Economies of Scale, Tariff Binding Liberalization and Dynamic Free Trade Agreement Formation

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Abstract

This paper examines how the degree of economies of scale affects the dynamic formation of free trade agreements (FTAs) as tariff binding liberalization occurs. Focusing on optimal tariffs within an oligopoly model of trade that incorporates flexible economies of scale, we demonstrate that changes in the optimal external tariffs of member and non-member countries resulting from FTA formation largely depend on the degree of economies of scale. Building on these optimal tariffs across all regimes, we further analyze scenarios where countries are constrained by exogenous tariff bindings and explore how liberalizing these bindings affects the FTA formation process under different economies of scale. We find that, starting with sufficiently high tariff bindings, liberalization initially promotes FTA formation by reducing dynamic free-riding incentives of the FTA outsider, thereby facilitating global free trade. This effect is more pronounced with stronger economies of scale. Conversely, when tariff bindings decrease further, dynamic exclusion incentives emerge for the FTA insiders, which can impede the expansion of FTAs toward global free trade, with these negative effects being amplified by economies of scale.

Keywords: Economies of Scale, Tariff Complementarity, Tariff Bindings, Free Trade Agreement,

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1 Introduction

One of the key features of the modern global policy landscape is the widespread prevalence of preferential trade agreements (PTAs).[1] All countries participate in at least one, but most are involved in multiple such agreements simultaneously. Before the rapid proliferation of PTAs, several multilateral negotiation rounds, since the formation of the General Agreement on Tariffs and Trade (GATT), delivered substantial Most Favoured Nation (MFN) tariff concessions, with countries committing to tariff bindings that set upper limits on their applied MFN tariffs. Lower MFN tariff bindings have limited countries' ability to impose their optimal tariffs. This has serious implications for the incentives to form PTAs, given the constraints of lower tariff bindings. Recently, Lake et al. (2020) [24] and Nken and Yildiz (2022) [31] show the implications of tariff-binding liberalization on the static and dynamic PTA formation. Additionally, we understand that trade flows significantly influence the welfare effects of international trade agreements and the optimal trade policies of countries. Changes in trade flows are, in turn, highly sensitive to the extent of economies of scale in production technology. Overlooking this heterogeneity in returns to scale presents a significant limitation when analyzing the MFN tariff binding liberalization and the dynamic formation of trade agreements.

Incorporating various levels of economies of scale into the analysis may elucidate the ambiguity observed in existing empirical studies concerning the impact of preferential trade agreements (PTAs) on trade, tariffs, and welfare. The empirical evidence regarding the average industry returns to scale is inconclusive, with a general consensus that estimates vary significantly across industries. Given these observations, along with the declining tariff bindings and the rapid proliferation of PTAs, many potential research questions arise regarding the implications of PTAs on trade, trade policies, and welfare when considering lower tariff bindings and varying natures and degrees of economies of scale. To the best of our knowledge, this is the first paper to investigate the dynamic implications of different degrees of economies of scale and tariff binding liberalization on the extent of free trade agreement (FTA) formation.

We initially analyze how the formation of the FTA affects the optimal external tariffs of both FTA members and non-members under varying degrees of economies of scale, in a setting where tariff bindings are sufficiently high and countries are able to impose their optimal tariffs. We confirm the results in our companion paper Azeem et al. (2025) [2] by showing that FTA insiders always have an incen-

[1] Following the conclusion of the Uruguay Round in 1994, the number of PTAs has grown significantly, with over 500 currently active. About 90% of these are Free Trade Agreements (FTAs), while the remaining predominantly comprise Customs Unions (CUs).

tive to lower their tariffs on the FTA outsider relative to the empty network, regardless of the degree of economies of scale. This tariff complementarity effect intensifies as the degree of economies of scale increases.[2] Similarly, when an industry exhibits economies of scale, increased production by FTA insiders—enabled by preferential access through FTA formation—results in higher per-unit profits for insiders. This, in turn, increases the incentives of outsiders to extract rent from insiders. As a result, the FTA outsider raises its tariffs on imports from insiders. Conversely, when an industry exhibits diseconomies of scale, the FTA outsider lowers its external tariffs.

Having established the significance of economies of scale in the external trade policy of both FTA insiders and outsiders, we now proceed to a three-country dynamic model of FTA formation. This model aims to investigate how the incorporation of tariff-binding liberalization and flexible economies of scale shapes the welfare implications of FTA formation and countries' incentives to enter such agreements. To this end, we deviate from optimal tariffs and consider a scenario where countries face exogenously given tariff bindings; consequently, their applied rates under any trade regime must not exceed these binding limits. Our dynamic FTA formation model follows directly from Lake and Yildiz (2016) [22] and Lake et al. (2020) [24].

We first isolate the driving forces behind the sequential FTA formation. In our dynamic model, incentives that involve payoff comparisons in the current period and the immediate next period are referred to as *myopic incentives*, which primarily capture short-run considerations. When countries make payoff comparisons between the current period and periods beyond the immediate next period, we call these incentives *farsighted incentives*, which involve long-run considerations. Specifically, what are the myopic and farsighted considerations of an FTA outsider under a bilateral FTA? On one hand, myopically, an FTA outsider decides whether to become a spoke country under a hub-and-spoke agreement relative to being an outsider under a bilateral FTA. On the other hand, farsightedly, the decision of an FTA outsider is between becoming a spoke on the path to global free trade or remaining an outsider. In our dynamic FTA formation setting, the discount factor serves as a mediator, and the trade-off between myopic and farsighted incentives of the FTA outsider determines whether dynamic free riding arises.

Next, consider the myopic and farsighted considerations of FTA insiders. We first address whether an FTA insider benefits from becoming the hub country under a hub-and-spoke agreement myopically. Second, farsightedly, an FTA insider decides whether to exclude the FTA outsider or reach global free

[2] Azeem et al. (2025) [2] tests this prediction by analyzing the response of MFN tariffs to preferential tariff reductions, using product-level tariff data across all FTAs signed from 1989 to 2014. It is found that the tariff complementarity effect is observed across all industries regardless of their economies of scale, with MFN tariffs adjusting steadily over the first three years of FTA implementation in response to preferential tariff reductions. More importantly, industries characterized by increasing returns to scale show markedly greater reductions in MFN tariffs, a difference that is both statistically and economically significant.

trade via the hub-and-spoke regime. The trade-off between myopic and farsighted incentives of FTA insiders determines whether dynamic exclusion incentives arise.

Specifically, this paper examines how tariff-binding liberalization, in interaction with flexible degrees of economies of scale, affects myopic and dynamic free-riding and exclusion incentives, which are vital in determining the equilibrium path of FTA formation. We show that, when tariff bindings are sufficiently high, tariff binding liberalization initially facilitates FTA formation, leading to global free trade via a reduction in dynamic free-riding incentives. This result is more likely to occur with economies of scale. However, when tariff bindings are at intermediate levels, dynamic exclusion incentives emerge and intensify as the tariff bindings decline further. In such a case, we argue that tariff-binding liberalization hinders the extension of the FTA formation process to global free trade, with these negative effects being stronger in the presence of economies of scale. These results underscore the significance of economies of scale and their interplay with tariff-binding liberalization in determining whether the formation of preferential trade agreements serves as a building block or stumbling block for achieving global free trade.

Note that there is extensive literature on the formation of preferential trade agreements (PTAs) and their implications for the prospects of multilateral free trade in a variety of settings (see Maggi (2014) [25] and Lake and Krishna (2019) [23] for excellent surveys). The discussion often centers on how PTA formation impacts external tariffs on non-members and whether the formation of PTAs act as building or stumbling blocs towards global free trade.[3] The theoretical and empirical results are mixed depending on the degree of asymmetry with respect to market size, technology, endowments and political economy factors (see Aghion et al.,2007[1]; Furusawa and Konishi (2007)[16]; Saggi and Yildiz, 2010[40] and Stoyanov and Yildiz, 2015[46]).

Our contribution to this body of literature lies in incorporating tariff-binding liberalization and flexible degrees of economies of scale into the analysis. Specifically, focusing on the FTA formation incentives, Saggi (2006)[39], Saggi and Yildiz (2011)[41], Ornelas (2005)[33], and Stoyanov and Yildiz (2015)[46] employed a similar oligopoly model of tradel as in the present paper, while overlooking the roles of tariff binding liberalization and different levels of economies of scale in the PTA formation. Finally, similar to the present paper, Lake et al. (2020) [24] and Nken and Yildiz (2022) [31] employ

[3]Notable contributions to this body of literature, exploring the implications of PTAs on optimal tariffs, reduction of multilateral tariffs, and their impact on achieving global free trade, include studies by Krugman (1991) [19], Bhagwati (1991)[8], Yi (1996)[48], Bagwell and Staiger (1997a, 1997b, 1998, 2005a, 2005b[3, 4, 5, 6, 7], Krishna (1998)[18], Riezman (1999)[38], Bond et al. (2004)[9], Bond (2009)[10], Goyal and Joshi (2006)[17], Furusawa and Konishi (2007)[16], Aghion et al. (2007)[1], Missios et al. (2016)[28], Ornelas (2005a, 2005b, 2007)[33, 34, 35], Saggi (2006)[39], Saggi and Yildiz (2010, 2011)[40, 41], Saggi et al. (2013, 2018, 2019)[42, 43, 44], Stoyanov and Yildiz (2015)[46], and Lake (2017)[21], Lake et al. (2020) [24], Chi and Yildiz (2024a, 2024b)[12, 13].

a dynamic PTA formation model to examine the implications of tariff binding liberalization on the equilibrium path of PTAs. Unlike the present paper, they utilize perfectly competitive models with DRS. Since the welfare properties of FTAs, and consequently the incentives of countries to form FTAs, heavily rely on the scale economies of production technology, this paper aims to fill the gap in the literature by incorporating a flexible degree of economies of scale. The objective is to gain a better understanding of the equilibrium path of FTAs and whether FTA formation undermines multilateral trade liberalization in a more general setting.

Next, Section 2 describes our oligopoly trade model, introducing flexible degrees of economies of scale and deriving optimal tariffs. Section 3 introduces our equilibrium concept and strategies in a dynamic FTA formation model. Then, Section 4 examines the driving forces behind the FTA formation when countries are bound by tariff bindings. Section 5 examines how tariff-binding liberalization influences the equilibrium path of networks with different degrees of economies of scale. Finally, Section 6 concludes. The Appendix contains all proofs.

2 Model

We utilize an adapted version of Brander and Krugman (1983)[11] oligopoly trade model. There are three symmetric countries: i, j, k and two goods: a non-numeriare good x and a numeriare good y. Hereafter, due to symmetry, we use country i as a generic notation for countries.

On the demand side, the representative consumer's utility function is quasi-linear

$$U_i\left(x_i, y_i\right) = u_i\left(x_i\right) + y_i$$

where the subutility $u_i(x_i)$ is quadratic: $u_i(x_i) = \alpha x_i - \frac{x_i^2}{2}$ where x_i is the total output sold in country i: $x_i = \sum_{z=i,j,k} x_{zi}$ Thus, a representative consumer from country i has the following linear demand function:

$$p_i = \alpha - x_i \tag{1}$$

where p_i denotes the price of good x in country i. Good x is produced by a single profit-maximizing firm in each country with the following cost function:[4]

[4]The numeraire good is produced by perfectly competitive firms operating under constant returns to scale and is freely traded internationally to prevent potential balance of trade issues.

$$C_i\left(q_i\right) = cq_i - \delta q_i^2 \text{ where } \left\{ \begin{array}{c} \delta > 0 \text{ if there is Economies of Scale} \\ \delta = 0 \text{ if there is Constant Returns to Scale} \\ \delta < 0 \text{ if there is Diseconomies of Scale} \end{array} \right\}$$

where q_i denotes the total production of good x by firm i: $q_i = \sum_{z=i,j,k} x_{iz}$. Note from the cost function above that δ characterizes the extent of economies of scale. Most of the existing literature employing oligopoly model of trade assumes constant marginal cost and thus assume $\delta = 0$, implying constant returns to scale.[5].

We assume that firms engage in Cournot competition in all markets. In the absence of any FTAs, firm i faces a specific tariff t_{ji} when exporting to country i.[6] Firm i solves the following problem:

$$\max_{x_{ii},x_{ij},x_{ik}} \pi_i = \sum_{z=i,j,k} p_z x_{iz} - cq_i + \delta q_i^2 - \sum_{z \neq i} t_{zi} x_{iz}$$

Given equilibrium prices and export volumes across all countries, the national welfare of country i, denoted by $w_i(\mathbf{t})$ is defined as the sum of consumer surplus (CS_i), producer surplus (PS_i), and tariff revenue (TR_i):

$$w_i(\mathbf{t}) = \underbrace{u_i(x_i(\mathbf{t})) - p_i(\mathbf{t})x_i(\mathbf{t})}_{CS_i(\mathbf{t})} + \underbrace{\pi_i}_{PS_i(\mathbf{t})} + \underbrace{\sum_{z \neq i} t_{iz} x_{zi}}_{TR_i(\mathbf{t})}$$

where $\mathbf{t}$ represents the tariff vector that involves all external tariffs: $\mathbf{t} = (t_{ij}, t_{ik}, t_{ji}, t_{jk}, t_{ki}, t_{kj})$. Next, we discuss the optimal tariff setting under different possible regimes.

2.1 Optimal applied tariffs

Borrowing the terminology from the existing network literature, countries are treated as nodes in a "graph," and the bilateral FTA links between countries are viewed as edges on this graph.[7] The graph, symbolized as g, represents the array of bilateral FTA connections between countries. Henceforth, g will be referred to as the network of FTAs. Figure 1 provides visual representations of these potential

[5] We employ this cost function for simplicity and more tractable analytical results. Azeem et al. (2025) [2] showed that this cost function yields results equivalent to those obtained from a general Cobb–Douglas production function, as there is a one-to-one correspondence between δ in our cost function and the exponent parameters in the general form of the Cobb–Douglas production function.

[6] It is obvious that $t_{ii} = 0$ since countries do not impose taxes on their local firms and there are no tariffs on the numeraire good (that may be traded internationally in order to balance trade).

[7] Some notable works that have used this terminology for PTAs include Goyal and Joshi (2006) [17], Furusawa and Konishi (2007)[16], Xue et al. (2013)[47], Lake and Yildiz (2016)[22], Lake (2017)[21], Lake et al. (2020)[24], and Nken and Yildiz (2022)[31].

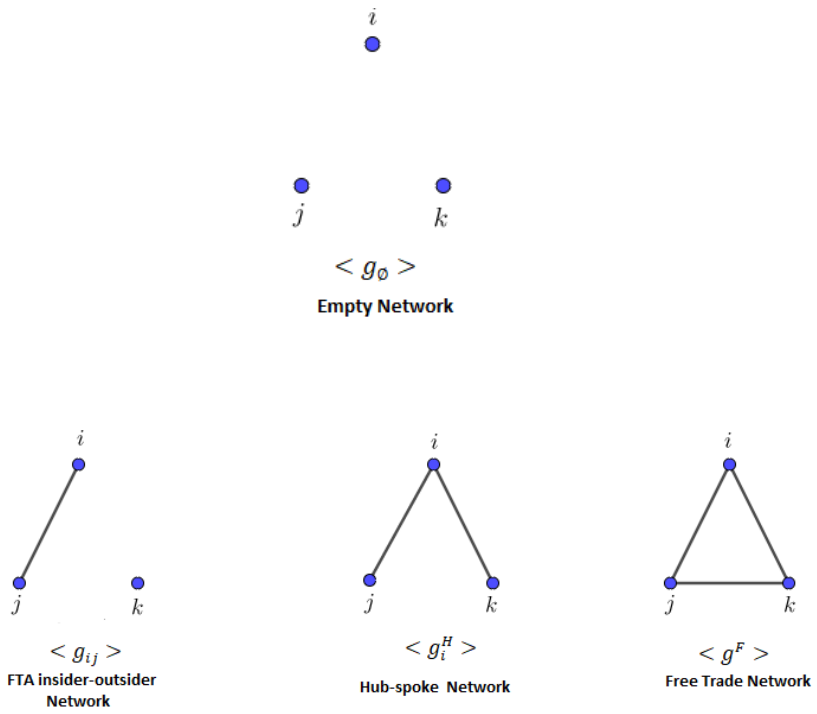


Figure 1: Network Position

networks. The "empty network" g_ϕ emerges in the absence of any FTAs while g_{ij} is the "FTA insider-outsider network" where the FTA non-member k is the "FTA outsider" and the FTA members i and j are "FTA insiders". g_i^H is the "hub-spoke" network where countries j and k are "spokes" and each have an FTA with country i who is the "hub". Finally, g^F is the "global free trade network" where all countries are linked through FTAs.

Under the empty network g_ϕ, Article I of the GATT forbids tariff discrimination and thus all countries simultaneously choose their respective non-discriminatory MFN tariffs: $t_{ij}(g_\phi) = t_{ik}(g_\phi) = t_i(g_\phi) \equiv \arg\max w_i(g_\phi)$.[8] In the case of an FTA insider-outsider network g_{ij}, internal tariffs are eliminated between insiders: $t_{ij} = t_{ik} = 0$ while each country retains autonomy in setting its own external tariffs on the outsider country. The outsider country, in turn, imposes the MFN tariff on both insiders. Similarly, under a hub-spoke network g_i^H, the hub country imposes zero external tariffs on spokes while spokes impose external tariffs on each other: $t_{ij} = 0, t_{ji} = 0, t_{ik} = 0, t_{ki} = 0$.

In this section, we focus on optimal applied tariffs and ignore tariff bindings. Section 4 considers the tariff bindings that impose an upper constraint for applied tariffs. Our first finding suggests that, regardless of the FTA networks, countries have incentives to impose higher external tariffs as δ rises,

[8] We report the output, price and tariff levels in the appendix.

implying higher optimal tariffs with a greater degree of economies of scale:

$$\frac{\partial t_i(g)}{\partial \delta} > 0, \text{ where } g = g_\phi, g_{ij}, g_{ik}, g_{jk}, g_j^H \text{ and } g_k^H \tag{2}$$

The intuition behind the above result is as follows: as δ rises, an increase in the production leads to lower unit cost of production, leading to a higher per unit profit. As a result, each country has incentive to impose higher external tariffs to protect the domestic market and extract rent from exporters into their markets. As in Azeem et al. (2025) [2], when we examine the implications of FTA formation on the external tariffs of insiders, we confirm that economies of scale play a pivotal role. Before proceeding, let $\Delta t_i(g - g')$ denote the difference of the external tariffs country i imposes under network g and network g': $\Delta t_i(g - g') = t_i(g) - t_i(g') > 0$. We first focus on how a bilateral FTA formation changes the insiders' external tariff on the outsider relative to g_ϕ where $\Delta t_{ik}(g_\phi - g_{ij}) = t_i(g_\phi) - t_{ik}(g_{ij})$. Then, we turn our attention to the tariff implications of an additional bilateral FTA under g_{ij}, leading to a hub and spoke regime where the external tariff of country k changes as follows: $\Delta t_{kj}(g_{ij} - g_i^H) = t_{kj}(g_{ij}) - t_{ik}(g_i^H)$.

Our findings follow directly from Azeem et al. (2025) [2]: upon formation of a bilateral FTA, insiders have an incentive to lower their tariffs on the FTA outsider regardless of the degree of economies of scale:

$$\Delta t_{ik}(g_\phi - g_{ij}) > 0 \;\; \textit{and} \; \Delta t_{kj}(g_{ij} - g_i^H) > 0 \, \textit{for all} \; \delta \tag{3}$$

The rationale behind this result lies in the preferential access between member countries, which diminishes the importance of non-member firms as a source of rent extraction in the markets of FTA members, thereby reducing the incentive to impose external tariffs. As a result, the reduction in external tariffs on the imports from non-member countries $\Delta t_i(g - g') > 0$ consistently holds. This mechanism is known in the literature as the *tariff complementarity effect,* a term coined by Bagwell and Staiger (1997b) [4]. Empirical support for tariff complementarity has been provided by Estevadeordal et al. (2008) [14], Mai and Stoyanov (2015) [26], Kuenzel and Sharma (2021) [20] and Azeem et al. (2025) [2].

Next, we also confirm Azeem et al. (2025) [2] demonstrating that this tariff complementarity effect intensifies as the degree of economies of scale becomes more pronounced:

$$\frac{\partial \Delta t_{ik}(g_\phi - g_{ij})}{\partial \delta} > 0 \text{ and } \frac{\partial \Delta t_{kj}(g_{ij} - g_i^H)}{\partial \delta} > 0 \, \textit{for all} \; \delta \tag{4}$$

Intuitively, when two countries form an FTA, their exports to each other's markets increase due

to preferential access. When the industry exhibits stronger economies of scale, an increase in domestic production caused by an FTA reduces the average cost of production for insiders, thereby increasing their profit per unit. Conversely, the outsider faces discrimination in insiders' markets and does not benefit from the economies of scale that insiders enjoy. As a result, the outsider becomes a less important source of rent extraction, which decreases insiders' incentives to impose external tariffs even further compared to cases with constant returns to scale and diseconomies of scale.

Note here that the existence of economies of scale creates a link between the outputs of a firm in the domestic and export markets, and thus, unlike the constant returns to scale, markets are not strategically separated. Therefore, FTA formation affects not only the external tariffs of FTA members but also the external tariffs of the non-member country under a bilateral FTA. [9] Our results confirm the findings in Azeeem et al. (2025): the response of the FTA outsider's external tariff heavily depends upon the nature of the economies of scale. Specifically, FTA formation induces the FTA outsider to raise its tariffs on imports from FTA insiders only when there exist economies of scale:

$$\Delta t_k(g_\phi - g_{ij}) = t_k(g_\phi) - t_k(g_{ij}) \leq 0 \textit{ if and only if } \delta \geq 0 \tag{5}$$

When the industry exhibits economies of scale ($\delta > 0$), the larger production of FTA insiders, facilitated by preferential access through FTA formation, results in a lower average production cost and higher per-unit profit for insiders. As a result, the outsider has a greater incentive to extract rent from insiders and thus raise its tariff on imports from insiders relative to g_ϕ. The opposite result obtains when the industry exhibits diseconomies of scale, lending support to Missios et al. (2016) [28]and Saggi et al. (2018) [43] when there exist diseconomies of scale.

Would the above result extend to the case where i and k form an additional FTA, leading to a deviation from g_{ij} to the hub and spoke regime g_i^H? We argue that this is not the case, and the opposite result obtains. Note first that the outsider country (j) under such an FTA is already a partner of country i, and thus can not be identified as a true outsider. Second, since it gives up its unconstrained domestic market protection, country k's total output declines when it forms an FTA with country i and becomes a spoke country under g_i^H. This is due to the fact that the decline in output in the domestic market exceeds the limited increase in export in the hub's market. This implies that country k's firm's per unit profit falls (rises) under economies (diseconomies) of scale. As a result, country j's incentive to extract rent

[9] We know from Missios et al. (2016) [28] and Saggi et al. (2018) [43] that the FTA outsider has an incentive to reduce its tariffs on imports from FTA insiders due to external trade diversion under perfectly competitive markets with increasing marginal costs.

from country k's firm weakens (strengthens) under economies (diseconomies) of scale.

Next, we introduce our equilibrium concept and strategies.

3 Equilibrium Theory: Concepts and Strategies

Building upon the models by Seidmann (2009) [45], Lake and Yildiz (2016) [22], and Lake et al. (2020) [24], we employ a dynamic FTA formation model that initiates from an empty network. Consistent with Ornelas (2008) [36] and Ornelas and Liu (2012) [37], we assume that at most one FTA can be formed in one period and that FTAs formed in previous periods are binding and cannot be severed.[10] We define a period as the duration required to negotiate an agreement, thereby tying our model more closely to empirical realities in the field.[11] Let g_{t-1} denote the network at the beginning of time t, and the transition of network in the current period be denoted by $g_{t-1} \to g_t$. As an example, we denote the transition of networks $g_{t-1} \to g_t \to g_{t+1}$, where the network g_{t-1} evolves into g_{t+1} through g_t and then remains at g_{t+1} forever. Finally, our network remains permanent when one of two conditions occurs: either no agreement forms in a given period or once global free trade emerges.[12] First, when no agreement forms in a given period, the assumption of Markov strategies implies no agreement forms in any subsequent periods. Second, once global free trade emerges, the assumption that previously formed agreements cannot be severed implies that global free trade will remain forever. Table 1 depicts the feasible transitions for the current period, moving from g_{t-1} to g_t, where g_t represents the network at the end of the current period. A path of networks, $g_{t-1} \to g_t \to g_{t+1}$, indicates a progression beginning at g_{t-1}, passing through g_t, and ultimately settling permanently at g_{t+1}. Consistent with our model, the network remains unchanged from the third period onwards. Alternatively, the path of networks $g_\phi \to g_\phi$ denotes a situation where no FTA formation takes place.

Countries hold preferences over various paths of FTA networks, which is illustrated by the continuation payoffs. Let β denote the discount factor and $V_i(g_t)$ denote the continuation payoff from the path of networks. Assuming that the network at the beginning of the current period is empty, denoted by g_ϕ, and a country i's one-period payoff is equivalent to the national welfare $W_i(g)$, the continuation payoff for country i from the path of networks $g_\phi \to g_{ij} \to g_i^H \to g^F$ is defined as

[10] The binding nature of trade agreements is pervasive in the literature and realistic in terms of real-world observation. It can represent a reduced form for more structural justifications, such as sunk costs (see McLaren (2002) [27] for empirical support).

[11] This interpretation aligns with the observation by Odell (2006, p.193) [32] that NAFTA negotiations began in 1986, but the agreement wasn't signed until 1992. Similarly, Mölders (2012, 2015) [29, 30] and Freund and McDaniel (2016) [15] provide additional empirical evidence, illustrating the extended time frames often associated with FTA negotiations.

[12] These conditions are expected to take place no later than the third period, a feature that is vital in applying backward induction within our model.

Network at the beginning of the Current Period	Network at the end of the Current Period
g_ϕ	g_ϕ, g_{ij}, g_{ik}, g_{jk}
g_{ij}	g_{ij}, g_i^H, g_j^H
g_i^H	g_i^H, g^F
g^F	g^F

Table 1: Pathways of Feasible Networks Transitions

$V_i(g_{ij}) = W_i(g_{ij}) + \beta W_i(g_i^H) + \frac{\beta^2}{1-\beta} W_i(g^F)$. In a different scenario, if no FTA forms in the current period, the empty network g_ϕ will remain indefinitely. Hence, the continuation payoff for country i from the path of networks $g_\phi \to g_\phi$ will be $V_i(g_\phi) = \frac{1}{1-\beta} W_i(g_\phi)$.

We employ a deterministic protocol as in Seidmann (2009) [45], Lake and Yildiz (2016) [22], Lake et al. (2020) [24], where the "leader" country has the first opportunity in each period to propose an FTA that forms if and only if recipient countries accept the proposal. If the leader country does not have a proposal accepted by the follower countries, then one of the follower countries has the opportunity to propose an FTA.[13]

Without loss of generality, from hereon, we assume that country i is the leader country and countries j and k are the recipients. Due to complete symmetry, multiple equilibria could arise. In order to eliminate this possibility, we assume some infinitesimal non-economic benefit $\epsilon > 0$ that countries j and k obtain when forming a PTA with country i. In other words, country i is assumed to be the leader country that is the most attractive PTA partner. Similarly, country i receives some $\epsilon > 0$ when forming with country j rather than country k. Formally, stages 1-2 describe the protocol in every period:

- **Stage 1(a):** Country i proposes an FTA to a country. If the recipient country accepts the proposal, then the period ends. If the recipient country rejects the proposal, then the game moves to stage 1(b). Otherwise, the game moves to stage 2.
- **Stage 1(b):** Country i proposes to the country that didn't reject its proposal in stage 1(a). If FTA forms, then the period ends. Otherwise, the game moves to stage 2.
- **Stage 2:** Country j proposes an FTA, and the period ends no matter what happens in this stage.

The series of the above stages indicates that the network remains unchanged once global free trade is established or when a period ends without any FTA formation. Table 2 represents the available pro-

[13] Unlike Aghion et al. (2007) [1], where only the leader country can make proposals, our protocol empowers the follower countries to propose FTAs and thus follower countries can form their own FTA.

	$S_i(g)$	$S_j(g)$	$S_k(g)$
g_ϕ	$\{\phi$, ij, ik $\}$	$\{\phi$, ij, jk$\}$	$\{\phi$, ik , jk$\}$
g_{ij}	$\{\phi$, ik$\}$	$\{\phi$, jk$\}$	$\{\phi$, ik , jk$\}$
g_i^H	$\{\phi\}$	$\{\phi$, jk$\}$	$\{\phi$, jk$\}$
g^F	$\{\phi\}$	$\{\phi\}$	$\{\phi\}$

Table 2: Action Space of Proposer Countries Across FTA Subgames

posals for each country acting as the proposer. The set of proposals for country i is denoted as $S_i(g)$, where $\rho_i(g) \in S_i(g)$ denotes a proposal. Once a proposal $\rho_i(g)$ from country i is received, every recipient country j, part of the proposed agreement, offers a response $r_j(g, \rho_i(g)) \in \{Y, N\}$, where '$Y$' signifies acceptance and 'N' implies rejection. For each subgame within network g, the Markov strategy of country i should accomplish two primary tasks: (i) designate a proposal $\rho_i(g) \in S_i(g)$ for the stage where it serves as the proposer, and (ii) allocate a response $r_i(g, \rho_j(g)) \in \{Y, N\}$ to any potential proposal it might receive from another country j. We solve for a type of pure strategy Markov perfect equilibrium. Specifically, using backward induction, we find a pure strategy subgame perfect equilibrium where the current period's proposal by the proposer and the responses by the respondent depend only on the history through the network established at the end of the preceding period.

4 FTA formation Incentives and Tariff Binding Liberalization

In this section, we examine the driving forces behind the FTA formation when countries are bound by tariff bindings and cannot impose their optimal tariffs. In a dynamic model of FTA formation, the tension between myopic and farsighted incentives of the FTA outsider and FTA insiders creates the possibility of dynamic free riding and dynamic exclusion incentives. As a result, the equilibrium path of networks revolves around the dynamic free-riding incentive of an FTA outsider and the dynamic exclusion incentive of FTA insiders. These dynamic incentives heavily depend on the degree of economies of scale, the level of bound tariffs, and how patient the countries are.

Let $w_i(g)$ denote country i's welfare as a function of network g and $\Delta w_i(g' - g)$ represent the difference between country i's welfare under networks g_0 and g, where $g' = g + ij$ denotes the trade network that results when an FTA between countries i and j is added to the network g. In our dynamic model, incentives that involve a payoff comparisons in the current period and in the immediate next period are called *myopic incentives* that capture mainly short-run considerations. When governments

make payoff comparisons between the current period and periods beyond the immediate next period, we call these incentives *farsighted incentives*, which involve long-run considerations. Specifically, what are the myopic and farsighted considerations of an FTA outsider under a bilateral FTA? On one hand, myopically, an FTA outsider decides whether to become a spoke country under a hub-and-spoke agreement relative to being an outsider under a bilateral FTA. On the other hand, farsightedly, the decision of an FTA outsider is between becoming a spoke on the path to global free trade and remaining as an outsider. Similarly, an FTA insider myopically decides whether to become a hub country under a hub-and-spoke agreement relative to being an insider under a bilateral FTA, while farsightedly, the decision of an FTA insider is between becoming a hub on the path to global free trade and remaining as an insider.

4.1 Tariff Binding Liberalization

Given that countries are symmetric, we assume symmetric exogenous tariff binding, τ, which prevents countries from increasing their applied tariffs beyond this binding level. Based on our optimal tariff discussion in Section 2, Figure 2 illustrates the possible regions of exogenous tariff bindings that impose an upper constraint on applied tariffs under different scenarios of economies of scale. Consider the case of CRS first. The tariff binding is not applicable in the "No Binding Region", where the tariff binding τ is greater than optimal applied tariffs for all countries; this is expressed as $\tau > t_\phi > t_{ik}(g_{ij})$. This region is typically examined in existing PTA literature with optimal tariffs, which generally overlooks the existence of tariff bindings.[14] However, the tariff binding becomes relevant when $\tau < t_\phi$. In the "Outsiders Binding Region", where $t_{ik}(g_{ij}) < \tau < t_\phi$, FTA-outsiders are bound and consequently levy τ, which is lower than their optimal applied tariff t_ϕ or $t_{ki}(g_{ij})$. Finally, in the "Binding Region", where $\tau < t_{ik}(ij)$, all countries, including FTA-insiders and spokes under a hub-and-spoke regime, are bound by the tariff binding, and thus levy τ.

Now, let's consider the case of DRS. The tariff binding is not applicable in the "No Binding Region", expressed as $\tau > t_k(g_{ij})$ or $\tau > t_\phi > t_k(g_{ij})$. In the "Outsiders Binding Region", where $t_k(g_{ij}) > \tau > t(g_i^H)$, the FTA-outsider is bound, and thus, it imposes τ. When $t_k(g_{ij}) > t(g_i^H) > \tau > t_{ik}(g_{ij})$, both the FTA-outsiders and spoke countries are bound, and they impose τ that is lower than their optimal applied tariffs, which are $t_k(g_{ij})$ and $t(g_i^H)$ respectively. Finally, in the "Binding Region", where $\tau < t_{ik}(g_{ij})$, all countries are bound, and thus, they all impose τ.

In the case of IRS, the "No Binding Region" is expressed as $\tau > t_k(g_{ij}) > t_\phi$. In the "Outsiders

[14] Lake et al. (2020) [24] analyze the exogenous tariff bindings in the context of CRS only. In this paper, we extend their analysis via integrating flexible degrees of economies of scale.

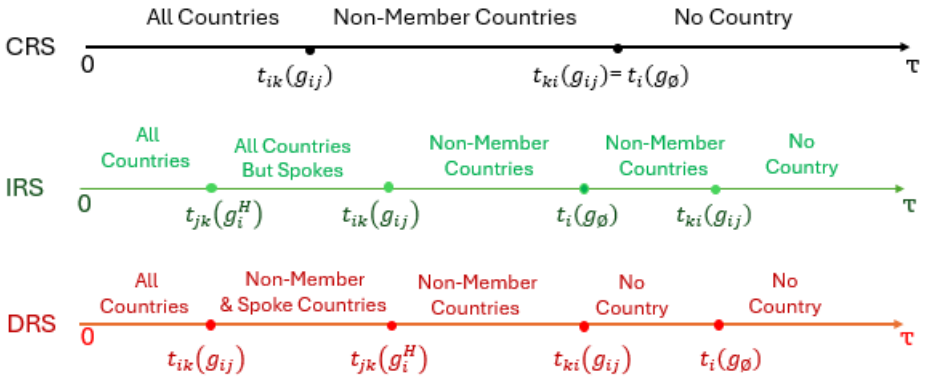


Figure 2: Tariff Binding Regions.

Binding Region", where $t_k(g_{ij}) > t_\phi > \tau > t_{ik}(g_{ij})$, the FTA-outsider is bound, and imposes τ. When $t_{ki}(g_{ij}) > t_{ik}(g_{ij}) > \tau > t(g_i^H)$, both FTA-outsiders and FTA-insiders are bound, but not spoke countries. Finally, in the " Binding Region", where $\tau < t(g_i^H)$, all countries are bound, and thus, they all impose τ that is lower than their optimal applied tariffs.

5 Equilibrium path

In this section, we explore the implications of different degrees of economies of scale along with tariff binding liberalization on the driving forces behind FTA formation in our analysis of the "FTA game. To this end, we compare continuation payoffs across different paths of FTA networks under the varying degrees of economies of scale and bound tariffs, uncovering tensions between myopic and farsighted incentives. This approach enables us to clarify how tariff-binding liberalization influences the equilibrium path of networks with different degrees of economies of scale.

5.1 Myopic and Farsighted incentives

Let country i's welfare as a function of network g with a given degree of economies of scale, δ be denoted as $w_i(g, \delta) \equiv w_i(g)$. Given δ, we define $\Delta w_i(g' - g)$ to represent the difference between country i's welfare under networks g and g', where $g' = g + ij$ denotes the trade network that results when an FTA between countries i and j is added to network g. The following lemma describes the myopic incentives:

Lemma 1. ***(Myopic Properties)*** *Given the degree of economies of scale, δ, we identify the following myopic incentives:*

(i) (Participation incentive): A country always benefits from becoming an FTA insider relative to an empty network: $\Delta w_i(g_{ij} - g_\phi) > 0$, $\forall \tau$.

(ii) (Attractiveness of being hub): An FTA insider always has an incentive to become the hub: $\Delta w_i(g_i^H - g_{ij}) > 0$,$\forall \tau$.

(iii) (Spoke-spoke FTA): Two spoke countries always have incentives to form the final FTA: $\Delta w_i(g^F - g_j^H) > 0$, $\forall \tau$.

(iv) (Myopic Free Riding Incentive): An FTA outsider does not benefit from becoming a spoke: $\Delta W_i(g_j^H - g_{jk}) < 0$ if and only if $\tau > \bar{\tau}_{OUT}$ where $\bar{\tau}_{OUT}^{\delta<0} < \bar{\tau}_{OUT}^{\delta=0} < \bar{\tau}_{OUT}^{\delta>0}$.

The first part of the above lemma highlights that two countries always have incentives to form a bilateral FTA under the empty network regardless of the level of tariff bindings. Each insider benefits from preferential access in each other's markets while facing the external tariffs that are below the optimal tariffs and remain unchanged due to tariff binding. Part (ii) of the above lemma informs that, regardless of the degree of economies of scale and level of tariff bindings, an FTA insider always has a myopic incentive to initiate another independent FTA to become the hub country, due to its sole preferential access in both spoke markets. Part (iii) argues that, once a hub-and-spoke regime is reached via FTAs, the two spoke countries would form the final FTA, leading to global free trade.

Now consider part (iv) of the above lemma that informs us that the formation of a bilateral FTA is not always advantageous for countries. If we consider the FTA outsider's perspective, we find that remaining as an outsider under a bilateral FTA can lead to higher welfare relative to becoming a spoke under a hub-and-spoke regime, but this holds only when the tariff binding exceeds a specific threshold for different types of economies of scale. The intuition can be explained as follows. An FTA outsider suffers discrimination in FTA insiders' markets, and forming an additional FTA and becoming a spoke can alleviate this bias in the hub's market. However, due to the tariff complementarity effect, we know that the outsider benefits from the reduced tariffs when exporting to the FTA insiders, and this effect deepens as the degree of economies of scale increases. When tariff binding is significantly large, the benefit from the tariff complementarity (weaker discrimination) exceeds the benefit from eliminating the preferential bias in the hub's market, leading to what is referred to as a myopic free-riding incentive for the FTA outsider. Conversely, as tariff binding decreases, myopic free-riding incentives disappear first

in IRS, then in CRS, and finally in DRS: $\bar{\tau}_{\text{OUT}}^{\delta<0} < \bar{\tau}_{\text{OUT}}^{\delta=0} < \bar{\tau}_{\text{OUT}}^{\delta>0}$. When production technology exhibits IRS, FTA insiders become more efficient, leading to higher protection incentives for the FTA outsider. By contrast, with CRS, such an efficiency effect for the FTA insiders disappears, and hence, an FTA outsider has a moderate protection incentive. Finally, with DRS, the efficiency effect for insiders gets reversed, leading to the lowest protection incentive for the FTA outsider.

We now turn to the farsighted incentives that play a crucial role in the formation of FTAs, as summarized in the following lemma:

Lemma 2. ***(Farsighted Properties)*** *Given the degree of economies of scale, δ, we identify the following farsighted incentives:*

(i) (Farsighted incentive to become a spoke): Countries always prefer global free trade relative to remaining as an FTA outsider: $\Delta W_i(g^F - g_{jk}) > 0$ for all τ.

(ii) (Attractiveness of being hub): A hub country is worse off under global free trade relative to the hub-and-spoke network: $W_i(g_i^H - g^F) > 0$ for all τ.

(iii) (Farsighted incentive to exclude): FTA insiders have incentives to exclude the FTA outsider from the global free trade network when the tariff binding is sufficiently low: $\Delta W_i(g^F - g_{ij}) < 0$ if and only if $\tau < \bar{\tau}_{IN}$ where $\bar{\tau}_{IN}^{\delta<0} < \bar{\tau}_{IN}^{\delta=0} < \bar{\tau}_{IN}^{\delta>0}$.

The first part of the above lemma informs us that an FTA outsider possesses a farsighted incentive to transition to a spoke, ultimately reaching global free trade, regardless of the degree of economies of scale and level of tariff binding. This desire is driven by the potential to counter the discrimination they face in the FTA insiders' markets. The discussion in the next section will further elucidate the tension between the FTA outsider's myopic incentive to free ride and its farsighted aspirations to expand the FTAs to global free trade. This tension plays a pivotal role in shaping the dynamic free riding incentives of an FTA outsider. The intuition behind part (ii) unfolds as follows: when spoke countries form the final FTA, the hub country loses its privileged market access in the export markets in spoke countries and thus it loses its hub status.

Furthermore, as stated in Lemma 1, FTA insiders always have a myopic incentive to become the hub under a hub-and-spoke regime. However, we also know that, once a hub-spoke network is established, the subsequent FTA formation between the spokes results in a global free trade network. Part (iii) of the above lemma informs us that, given the degree of economies of scale, FTA insiders have farsighted

incentives to permanently exclude the FTA outsider when the tariff binding is sufficiently small, that is, $\tau < \bar{\tau}_{IN}$. Intuitively, as tariff bindings decline, insiders face lower tariffs in the outsider's market. This lowers the incentive to give up the preferential access they enjoy in each other's market. Another critical observation is that the farsighted exclusion incentive first appears in the context of the IRS, followed by the CRS, and finally in the DRS. This result suggests that preferential access, combined with lower external tariffs in the outsiders' markets, enhances the efficiency gains and thus amplifies the exclusion incentives.

5.2 Subgames: Hub-and-Spoke and FTA Insider-Outsider Networks

We next determine the equilibrium path of networks within the FTA game via backward induction, starting with the subgame occurring at the hub-and-spoke network, g_i^H. This represents the final configuration of the network that countries can establish before attaining a global free trade network. Assuming that country i has established bilateral FTAs with both countries j and k, country j is positioned as the proposer and country k as the recipient in this subgame. The following lemma follows directly from Lemma 1(iii):

Lemma 3. ***(Subgame at a hub-and-spoke network)****: For all degrees of economies of scale, δ, in the subgame at a hub-and-spoke network g_i^H, spoke countries form the final FTA that leads to the global free trade network: $g_i^H \rightarrow g^F$.*

Continuing with our analysis using backward induction, we now shift our focus back to a preceding stage: a subgame at the FTA insider-outsider network, g_{ij}. This subgame enables us to analyze the tensions between myopic and farsighted incentives for both FTA outsiders and insiders, in the context of a flexible degree of economies of scale. When the tariff binding is sufficiently high, the FTA outsider has a myopic incentive to free ride. However, we also know, from Lemma 2, that the FTA outsider has a farsighted incentive to become a 'spoke', leading the way to global free trade. Turning our attention to FTA insiders, we know from Lemma 1 that FTA insiders always have a myopic incentive to become a 'hub' while they have farsighted incentives to exclude the outsider from the global free trade network when the tariff binding is sufficiently low. These conflicting incentives lead to dynamic free-riding incentives by the FTA outsider and dynamic exclusion incentives by FTA insiders. A key consideration here is how tariff-binding liberalization and different degrees of economies of scale can mediate these tensions. We first examine the balance between myopic and farsighted incentives from the perspective of the FTA outsider.

5.2.1 Dynamic Free Riding Incentive

We know from Lemma 2(i) that the FTA outsider always has an incentive to eliminate discrimination in both insiders market, and thus, have the farsighted incentive to form an FTA that ultimately leads to global free trade: $\Delta W_i(g^F - g_{jk}) > 0$ for all τ. However, Lemma 1(iv) highlights that the FTA outsider has a myopic free riding incentive when the tariff binding is sufficiently lax: $\tau > \bar{\tau}_{OUT}$ for all δ. Now consider how these incentives respond to tariff binding liberalization and how this response depends on the degree of economies of scale. With the reduction in tariff bindings, FTA outsiders' ability to impose tariff gets limited, and thus the myopic free riding incentive gets weaker. We find that the dynamic free riding incentive vanishes when tariff binding is sufficiently low: $\tau < \bar{\tau}_{OUT}$ for all δ. In that sense, both the discount factor β and the degree of economies of scale δ influence the FTA outsider's dynamic free-riding incentives, along with tariff binding liberalization. For any given degree of economies of scale δ:

$$W_k(g_i^H) + \frac{\beta}{1-\beta} W_k(g^F) > \frac{1}{1-\beta} W_k(g_{ij}) \Leftrightarrow \beta > \bar{\beta}^{OUT}(\tau) \equiv \left[1 + \frac{\Delta W_k(g^F - g_{ij})}{\Delta W_k(g_{ij} - g_i^H)}\right]^{-1} \tag{6}$$

Note first that when $\tau > \bar{\tau}_{OUT}$ holds for the given degree of economies of scale, the FTA outsider has a myopic incentive to free ride. Under such a case, the inequality in (6) fails to hold only when countries are sufficiently impatient. In such a case, the farsighted incentive to become a spoke on the path to global free trade is dominated by the myopic incentive to free ride, and thus a dynamic free riding incentive arises when $\beta < \bar{\beta}^{OUT}$. However, when the discount factor is sufficiently high and countries are sufficiently patient, $\beta > \bar{\beta}^{OUT}$, the FTA outsider's farsighted incentive to become a spoke on the path to global free trade dominates its myopic incentive, and thus the dynamic free riding incentive disappears. Note from Figure 3, that, regardless of the degree of economies of scale, starting from sufficiently high tariff bindings (suppose bound tariff is equal to optimal MFN tariff of the outsider: $\tau = t_k(g_{ij})$), tariff binding liberalization weakens the dynamic free riding incentives and then it completely disappears for moderate bound tariffs.

In order to understand the role of economies of scale in addressing how tariff binding liberalization affects the dynamic free riding incentive, we show that $\tau_{\text{OUT}}^{\delta<0} < \tau_{\text{OUT}}^{\delta=0} < \tau_{\text{OUT}}^{\delta>0}$ holds. It is immediate from Figure 3 that, as the bound tariffs decline, dynamic free-riding incentives disappear first in the IRS scenario, then in the CRS scenario, followed by the DRS scenario. We should also note that the dynamic free riding incentive is strongest when the production technology exhibits IRS and weakest when we have DRS for sufficiently high bound tariffs: $\tau = t_k(g_{ij})$. With tariff-binding liberalization,

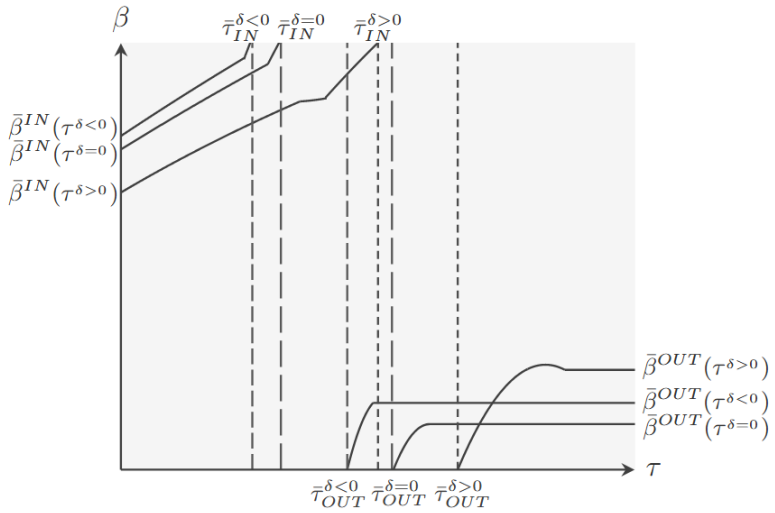


Figure 3: Dynamic Free Riding and Dynamic Exclusion Incentives: CRS, DRS, IRS

the efficiency gain due to IRS becomes highly effective, and thus the farsighted incentive to become a spoke on the path to global free trade quickly starts dominating the myopic incentive to free ride. As a result, the dynamic free-riding incentive disappears first under the IRS scenario compared to the CRS and DRS scenarios. These findings imply two important results. First, when the initial bound tariffs are sufficiently high, tariff binding liberalization facilitates the formation of FTAs, leading to global free trade, regardless of the degree of economies of scale. In other words, coupled with tariff-binding liberalization, FTA formation acts as a building block on the path to global free trade when the initial bound tariff rates are sufficiently high, as dynamic free-riding incentives are weakened. Second, this positive result is more likely to arise when the production technology exhibits economies of scale, since there is more to gain from efficiency from the FTA outsider's perspective.

Next, we turn our attention to FTA insiders and examine how the balance between myopic and farsighted incentives leads to dynamic exclusion incentives, and how tariff binding liberalization affects such incentives for different degrees of economies of scale.

5.2.2 Dynamic Exclusion Incentives

As outlined in detail in part (ii) of Lemma 1, an FTA insider always has a myopic incentive to become the hub country in a hub-and-spoke regime since having sole preferential access in spoke markets is always attractive. We also demonstrate that such incentives increase as the degree of economies of scale rises. However, FTA insiders also know that, once countries reach the hub-and-spoke regime, it would lead to global free trade. The question is whether FTA insiders prefer global free trade to a permanent FTA insider-outsider network. To address this, part (iii) of Lemma 2 informs us that, when the

bound tariffs are sufficiently low, FTA insiders have farsighted incentives to exclude the FTA outsider from the global free trade network. These incentives arise because FTA insiders face sufficiently low bound tariff rates in the FTA outsider's market, and thus, they do not want to share their preferential access with the FTA outsider. For dynamic exclusion incentives to arise, a farsighted incentive to exclude must exist and therefore, we focus on the range where $\tau < \bar{\tau}_{IN}$. One should note that, similar to the myopic incentive to become a hub, farsighted incentives also rise with the degree of economies of scale. For a given degree of economies of scale, FTA insiders prefer to engage in FTA formation that leads ultimately to global free trade, relative to being a permanent FTA insider if and only if the following holds:

$$W_i(g_i^H) + \frac{\beta}{1-\beta} W_i(g^F) > \frac{1}{1-\beta} W_i(g_{ij}) \Leftrightarrow \beta < \bar{\beta}^{IN}(\tau) \equiv \left[1 + \frac{\Delta W_i(g_{ij} - g^F)}{\Delta W_i(g_i^H - g_{ij})}\right]^{-1} \tag{7}$$

The above result informs us that, only when countries are sufficiently patient $\beta > \bar{\beta}^{IN}$ and bound tariffs are sufficiently low $\tau < \bar{\tau}_{IN}$, FTA insiders have dynamic exclusion incentives via refusing any subsequent FTA formation with the FTA outsider and thus permanent FTA insider outsider network arises rather than subsequent FTA formation leading to global free trade. As represented in Figure 3, as tariff binding liberalization happens, dynamic exclusion incentives arise first under IRS, followed by CRS and then DRS: $\bar{\tau}_{IN}^{\delta<0} < \bar{\tau}_{IN}^{\delta=0} < \bar{\tau}_{IN}^{\delta>0}$. Moreover, we also show in Figure 3 that dynamic exclusion incentive is more likely to arise under economies of scale relative to other scenarios: $\bar{\beta}^{IN}(\tau^{\delta>0}) < \bar{\beta}^{IN}(\tau^{\delta=0}) < \bar{\beta}^{IN}(\tau^{\delta<0})$. The intuition behind this result is as follows. FTA insiders reduce their external tariffs more significantly when there is IRS $(\delta > 0)$ while facing higher external tariffs in the FTA outsider's market when bound tariffs are high enough. However, as bound tariffs decline, the FTA outsider is limited in its ability to impose higher tariffs, enabling FTA insiders to extract larger export profits in the FTA outsider market without being involved in dynamic FTA expansion. Consequently, they refrain from transforming into a hub country and have incentives to enjoy preferential access in each other's markets. These incentives are larger under economies of scale since efficiency gains reinforce them. As a result, stronger dynamic exclusion incentives of FTA insiders arise relative to CRS and DRS scenarios.

The above findings suggest that when countries are sufficiently patient and bound tariffs are moderately high, tariff binding liberalization can hinder FTA formation, acting as a stumbling block to global free trade. In this scenario, a bilateral FTA would emerge in the equilibrium path rather than subsequent FTA formation leading to global free trade. More importantly, such an outcome is more likely to happen

if the production technology exhibits IRS relative to CRS and DRS. These results are contrary to our findings in the discussion of dynamic free riding incentives.

Our findings inform us that subsequent FTAs form between insiders and the outsider fail to occur only when the outsider has a dynamic free riding incentive or when insiders have dynamic exclusion incentives. The next Lemma summarizes these findings:

Lemma 4. *Consider a subgame at an FTA insider-outsider network g_{ij}. Then, given the degree of economies of scale, the equilibrium outcome in the subgame is:*

(i) If $\bar{\beta}^{OUT}(\tau) < \beta < \bar{\beta}^{IN}(\tau)$, then an FTA is established between the outsider and an insider, represented as $g_{ij} \rightarrow g_i^H$.

(ii) If $\beta < \bar{\beta}^{OUT}(\tau)$ or $\beta > \bar{\beta}^{IN}(\tau)$, then no FTA is formed between the outsider and an insider, represented as $g_{ij} \rightarrow g_{ij}$.

5.3 Subgame: Empty Network

Next, we move backward and examine the incentives, starting with the empty network g_ϕ. This way, the equilibrium outcome provides a complete path of networks. Key to this analysis are the dynamic free riding incentives of the FTA outsider and the dynamic exclusion incentives of FTA insiders. As highlighted above, both of these incentives heavily depend on the level of tariff bindings and the degree of economies of scale. Now, we need to establish that countries have incentives to participate in the FTA formation at the empty network g_ϕ, regardless of being an FTA insider or FTA outsider in the process. We know from the lemma 4 that FTA formation progresses towards global free trade, particularly when $\bar{\beta}^{\text{OUT}}(\tau) < \beta < \bar{\beta}^{\text{IN}}(\tau)$, for all δ. At the empty network g_ϕ, two additional dynamic properties emerge. First, a country being an insider and turning into a hub or spoke on the path consistently demonstrates a preference for the subsequent FTA formation relative to permanently staying at the empty network: $V_z(g_{ij}) > V_z(g_\phi)$ for $z \in \{i, j\}$ and for all δ. Given the benefits of tariff complementarity for an FTA outsider, a country may myopically prefer being an FTA outsider over an FTA insider. Nevertheless, we show that when FTAs lead to global free trade, a country's continuation payoff as an FTA insider-turned-hub exceeds that as an FTA outsider-turned-spoke. Intuitively, if a country participates in FTA expansion to achieve global free trade as an FTA outsider, then the myopic free riding incentive is sufficiently weak that the benefit of being the hub ensures it prefers being the FTA insider-turned-hub over being the

FTA outsider-turned-spoke. This leads to our second important finding for the participation constraint: a country exhibits a clear preference to transition from an FTA insider to a hub rather than moving from an FTA outsider to a spoke, given by $V_i(g_{ij}) > V_k(g_{ij})$, for all δ, [15] The following proposition summarizes our main result in the FTA game regarding the equilibrium path of networks.

Proposition 1. *Given the degree of economies of scale* (δ)*., the equilibrium path of networks in the FTA game is:*

(i) If $\bar{\beta}^{OUT}(\tau) < \beta < \bar{\beta}^{IN}(\tau)$*, then* $g_\phi \rightarrow g_{ij} \rightarrow g_i^H \rightarrow g^F$.

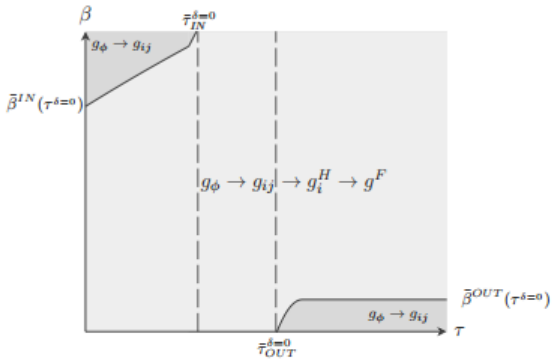
(ii) If $\beta < \bar{\beta}^{OUT}(\tau)$ *or* $\beta > \bar{\beta}^{IN}(\tau)$*, then* $g_\phi \rightarrow g_{ij}$.

As already established, the equilibrium path of networks revolves around the FTA outsider's dynamic free riding incentive and the FTA insiders' dynamic exclusion incentive. If neither the FTA outsider holds a dynamic free riding incentive (i.e. $\beta > \bar{\beta}_{OUT}(\tau)$) nor does an FTA insider hold a dynamic exclusion incentive (i.e. $\beta < \bar{\beta}_{IN}(\tau)$), the leader country a becomes the hub on a path of FTAs leading to global free trade. However, the leader country is a member of a permanent FTA in the presence of either an FTA outsider dynamic free riding incentive or an FTA insider dynamic exclusion incentive (i.e. $\beta \notin \left(\bar{\beta}_{OUT}(\tau), \bar{\beta}_{IN}(\tau)\right)$). Thus, these dynamic incentives drive the equilibrium. Figure 4 presents the equilibrium network paths for CRS, DRS, and IRS.

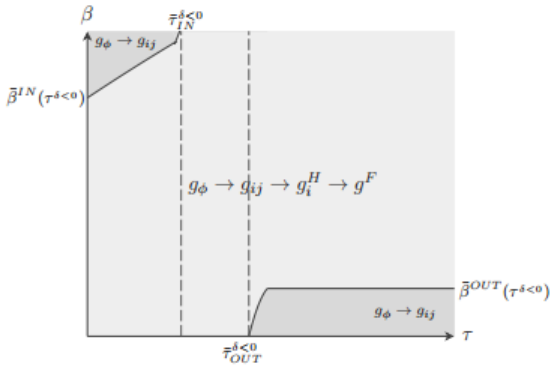
One subtle point emerges regarding the equilibrium path of networks. When $\tau > \bar{\tau}_{OUT}$, the tariff binding is so lax that the myopic free riding incentive is sufficiently strong that countries myopically prefer being an FTA outsider than an FTA insider. Thus, when FTA formation leads to global free trade, country j prefers being an FTA outsider-turned spoke over an FTA insider-turned-spoke. Indeed, if country j makes an FTA proposal in stage 2 of the protocol, the attractiveness of being the hub implies it proposes an FTA with country k and becomes the FTA insider-turned-hub. Hence, country j can credibly threaten to reject country i's FTA proposal (in stage 1a) knowing that such rejection will force country i to propose an FTA with country k (in stage 1b) and leave country j as the FTA outsider-turned-spoke. However, when FTA formation does not expand to global free trade, the non-economic benefits imply that country j proposes an FTA with country i if it makes an FTA proposal in stage 2. Hence, country j cannot credibly reject an FTA proposal from country i in stage 1a because it will eventually accept such a proposal.

Figure 3 shows how tariff-binding liberalization changes the incentives that constrain FTA formation from achieving global free trade. For sufficiently high tariff bindings $\tau > \bar{\tau}_{OUT}$, FTA insiders do

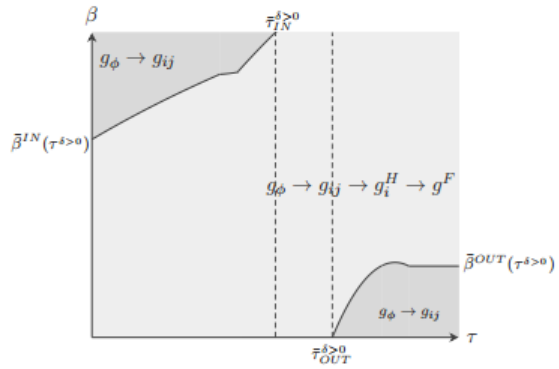
[15] This represents that the participation constraint always holds for the FTA insiders and FTA outsider.



(a) Constant Returns to Scale



(b) Decreasing Returns to Scale



(c) Increasing Returns to Scale

Figure 4: Equilibrium Paths of Networks

not hold an exclusion incentive because the FTA outsider's relatively high applied tariffs create strong incentives to form an FTA with the FTA outsider. In turn, a dynamic exclusion incentive does not exist. However, an FTA outsider holds a myopic free riding incentive. Forming an FTA is myopically unattractive for the FTA outsider because the relatively lax tariff bindings imply that it would give relatively large tariff concessions via FTA formation, but receive relatively small concessions due to the tariff complementarity practiced by FTA insiders. In turn, a sufficiently impatient FTA outsider holds a dynamic free-riding incentive and thus refuses to enter an FTA with an FTA insider. Ultimately, with relatively high tariff bindings, the dynamic free riding incentive constrains the attainment of global free trade.

However, as tariff bindings continually fall, the dynamic free-riding incentive eventually disappears, and the dynamic exclusion incentive now constrains the attainment of global free trade. Once the tariff binding falls below $\bar{\tau}_{OUT}$, the tariff binding constrains the FTA outsider such that its tariffs on the FTA insiders differ little from those imposed on the FTA outsider. This makes the discrimination faced by the FTA outsider more pronounced and eliminates any dynamic free-riding incentive. However, the relatively low tariff binding means that FTA insiders have already extracted substantial tariff concessions from the FTA outsider, which generates an exclusion incentive for FTA insiders. In turn, despite the myopic incentive to become the hub, a sufficiently patient FTA insider holds a dynamic exclusion incentive and thus refuses subsequent FTA formation with the FTA outsider. As a result, with relatively low tariff bindings, the dynamic exclusion incentive of FTA insiders constrains the attainment of global free trade.

Based on these forces constraining FTA expansion, we can now highlight the fundamental importance of multilateral tariff binding liberalization and the degree of economies of scale for the prospect of FTA expansion leading to global free trade. First, consider the scenario where global free trade would not be attained when tariff binding is sufficiently high due to dynamic free riding incentives, regardless of the degrees of economies of scale. Then, multilateral tariff binding liberalization facilitates FTA formation in achieving global free trade. This is more likely to happen when the production technology exhibits IRS relative to CRS and DRS. What if global free trade would be attained regardless of the degrees of economies of scale and tariff binding is in the intermediate range? In such a case, our results imply that multilateral tariff binding liberalization never facilitates but can impede FTA formation in achieving global free trade. This is more likely in the scenario where the industry exhibits IRS relative to CRS and DRS. Finally, when β lies in the intermediate range $\bar{\beta}^{\text{OUT}}(\tau) < \beta < \bar{\beta}^{\text{IN}}(\tau)$, tariff binding liberalization neither facilitates nor impedes FTA expansion to global free trade. These results highlight that the role of tariff binding liberalization in attaining global free trade heavily depends on the degree of economies of scale. Having a flexible degree of economies of scale generalizes the findings in the existing literature.

6 Concluding Remarks

Trade liberalization has progressed through two main channels since the start of GATT's periodic negotiations. These negotiations lead to MFN tariff concessions, where participating countries agree to "tariff bindings' that set upper limits on their applied MFN tariffs. Concurrently, the formation of

preferential trade agreements (PTAs) allows for discriminatory trade liberalization among a subset of WTO members, as permitted under GATT Article XXIV. These two mechanisms are closely connected, with their interplay heavily influenced by trade flows between countries, which, in turn, are affected by the degree of economies of scale.

Based on these observations, this paper explores the interaction between tariff binding levels, economies of scale, and the dynamic formation of FTAs. To this end, we deviate from optimal tariffs by assuming exogenous tariff bindings in an imperfectly competitive setting, and examine how tariff-binding liberalization, combined with flexible economies of scale, influences myopic and dynamic free-riding and exclusion incentives, which are crucial in shaping the equilibrium path of FTA formation.

Our findings indicate that, starting from sufficiently high tariff bindings, the dynamic free-riding incentives of the FTA outsider prevent the attainment of global free trade. We demonstrate that tariff-binding liberalization initially promotes FTA expansion toward global free trade by weakening these free-riding incentives and eventually eliminating them. This encouraging news regarding the effects of tariff-binding liberalization is more likely when industries exhibit economies of scale. However, when bound tariffs are at an intermediate level, tariff-binding liberalization begins to hinder the attainment of global free trade due to the emergence of dynamic exclusion incentives that intensify as tariff bindings decrease. This negative effect of tariff-binding liberalization is more pronounced in industries with economies of scale. These results highlight the crucial role of economies of scale and their interplay with tariff-binding liberalization in determining whether preferential trade agreements serve as stepping stones or obstacles to global free trade.

Although our primary focus in this paper is on tariff binding liberalization, it is crucial to understand that the implications of our findings are highly relevant in the broader context of current trade policy developments. Specifically, in a climate where trade tensions are escalating and countries are contemplating or implementing measures to raise applied tariffs—whether unilaterally or reciprocally—the importance of our results becomes even more evident. Our results indicate that the impact of these policy shifts on global trade dynamics depends on the degree of economies of scale exhibited by the industries.

7 Appendix

7.1 Baseline Trade Model

Let $\mathbf{t}$ be a tariff vector for all countries, such that $\mathbf{t} = (t_{ij}, t_{ik}, t_{ji}, t_{jk}, t_{ki}, t_{kj})$. The functions $p_i(\mathbf{t})$ and $x_{ij}(\mathbf{t})$ denote, respectively, the price level and export volume from country i to country j. Cournot

competition in all markets leads to the following prices and export volumes. Due to symmetry, we report only those for country i:

$$p_i(\mathbf{t}) = \frac{2\delta+2}{4(3\delta+2)}\sum_{z\neq i} t_{iz} - \frac{\delta}{4(3\delta+2)}\sum_{z\neq j} t_{jz} - \frac{\delta}{4(3\delta+2)}\sum_{z\neq k} t_{kz} + \frac{(12\delta+2)\alpha+6c}{4(3\delta+2)} \tag{A.1}$$

$$x_{ii}(\mathbf{t}) = \frac{1}{4(6\delta+1)(3\delta+2)}\left(2(\delta+1)(3\delta+1)\sum_{z\neq i} t_{iz} + \delta(18\delta+11)\sum_{z\neq j} t_{zi} - \delta(6\delta+5)(t_{jk}+t_{kj}) + 2(6\delta+1)(\alpha-c)\right) \tag{A.2}$$

$$x_{ij}(\mathbf{t}) = \frac{1}{4(6\delta+1)(3\delta+2)}\left(-\delta(6\delta+5)\left(\sum_{z\neq i} t_{iz} + t_{kj}\right) + \delta(18\delta+11)t_{ki} + 2(\delta+1)(3\delta+1)t_{jk} - 2\left((2\delta+1)(9\delta+4)-7\right)t_{ji} + 2(6\delta+1)(\alpha-c)\right) \tag{A.3}$$

let $g \in \{g_\phi, g_{ij}, \dots\}$ denote the network configuration. Utilizing the equilibrium price and export volume equations, we derive each country's welfare function and then solve for the welfare-maximizing tariffs. The optimal tariffs for country i under different networks are reported as follows:

$$t_i(g_\phi) = \frac{3(2\delta+1)(3\delta+1)(\alpha-c)}{2(\delta+1)(6(2\delta+1)(3\delta+1)-1)} \tag{A.4}$$

$$t_{ki}(g_{ij}) = \frac{3(2\delta+1)(3\delta+1)\left(2(27\delta+10)\left(2(2\delta+1)(3\delta+1)-1\right)+1\right)(\alpha-c)}{2(29376\delta^6+84240\delta^5+94608\delta^4+52552\delta^3+14996\delta^2+2057\delta+105)} \tag{A.5}$$

$$t_{ik}(g_{ij}) = \frac{3(2\delta+1)(3\delta+1)\left(3(2\delta+1)\left(2(2\delta+1)(4\delta+1)-2\right)+2\right)(\alpha-c)}{29376\delta^6+84240\delta^5+94608\delta^4+52552\delta^3+14996\delta^2+2057\delta+105} \tag{A.6}$$

$$t_{jk}(g_i^H) = \frac{6(2\delta+1)(3\delta+1)(6\delta+1)(\alpha-c)}{2232\delta^4+3948\delta^3+2354\delta^2+541\delta+42} \tag{A.7}$$

7.2 Proofs

Using the equilibrium expressions for prices, export volumes, and optimal tariffs derived above, we employ the welfare definitions introduced in Section 2 to compute the welfare levels under each regime. These welfare measures are used in the proofs that follow. The welfare functions depend on the network configuration and the degree of economies of scale, δ. The exogenous tariff binding is represented by τ, and the intertemporal discount factor by β.

Proof of Lemma 1

Using the optimal welfare levels under each regime and across different tariff-binding scenarios, the following results immediately follow:

$$\text{(i)} \quad w_i(g_{ij}) > w_i(g_\phi), \quad \forall\, \delta, \tau$$

$$\text{(ii)} \quad w_i(g_i^H) > w_i(g_{ij}), \quad \forall\, \delta, \tau$$

$$\text{(iii)} \quad w_i(g^F) > w_i(g_j^H), \quad \forall\, \delta, \tau$$

$$\text{(iv)} \quad w_i(g_j^H) < w_i(g_{jk}) \quad \text{if and only if} \quad \tau > \bar{\tau}_{OUT}, \quad \forall\, \delta$$

■

Proof of Lemma 2

Using the optimal welfare levels under each regime and across different tariff-binding scenarios, the following results immediately follow:

$$\text{(i)} \quad w_i(g^F) > w_i(g_{jk}), \quad \forall \delta, \tau$$

$$\text{(ii)} \quad w_i(g_i^H) > w_i(g^F), \quad \forall\, \delta, \tau$$

$$\text{(iii)} \quad w_i(g^F) < w_i(g_{ij}) \quad \text{if and only if} \quad \tau < \bar{\tau}_{IN}, \quad \forall\, \delta$$

■

Proof of Lemma 3

It follows immediately from part (iii) of Lemma 1.■

Proof of Lemma 4

Lemma 3 suggests that two spokes always have an incentive to form the final FTA. The following expression represents the dynamic trade-off faced by the FTA insider: $V_i(g_i^H) = W_i(g_i^H) + \frac{\beta}{1-\beta} W_i(g^F) > \frac{1}{1-\beta} W_i(g_{ij}) = V_i(g_{ij})$ provided that $\beta < \bar{\beta}^{\text{IN}}(\tau)$, for all δ. Similarly, dynamic trade-off faced by the FTA outsider is $V_k(g_i^H) = W_k(g_i^H) + \frac{\beta}{1-\beta} W_k(g^F) > \frac{1}{1-\beta} W_k(g_{ij}) = V_k(g_{ij})$ when $\bar{\beta}^{\text{OUT}}(\tau) < \beta$, for all δ. As a result, FTA formation leads to a hub-and-spoke regime on the path toward

global free trade, $g_{ij} \rightarrow g_i^H$, if and only if $\bar{\beta}^{\text{OUT}}(\tau) < \beta < \bar{\beta}^{\text{IN}}(\tau)$, for all δ. Otherwise, if $\beta < \bar{\beta}^{\text{OUT}}(\tau)$, the FTA outsider has no incentive to engage in FTA formation, and if $\beta > \bar{\beta}^{\text{IN}}(\tau)$, the FTA insider has no such incentive. As a result, the network remains at $g_{ij} \rightarrow g_{ij}$, for all δ.■

Proof of Proposition 1

Given the degree of economies of scale, δ, let's consider the infinitesimally small non-economic advantage, ϵ, achieved when countries j or k form an FTA with country i. By symmetry, country i also obtains this infinitesimal advantage when forming an FTA with j. Given Lemmas 1, 2 and 3: For an FTA-insider country i, if it is the preferred partner for another FTA insider, the equilibrium network transition is $g_{ij} \rightarrow g_i^H \rightarrow g^F$, subject to the condition $\bar{\beta}^{\text{OUT}}(\tau) < \beta < \bar{\beta}^{\text{IN}}(\tau)$ and a given δ. Conversely, the network remains stable at $g_{ij} \rightarrow g_{ij}$. **Stage 2:** Using Lemmas 1, 2 and 3, we can deduce: $g_{ij} \rightarrow g_i^H \rightarrow g^F$. Given this, consider two scenarios: First, for $\beta < \bar{\beta}^{\text{OUT}}(\tau)$ or $\bar{\beta}^{\text{IN}}(\tau) < \beta$ then Country j proposes an FTA with country i due to non-economic benefits, Country i accepts. Second, if $\bar{\beta}^{OUT}(\tau) < \beta < \bar{\beta}^{IN}(\tau)$ Country j proposes an FTA with country k. Country k accepts based on the implications of Lemmas $1(ii)$ and $2(ii)$ leads to $w_j(g_j^H) > w_j(g^F) > w_j(g_i^H)$ and, in turn, $V_j(g_{jk}) > V_j(g_{ij})$.

Stage 1b: For stage 2, for a given δ, let the equilibrium outcome be denoted by E. Then, $E = g_{ij}$ if the conditions $\beta < \bar{\beta}^{\text{OUT}}(\tau)$ or $\bar{\beta}^{\text{IN}}(\tau) < \beta$ are satisfied. Conversely, $\bar{\beta}^{\text{OUT}}(\tau) < \beta < \bar{\beta}^{\text{IN}}(\tau)$ holds under the alternative equilibrium path. Furthermore, under the conditions $\beta < \bar{\beta}^{\text{OUT}}(\tau)$ or $\bar{\beta}^{\text{IN}}(\tau) < \beta$, Country k's proposal is rejected at stage 1a, and we can represent the proposal function from Country i to Country j as the probability that Country i proposes and Country j accepts an FTA, which is equal to one. However, if Country j rejects at stage 1a and the stage 2 outcome is g_{ij}, then the probability that Country i proposes and Country j accepts is zero. In the case where $\bar{\beta}^{\text{OUT}}(\tau) < \beta < \bar{\beta}^{\text{IN}}(\tau)$ and Country j's proposal is rejected, the probability that Country i proposes and Country k accepts is one. Conversely, if under the same conditions Country k rejects Country i's initial offer at stage 1a, then the probability that Country j proposes and Country i accepts is zero.

Stage 1a: Given δ, consider the scenario where $\bar{\beta}^{OUT}(\tau) < \beta < \bar{\beta}^{IN}(\tau)$. Under these conditions, one can establish that, for any $z \in \{j, k\}$, $V_i(g_{iz}) > V_i(g_{jk})$. Referring to Lemma $1(i)$, it is given that $V_j(g_{ik}) < V_j(g_{ij})$ because of participation incentive. This incentive signifies that, due to the non-economic benefits that country a receives from j, country i is more likely to propose to j. Anticipating the formation of g_{ik} in stage 1b upon its rejection, country j will accept this proposal. On the other hand, in the converse scenario where $\beta < \bar{\beta}^{\text{OUT}}(\tau)$ or $\bar{\beta}^{\text{IN}}(\tau) < \beta$, country i proposes to j and owing

to the non-economic benefits, j accepts. This equilibrium transition for networks is represented as $g_\phi \rightarrow g_{ij} \rightarrow g_i^H \rightarrow g^F$ when $\bar{\beta}^{OUT}(\tau) < \beta < \bar{\beta}^{IN}(\tau)$. In any other case, the network transition follows the representation $g_\phi \rightarrow g_{ij}$ when $\beta < \bar{\beta}^{\text{OUT}}(\tau)$ or $\bar{\beta}^{\text{IN}}(\tau) < \beta$.■

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