta}^{OUT}_{l,m} < 1$ and, using lemma 3(iv), $V_l(g^{FTA}_{sl}) > V_l(g^{CU}_{ml}) > V_l(g^{FTA}_{sm})$. Thus, l proposes sl^{FTA} to s who accepts by lemma 1(i). Hence, regardless of m's proposal in stage 2, l proposes sl^{FTA} to s who accepts when $\delta > \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$.

Second, suppose s rejected l's proposal in stage 1(a) so that l can now propose to m. Given m proposes either ml^{CU} or sm^{FTA} in stage 2 (and the proposal is accepted), m will accept only a proposal of ml^{CU} from l. Further, m accepts this proposal if and only if it proposes ml^{CU} in stage 2, which, given $\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}) \leq \underline{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha})$ by lemma 3(vi), is true when $\delta \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$.

Stage 1(a). Let $\delta \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$. Then, using parts (i) and (iii)–(iv) of lemma 1, $V_l(g^{CU}_{ml}) \geq \max\{V_l(g^{FTA}_{sl}), V_l(g^{CU}_{sl})\}$. Note, the eventual outcome outcome in stage 1(b) or stage 2 is g^{CU}_{ml}. Thus, given $V_m(g^{CU}_{ml}) > V_m(g^{FTA}_{ml})$, m accepts l's proposal of ml^{CU} but rejects its proposal of ml^{FTA}. In turn, l proposes ml^{CU} to m who accepts. Hence, the equilibrium path of networks is $g_{\varnothing} \to g^{CU}_{ml} \to g^{FT}$ when $\delta \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$.

Let $\delta > \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$ so that $g^{FTA}_{sl} \to g^H_l \to g^{FT}$ and $g^{FTA}_{ml} \to g^H_l \to g^{FT}$ by lemma 3(iii) and $\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}) \leq \underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})$. Then, $V_l(g^{FTA}_{ml}) \geq V_l(g^{FTA}_{sl}) > \max\{V_l (g^{CU}_{ml}), V_l(g^{CU}_{sl})\}$ by lemma 1(i). If m rejects l's proposal of ml^{FTA}, l proposes sl^{FTA} to s in stage 1(b) and s accepts. In turn, given $V_m(g^{FTA}_{ml}) > V_m(g^{FTA}_{sl})$

by lemma 1(v), m will accept l's proposal of ml^{FTA}. Thus, l proposes ml^{FTA} to m. Hence, the equilibrium path of networks is $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ when $\delta > \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$. ■

PROPOSITION 4 *Let $\alpha_l \ge \alpha_m \ge \alpha_s$. Further, suppose $v_l(g_{ml}^{CU}) \ge v_l(g^{FT})$ and $\delta \le \bar{\delta}(\boldsymbol{\alpha})$. When $\delta \notin (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$, the equilibrium path of networks is:*

(i) $g_\varnothing \to g_{ml}^{CU}$ *if* $\delta \notin (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$,
(ii) $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ *if* $\delta \in (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$.

When $\delta \in (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$, the equilibrium path of networks is:

(i) $g_\varnothing \to g_{ml}^{CU}$ *if* $\delta \notin (\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}))$,
(ii) $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ *if* $\delta \in (\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}))$.

Proof. Throughout the proof, note that: (i) equations (A1) and (A2) define $\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha})$ and $\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$, (ii) when $g_{sm} \to g_m^H \to g^{FT}$, then $V_m(g_{sm}^{FTA}) > V_m(g_{ml}^{CU})$ if and only if $\delta \in (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$ and (iii) lemma 1(i) implies $\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}) \le \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$. Moreover, the non-economic benefits $\epsilon > 0$ imply the one-period payoff for s is higher for a PTA with l rather than m even if $\alpha_l = \alpha_m$, and analogously for m with respect to its PTA partners l and s when $\alpha_l = \alpha_s$, and analogously for l with respect to its PTA partners m and s when $\alpha_m = \alpha_s$.

Lemma 2 provides the equilibrium transitions conditional on an initial PTA. Given $v_l(g_{ml}^{CU}) \ge v_l(g^{FT})$ then $g_{ml}^{CU} \to g_{ml}^{CU}$. However, given parts (ii) and (iv) of lemma 1 then $g_{sm}^{CU} \to g^{FT}$. Moreover, lemma 3(iii) implies $g_{ml}^{FTA} \to g_l^H \to g^{FT}$ and $g_{sl}^{FTA} \to g_l^H \to g^{FT}$ when, respectively, $\delta > \underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha})$ and $\delta > \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$. Finally, given $\alpha_i \ge \alpha_j$ and the non-economic benefit $\epsilon > 0$ that k derives from PTA formation with i rather j, $g_{ij}^{FTA} \to g_i^H \to g^{FT}$ or $g_{ij}^{FTA} \to g_{ij}^{FTA}$.

Stage 2. Note that $V_m(g) \ge \max\{V_m(g_{sm}^{CU}), V_m(g_{ml}^{FTA})\}$ for some $g = g_{ml}^{CU}$, g_{sm}^{FTA} because $V_m(g_{ml}^{CU}) \ge \max\{V_m(g_{sm}^{CU}), V_m(g_{ml}^{FTA})\}$ by definition of $\delta \le \bar{\delta}(\boldsymbol{\alpha})$ and $\alpha_l \ge \bar{\alpha}_l^{CU}$. Moreover, $V_m(g_{ml}^{CU}) > V_m(g_\varnothing)$ by lemma 1(ii). Hence m proposes either ml^{CU} to l or sm^{FTA}. A necessary condition for m proposing sm^{FTA} is $g_{sm}^{FTA} \to g_m^H \to g^{FT}$, which requires $\bar{\delta}_{l,m}^{OUT}(\boldsymbol{\alpha}) < 1$, because otherwise $g_{sm}^{FTA} \to g_{sm}^{FTA}$ and, in turn, $V_m(g_{ml}^{CU}) > V_m(g_{sm}^{FTA})$ by parts (i) and (iii) of lemma 1.

First, suppose $\delta \notin (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$ so that, using parts (i) and (iii) of lemma 1, $V_m(g_{ml}^{CU}) \ge V_m(g_{sm}^{FTA})$. In turn, m proposes ml^{CU} to l who accepts given lemma 1(ii) implies $V_l(g_{ml}^{CU}) > V_l(g_\varnothing)$. The proof for stages 1(a) and 1(b) now follows that of proposition 3 and hence the equilibrium path of networks is $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ when $\delta > \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$ but $g_\varnothing \to g_{ml}^{CU}$ when $\delta \le \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$.

Second, for the remainder of the proof, suppose $\delta \in (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$ so that $V_m(g_{sm}^{FTA}) > V_m(g_{ml}^{CU})$ noting this requires $g_{sm}^{FTA} \to g_m^H \to g^{FT}$. Thus, m proposes sm^{FTA} in stage 2 to s who accepts given lemma 3(ii) implies $V_s(g_{sm}^{FTA}) > V_s(g_\varnothing)$. Note, unlike the case of proposition 3, $v_l(g_{ml}^{CU}) > v_l(g^{FT})$ implies $\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}) < \underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})$ could hold.

Stage 1(b). First, suppose m rejected l's proposal in stage 1(a) so that l can now propose to s. Then, $\delta > \bar{\delta}^{OUT}_{m,l}(\boldsymbol{\alpha})$ and, hence, $g^{FTA}_{sl} \to g^H_l \to g^{FT}$ given $\bar{\delta}^{OUT}_{l,m}(\boldsymbol{\alpha}) \geq \bar{\delta}^{OUT}_{m,l}(\boldsymbol{\alpha})$ by lemma 3(vi) and that $g^{FTA}_{sm} \to g^H_m \to g^{FT}$ in stage 2 requires $\delta > \bar{\delta}^{OUT}_{l,m}(\boldsymbol{\alpha})$. Thus, l makes some proposal to s because: (i) $V_l(g^{FTA}_{sl}) > V_l(g^{FTA}_{sm})$ when $\delta > \underline{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha})$ by lemma 3(v) and (ii) $V_s(g^{FTA}_{sl}) \geq V_s(g^{FTA}_{sm})$ by lemma 1(i).

Second, suppose s rejected l's proposal in stage 1(a) so that l can now propose to m. Given $V_m(g^{FTA}_{sm}) > V_m(g^{CU}_{ml}) > V_m(g^{FTA}_{ml})$ by $\delta \in (\underline{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha}))$ and $\delta < \bar{\delta}(\boldsymbol{\alpha})$ then m rejects any proposal from l because the outcome in stage 2 is g^{FTA}_{sm}.

Stage 1(a). Note that $V_m(g^{CU}_{ml}) > \max\{V_m(g^{CU}_{sl}), V_m(g^{FTA}_{sl})\}$ when $\delta \notin (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$ follows from lemma 1(v), $\delta < \bar{\delta}(\boldsymbol{\alpha})$ and, without loss of generality, letting $g^{FTA}_{ml} \to g^H_l \to g^{FT}$. Moreover, $V_m(g^{FTA}_{ml}) > \max\{V_m(g^{CU}_{sl}), V_m(g^{FTA}_{sl})\}$ when $\delta \in (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$ follows from lemma 1(v) and lemma 3(i). Thus, m will accept a proposal of ml^{CU} when $\delta \notin (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$ and a proposal of ml^{FTA} when $\delta \in (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$.

Let $\delta \notin (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$ so that, using parts (i) and (iii) of lemma 1, $V_l(g^{CU}_{ml}) \geq \max\{V_l(g^{FTA}_{ml}), V_l(g^{FTA}_{sl})\}$ and $V_l(g^{CU}_{ml}) \geq V_l(g^{CU}_{sl})$. Thus, l proposes ml^{CU} to m who accepts. Now, let $\delta \in (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$ so that, using lemma 3(iii), $g^{FTA}_{ml} \to g^H_l \to g^{FT}$. In turn, using lemma 1(i) and lemma 3(iii), $V_l(g^{FTA}_{ml}) > \max\{V_l(g^{CU}_{ml}), V_l(g^{CU}_{sl})\}$ and $V_l(g^{FTA}_{ml}) \geq V_l(g^{FTA}_{sl})$. Thus, l proposes ml^{FTA} to m who accepts. Hence, when $\delta \in (\underline{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{m,s}(\boldsymbol{\alpha}))$, the equilibrium path of networks is $g_\varnothing \to g^{FTA}_{ml} \to g^H_l \to g^{FT}$ if $\delta \in (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$ but $g_\varnothing \to g^{CU}_{ml}$ if $\delta \notin (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$. ∎

Proof of lemma 1

Note throughout that $\alpha_i < 1.28\alpha_j$ for any countries i and j.

(i) Let $\alpha_j > \alpha_k$. Then, $v_i(g^{FTA}_{ij}) - v_i(g^{FTA}_{ik}) \propto \alpha_j - \alpha_k > 0$, $v_i(g^H_j) - v_i(g^H_k) \propto \alpha_j - \alpha_k > 0$, $v_i(g^{CU}_{ij}) - v_i(g^{CU}_{ik}) \propto \alpha_j - \alpha_k > 0$.

(ii) $v_i(g^{FTA}_{ij}) - v_i(g_\varnothing) = -.043\alpha_i^2 + .072\alpha_j^2 > 0$, $v_i(g^H_i) - v_i(g^{FTA}_{ik}) = -.013\alpha_i^2 + .072\alpha_j^2 > 0$, $v_i(g^{FT}) - v_i(g^H_k) = -.013\alpha_i^2 + .042\alpha_j^2 > 0$ and $v_i(g^{CU}_{ij}) - v_i(g_\varnothing) = -.042\alpha_i^2 + .021\alpha_i\alpha_j + .059\alpha_j^2 > 0$. Further, $v_i(g^{FT}) - v_i(g^{CU}_{jk})$ minimized when $i = l$ and, in turn, $v_l(g^{FT}) - v_l(g^{CU}_{sm}) \geq .027\alpha_s^2 > 0$.

(iii) $v_i(g^{CU}_{ij}) - v_i(g^{FTA}_{ij}) = .001\alpha_i^2 + .021\alpha_i\alpha_j - .013\alpha_j^2 > 0$.

(iv) First, $v_i(g^{FT}) - v_i(g^{FTA}_{ij}) = -.013\alpha_i^2 - .019\alpha_j^2 + .053\alpha_k^2 > 0$. Second, note that $v_i(g^{FT}) - v_i(g^{CU}_{ij}) = -.014\alpha_i^2 - .006\alpha_j^2 - .021\alpha_i\alpha_j + .053\alpha_k^2$. Thus, i can hold a CU exclusion incentive when $\alpha_i \geq \max\{\alpha_j, \alpha_k\}$ because $v_i(g^{FT}) - v_i(g^{CU}_{ij}) = -.004\alpha_k < 0$ if $\alpha_i = 1.28\alpha_j = 1.28\alpha_k$. But, neither i nor j can hold a CU exclusion incentive when the CU outsider is k and $\alpha_k \geq \max\{\alpha_i, \alpha_j\}$ because then $v_i(g^{FT}) - v_i(g^{CU}_{ij}) \geq .011\alpha_k > 0$. And, i cannot hold a CU exclusion incentive when the CU outsider is k and $\alpha_j \geq \alpha_k \geq \alpha_i$ because then $v_i(g^{FT}) - v_i(g^{CU}_{ij}) \propto -.014(\frac{\alpha_i}{\alpha_k})^2 - .006(\frac{\alpha_j}{\alpha_k})^2 - .021(\alpha_i/\alpha_k)(\alpha_j/\alpha_k) + .053$, which is minimized when $\alpha_j/\alpha_k = 1.28$ and, given the constraint $\alpha_k \geq \alpha_i$, when $\alpha_i/\alpha_k = 1$. In turn, $v_i(g^{FT}) - v_i(g_{ij}^{CU}) \geq .002$. Third, $[v_i(g_{ij}^{CU}) - v_i(g^{FT})] - [v_j(g_{ij}^{CU}) - v_j(g^{FT})] \propto \alpha_i - \alpha_j > 0$ and $[v_i(g_{ik}^{CU}) - v_i(g^{FT})] - [v_j(g_{jk}^{CU}) - v_j(g^{FT})] = .067(\alpha_i^2 - \alpha_j^2) + .021\alpha_k(\alpha_i - \alpha_k) > 0$.

(v) First, $v_i(g_{ij}^{CU}) - v_i(g_{jk}^{CU}) = -.042\alpha_i^2 + .021\alpha_i\alpha_j + .036\alpha_j^2 - .023\alpha_k^2 + .060\alpha_j \alpha_k$ is minimized when $\alpha_i = 1.28$ and $\alpha_j = \alpha_k = 1$, which implies $v_i(g_{ij}^{CU}) - v_i(g_{jk}^{CU}) \geq .027$. Second, $v_i(g_{ij}^{FTA}) - v_i(g_{jk}^{FTA}) = -.043\alpha_i^2 + .061\alpha_j^2 - .010\alpha_k^2 > 0$ when $\alpha_j \geq \max\{\alpha_i, \alpha_k\}$. ■

Proof of lemma 2

(i) For subgames at g_i^H and g_j^H, lemma 1(ii) implies that the equilibrium transitions are $g_i^H \to g^{FT}$ and $g_j^H \to g^{FT}$. For the subgame at g_{ij}^{FTA}, where $\alpha_i \geq \alpha_j$ and PTA formation for k with i rather than j yields a non-economic benefit $\epsilon > 0$, parts (ii) and (iv) of lemma 1 imply that $v_h(g_h^H) + \frac{\delta}{1-\delta} v_h(g^{FT}) > \frac{1}{1-\delta} v_h(g_{ij}^{FTA})$ for $h = i, j$ but, by definition, $v_k(g_h^H) + \frac{\delta}{1-\delta} v_k(g^{FT}) > \frac{1}{1-\delta} v_k(g_{ij}^{FTA})$ for some $k \neq h$ if and only if $\delta > \bar{\delta}_{k,h}^{OUT}(\boldsymbol{\alpha})$. Thus, given the protocol ordering and lemma 1(i), the equilibrium transition is $g_{ij}^{FTA} \to g_i^H$ if $\delta > \bar{\delta}_{k,i}^{OUT}(\boldsymbol{\alpha})$ but $g_{ij}^{FTA} \to g_{ij}^{FTA}$ otherwise.

(ii) Consider a CU insider–outsider network g_{ij}^{CU} where $\alpha_i \geq \alpha_j$. Thus, given parts (ii) and (iv) of lemma 1, the equilibrium transition is $g_{ij}^{CU} \to g^{FT}$ if and only if $v_i(g_{ij}^{FT}) > v_i(g_{ij}^{CU})$ but $g_{ij}^{CU} \to g_{ij}^{CU}$ otherwise. ■

Proof of proposition 1

To begin, let: (i) $\alpha_{l_1} \equiv \alpha_l$ and $\alpha_{l_2} \equiv \alpha_m$, (ii) $(\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l)) \equiv (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$ and (iii) $\bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}) \equiv 1$ when $v_l(g^{FT}) > v_l(g_{ml}^{CU})$.

First, suppose $v_l(g^{FT}) > v_l(g_{ml}^{CU})$. Then, proposition 3 implies the equilibrium path of networks is $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ when $\delta \in (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$ but $g_\varnothing \to g_{ml}^{CU} \to g^{FT}$ when $\delta \notin (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$.

Second, suppose $v_l(g_{ml}^{CU}) \geq v_l(g^{FT})$ and notice that $\alpha_m = \alpha_l$ implies $(\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha})) = (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$. Moreover, lemma 1(i) implies $(\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha})) \subset (\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}))$ and, in turn, $\delta \in (\underline{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{m,s}^{Flex}(\boldsymbol{\alpha}))$ implies $\delta \in (\underline{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,m}^{Flex}(\boldsymbol{\alpha}))$. Then, proposition 4 implies the equilibrium path of networks is $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ when $\delta \in (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$ but $g_\varnothing \to g_{ml}^{CU}$ when $\delta \notin (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$.

Hence, when $\delta \in (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$ the equilibrium path of networks is $g_\varnothing \to g_{ml}^{FTA} \to g_l^H \to g^{FT}$ but when $\delta \notin (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$ the equilibrium path of networks is $g_\varnothing \to g_{ml}^{CU} \to g^{FT}$ if $v_l(g^{FT}) > v_l(g_{ml}^{CU})$ but $g_\varnothing \to g_{ml}^{CU}$ if $v_l(g_{ml}^{CU}) \geq v_l(g^{FT})$. ■

Proof of proposition 2

To begin, let: (i) $\alpha_{s_1} \equiv \alpha_m$ and $\alpha_{s_2} \equiv \alpha_s$, (ii) $(\underline{\delta}_l^{Flex}(\alpha_l), \bar{\delta}_l^{Flex}(\alpha_l)) \equiv (\underline{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}), \bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}))$ and (iii) $\bar{\delta}_{l,s}^{Flex}(\boldsymbol{\alpha}) \equiv 1$ when $v_l(g^{FT}) > v_l(g_{ml}^{CU})$. Also, note the definition in the main text that $v_l(g^{FT}) > v_l(g_{sl}^{CU})$ if and only if $\alpha_l < \bar{\alpha}_l^{CU}$.

First, let $v_l(g^{FT}) > v_l(g^{CU}_{ml})$. Then, proposition 3 implies the equilibrium path of networks is $g_\varnothing \to g^{FTA}_{ml} \to g^H_l \to g^{FT}$ when $\delta \in (\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}))$ but $g_\varnothing \to g^{CU}_{ml} \to g^{FT}$ when $\delta \notin (\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}))$.

Second, let $\alpha_l \geq \bar{\alpha}^{CU}_l$ and notice that $\alpha_m = \alpha_s$ implies $(\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha})) = (\underline{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,m}(\boldsymbol{\alpha}))$. Then, proposition 4 implies the equilibrium path of networks is $g_\varnothing \to g^{CU}_{ml}$ if $\delta \notin (\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}))$ but $g_\varnothing \to g^{FTA}_{ml} \to g^H_l \to g^{FT}$ if $\delta \in (\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}))$.

Hence, when $\delta \in (\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}))$ the equilibrium path of networks is $g_\varnothing \to g^{FTA}_{ml} \to g^H_l \to g^{FT}$ but when $\delta \notin (\underline{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}), \bar{\delta}^{Flex}_{l,s}(\boldsymbol{\alpha}))$ the equilibrium path of networks is $g_\varnothing \to g^{CU}_{ml} \to g^{FT}$ if $v_l(g^{FT}) > v_l(g^{CU}_{ml})$ but $g_\varnothing \to g^{CU}_{ml}$ if $v_l(g^{CU}_{ml}) \geq v_l(g^{FT})$. ■

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