Third-Country Effects in the Formation of Free Trade Agreements*

October 2008

Abstract

The proliferation of regional economic integration has resulted in a complex and continually expanding network of free trade agreements (FTAs). In explaining the formation of these agreements, the literature has generally focused on the effect of country-pair characteristics and ignored the role of existing FTA network. In this paper we investigate, both theoretically and empirically, how third countries affect nations' incentives to form new FTAs in various types of network. We find the effect varies significantly with the network architecture. Compared to an empty network where there is no FTA between countries, having an exclusive FTA with a third country raises a country's incentives to form new FTAs but weakens the incentives of others to reciprocate. A new FTA will therefore only be jointly supported when the country with exclusive FTA partners has a sufficiently large market size and high marginal cost of production. In a hub-and-spoke network, however, where two countries are mutually linked to a third country, the existence of the mutual FTA partner raises both nations' incentives to form an agreement leading to an unambiguous increase in the probability of jointly supported FTAs.

Key words: free trade agreements, network, exclusive network, hub-and-spoke network, third-country effect

JEL codes: F11, F12, F15

*We are very grateful to Dan Trefler and three anonymous referees for many valuable comments and suggestions.

1 Introduction

Multilateral trade liberalization has faced tremendous hurdles in the past decade because of the often competing and contradictory objectives of negotiating members. This has led many countries to seek alternative means of trade liberalization, mostly in the form of bilateral and plurilateral free trade agreements (FTAs). As shown in Figure 1(i), the number of preferential trade agreements (PTAs) rose continuously in the period of 1990–2005. In the year of 2004 alone, 23 PTAs entered into force, making it the most prolific PTA period in recorded history. Two important observations can be discerned from this trend. First, an increasing number of countries are participating in regional economic integration (Figure 1(ii)). Second, and perhaps more importantly, countries are integrating with an increasing number of partners (Figure 1(iii)). In 1990, each country had on average 3.6 preferential trade partners; that number rose to 20.5 in 2005.[1] This phenomenon has resulted in a complex and continually evolving network of FTAs where countries are interlinked to one another, either directly or via third countries.

[Figure 1 about here]

The goal of this paper is to examine the role of third countries in shaping the incentives of two countries to form new FTAs. Our paper shows that the effect of third countries depends crucially on the architecture of the FTA network. To draw out the third-country effect in a transparent manner, we focus on a three-country model.[2] There are three types of networks that are of interest in this case and are shown in Figure 2. We will be interested in country a and country b's incentives to form an FTA as a function of their links to the third country c. In Figure 2(i), we have an *empty network* where there is no FTA among countries. In Figure 2(ii), countries a and c are linked through an FTA and form an *exclusive network*.[3] Figure 2(iii) depicts the case of a *hub-and-spoke network* where country c has an FTA with both a and b but the latter two do not have an FTA with each other.[4] Our paper demonstrates, both theoretically and empirically, that countries a and b's incentives to form an FTA vary significantly across these three networks. Compared to the empty network, country a has stronger incentives to form an FTA with country b

[1] Baldwin (1999) has vividly described the enlargement of a regional trading bloc, one of the causes of the above observation, as a "domino" effect.

[2] The three-country model has been the standard formulation in the regionalism literature (see, for example, Krishna, 1998; Saggi, 2006). We also show in Appendix B that our results generalize to the $N > 3$ country case.

[3] An example of this network is the EU, U.S. and Canada where U.S. and Canada share an FTA (NAFTA) which excludes the EU.

[4] Incidentally this indicates that, unlike a customs union, FTAs can be non-transitive. Examples of hub countries include the EU, Chile, and Singapore, which have formed FTAs with a number of countries over time.

when it has an exclusive FTA with country c. The incentives for country b to reciprocate the FTA in this exclusive network are, however, strictly lower. An FTA will therefore only be jointly supported by a and b when a has a sufficiently large market size and high marginal cost of production relative to b. In the hub-and-spoke network, the incentives of a and b to form an FTA with each other are affected symmetrically by country c: both countries have greater incentives to link up with each other given the existence of a mutual FTA partner.

[Figure 2 about here]

We now place our work in the context of the existing literature. A large body of theoretical and empirical literature has been devoted to the analysis of preferential trade agreements.[5] One main strand of the theoretical literature focuses on the economic impacts of FTAs (e.g., Bond *et al.*, 2004; Bond and Syropoulos, 1996; Frankel, 1997; Krugman, 1991; Yi, 1996; Yi, 2000). Another important strand addresses the relationship between FTAs and multilateral trade liberalization, in particular, whether FTAs constitute building or stumbling "blocs" towards the latter (e.g., Bhagwati and Panagariya, 1996; Levy, 1997; Ethier, 1998; Krishna, 1998; Freund, 2000; Saggi, 2006; Ornelas, 2005a; Ornelas, 2005b; Aghion, Antras and Helpman, 2007).[6] Our paper complements these two strands of the literature by emphasizing the interdependent nature of the FTA networks and, in particular, the role of third countries in stimulating or dampening countries' incentives to form new FTAs.[7]

The empirical literature on PTAs has been relatively concentrated on evaluating the agreements' ex-post impact on trade flows and has only recently been expanded in two main directions. The first direction is led by the contributions by Limao (2006) and Estevadeordal, Freund and Ornelas (2008), who formally test the debate on whether FTAs constitute building or stumbling blocs towards multinational trade liberalization. By estimating the effect of PTA participations on the level of MFN tariff rates, these studies find mixed evidence.

[5] Krishna (2004) provides an excellent survey of this literature.

[6] Some studies, including Goyal and Joshi (2006) and Furusawa and Konishi (2007), have also sought to characterize the architecture of equilibrium FTA networks and show that global free trade can arise as an equilibrium. Similar to these studies, we are interested in the architecture of FTA network. But instead of characterizing equilibrium networks, we focus on the impact of any given architecture on countries' incentives to sign FTAs.

[7] The recent theoretical work by Aghion, Antras and Helpman (2007) also addresses the potential externalities that can arise in the sequential negotiation of FTAs. They focus, however, on how the structure of coalition externalities shapes countries' choice between sequential and multilateral bargaining. Their results indicate that the leading country strictly prefers sequential bargaining when the coalition externalities are negative in at least one of the follower countries and multilateral bargaining when the coalition externalities are positive in both follower countries.

The other major development is marked by the studies of Baier and Bergstrand (2004) and Magee (2003), who have taken the first step to estimate the economic determinants of FTAs.[8] Both these papers find that trade creation is one of the main motives for countries to form FTAs.[9] In particular, they show that countries with relatively similar market size, similar factor endowments and geographic proximity are more likely to have FTAs in place. These results shed light on the economic characteristics that play a significant role in countries' selection of preferential trade partners. What they do not capture, however, is the dynamic and cross-country interdependence in the FTA network. First, by examining countries' *status of sharing* an FTA based on characteristics that do not significantly change over time, these studies do not take into account the evolving nature of the FTA network. The possibility that past FTAs can affect countries' future incentives to form FTAs has not been considered. Second, these analyses have mainly focused on the effect of country-pair characteristics. The role of third countries, in particular, those that have existing preferential trade relationships with the country pair, has not been taken into account. In this paper, we seek to extend these studies by introducing a dynamic network effect and estimating the extent of externalities exerted by third countries on the formation of new FTAs.

We first show analytically that when countries are part of an exclusive network, the country that is linked to a third country has stronger incentives to form new FTAs than the case of an empty network. This is because the FTA with the third country — and the consequent increase in imports from there — reduces the country's potential profit loss at home as compared to the case of an empty network. It also diverts the country's trade away from others and therefore decreases the country's potential tariff revenue loss when it forms additional agreements. The effect of the third country on other countries' incentives to reciprocate the FTA is, however, the opposite. While it increases the other countries' loss of being excluded from preferential treatment, it also dilutes their potential profit gain from forming the agreement. The latter effect has been labeled by Ethier (1998) as the *concession diversion* effect. An FTA will therefore only be jointly supported in an exclusive FTA network when the country with exclusive FTA partners has a sufficiently large market size and high marginal cost of production.

This result is confirmed by the empirical evidence. Based on a panel data that covers 80 countries (3160 country pairs) and 15 years (1991-2005), we estimate country pairs'

[8] See Baier, Bergstrand and Egger (2007) for a comprehensive discussion on the causes and consequences of regionalism.

[9] Baier and Bergstrand (2004) also examine whether country pairs' incentive to avoid trade diversion is present in their decision to form an FTA and find supporting evidence.

decision to form an FTA in a given period.[10] Our empirical results suggest that exclusive FTA networks exert on balance a significant and positive effect on countries' probability to form an FTA. This is especially true when the country that is linked to third countries has a relatively large market size and production cost. The positive effect exerted by the exclusive networks also increases with the third countries' marginal cost of production — when they cause a smaller concession diversion effect.

We also examine two countries' incentives to form an FTA in a hub-and-spoke network where they are mutually connected to a third country. We find, both theoretically and empirically, that the incentives are strengthened by the existence of a mutual FTA partner. In contrast with the exclusive FTA network where the third country poses opposing effects on the country pair, it affects them in a symmetric fashion here. While it dilutes the spoke countries' potential profit gain in each other's market after they form an FTA, it also shares their loss in the home market. According to both theory and empirics, the latter effect outweighs the former leading to a positive net effect on countries' probability to link up.

We address two potential econometric concerns that may arise in the paper: omitted variables and the causality between existing and future FTAs. To reduce the bias from omitted variables, we include both country-time and country-pair fixed effects in the estimations. The former controls for all time-variant country-specific factors such as countries' international trade policy at a certain time while the latter takes into account all country-pair specific characteristics such as colonial ties. The results remain largely robust. To establish the causal effect of existing FTAs, we propose two strategies: a quasi-natural experimental approach and a propensity-score matching method. In the former, we limit the analysis to consider only the effect of plurilateral trade agreements on the probability of two countries forming a bilateral FTA. The motivation is that, relative to bilateral FTAs, it is less likely that the decision to form a plurilateral agreement, such as the ASEAN, is determined by an individual country's FTA agenda. We also use a propensity-score matching method to address the causal effect of hub-and-spoke networks, in particular, the possibility that a country strategically forms an FTA with another country's partner in the hopes of linking up with that country in a later period. To do so, we match country pairs based on their propensity of sharing a mutual FTA partner and compare their decisions to form an agreement in a later period. We find these sensitivity analyses do not change the estimated effects of FTA networks significantly.

To examine how well our estimates predict the data, we obtain the fitted probabilities of two countries forming an FTA at a particular point of time. 59% of the 304 pairs that

[10] It is worth noting that both Baier and Bergstrand (2004) and Magee (2001) examine whether country pairs have an FTA in place by a particular point of time using cross-sectional data.

formed an agreement between 1991 and 2005 are successfully predicted by our empirical model. The results also suggest that 4% of the 2313 country pairs that did not have an FTA by 2005 would derive a sufficient welfare gain from forming one. In fact, we notice that 32% of these 94 country pairs have already either signed an FTA in 2006 or entered negotiations.

The rest of the paper is organized as follows. Section 2 develops a theoretical model and examines countries' incentives to form an FTA in different types of network. Section 3 describes the data used in the empirical analysis. Section 4 outlines the main hypotheses derived from the model and discusses the respective econometric results. Section 5 presents the sensitivity analysis. Section 6 interprets the results. The paper concludes in Section 7.

2 The model

2.1 Basic framework

In this section, we develop a model that is fairly standard in the regionalism literature and has been adopted in a number of studies including Krishna (1998), Freund (2000), Ornelas (2005), Saggi (2006) and Goyal and Joshi (2006). The model considers three countries, $\{a, b, c\}$, and two homogeneous goods, x and y. Both goods are produced with constant returns to scale technologies, but one in an oligopolistic market (x) and the other under perfect competition (y). The perfectly competitive good (y) is freely traded across countries and serves as the numeraire. Consumers' preferences over the two goods are represented by a quasilinear utility function, $U_i(X_i, Y_i) = u_i(X_i) + Y_i$, where X_i and Y_i denote, respectively, the aggregate consumption of good x and good y in country i. Assuming $u_i(X_i)$ has a quadratic form, this utility function generates a linear demand function for good x, $P_i(X_i) = \alpha_i - X_i$, where $P_i(X_i)$ is country i's inverse demand.

There is one firm in each country (also indexed by $i \in \{a, b, c\}$) that produces good x.[11] These firms pay a constant (and strictly positive) marginal cost γ_i to produce each unit of x, which we assume can differ across countries. They also pay unit specific trade costs, including both transport cost and tariff, when they export to foreign countries. We let τ_j^i and T_j^i represent, respectively, the level of transport cost and tariff required to export one unit of x from country i to country j where $\tau_i^i = 0$ and $T_i^i = 0$. We assume that the transport cost is symmetric within each pair of countries, i.e., $\tau_j^i = \tau_i^j$, while tariffs can be asymmetric between two countries. We also assume that the tariff level is non-prohibitive

[11] It may be noted that the assumption of one firm is made for analytical convenience. Our results would be equally valid if each country had a fixed number of firms (see also Goyal and Joshi, 2006, Section 3.1.2). The main idea is that there exist barriers to entry for new firms.

and, as a result, firms from each country compete in all three markets.

Under the most-favored-nation (MFN) clause, each country sets a non-discriminatory tariff, T_i, on all trading partners unless there is a bilateral free trade agreement. When that is the case, tariffs fall to zero between the participating members. The existence of an FTA between i and j is denoted by $g_{ij} = 1$ while $g_{ij} = 0$ means that no FTA is in effect. Formally, $T_i^j = T_i > 0$ if $g_{ij} = 0$ and $T_i^j = 0$ if $g_{ij} = 1$. We also note that $g_{ii} = 1$ for each country i and $g_{ij} = g_{ji}$ for each pair of i and j.

Following Goyal and Joshi (2006) and Furusawa and Konishi (2007), we adopt the notion of a *network*, $g = \{g_{ij}\}$, to describe the FTAs that exist in the considered set of countries $\mathcal{N} \equiv \{a, b, c\}$. In particular, we define a network as an empty network g^e when $g_{ij} = 0$ for all $i, j \in \mathcal{N}$ and a complete network g^c when $g_{ij} = 1$ for all $i, j \in \mathcal{N}$. We also let $\mathcal{N}_i(g) = \{j \in \mathcal{N} : g_{ij} = 1\}$ denote the set of countries, including i, with whom i has an FTA and $n_i(g)$ denote the cardinality of this set.

Now let us consider firms' behavior in a given network g. We assume in this model that firms compete in a Cournot fashion and treat each country as a separate market. Given these assumptions, firms from each country, say i, maximize their profit for each market given by

$$\begin{aligned} \pi_i^i(g) &= [P_i(g) - \gamma_i]\, x_i^i(g) \\ \pi_j^i(g) &= \left[P_j(g) - \gamma_i - \tau_j^i - T_j^i(g)\right] x_j^i(g), \end{aligned} \tag{1}$$

choosing the quantity to supply the market, i.e., $x_i^i(g)$ and $x_j^i(g)$. This yields

$$\begin{aligned} x_i^i(g) &= \frac{1}{4}\left[\alpha_i - 3\gamma_i + \sum_{k \in \mathcal{N}\setminus\{i\}} \left(\gamma_k + \tau_i^k + T_i^k(g)\right)\right] \\ x_j^i(g) &= \frac{1}{4}\left[\alpha_j - 3\left(\gamma_i + \tau_j^i + T_j^i(g)\right) + \sum_{k \in \mathcal{N}\setminus\{i\}} \left(\gamma_k + \tau_j^k + T_j^k(g)\right)\right] \end{aligned} \tag{2}$$

as the Nash equilibrium output level, with i's aggregate output given by $X^i(g) = x_i^i(g) + \sum_{j \in \mathcal{N}\setminus\{i\}} x_j^i(g)$. Firms' Nash-equilibrium profits from their home and export markets can also be written, respectively, as $\pi_i^i(g) = \left[x_i^i(g)\right]^2$ and $\pi_j^i(g) = [x_j^i(g)]^2$ for $j \in \mathcal{N}\setminus\{i\}$.

It is easy to see that firms earn a greater profit at home when their home countries raise the tariffs on foreign firms, i.e., $d\pi_i^i(g)/dT_i^j(g) > 0$, and a lower profit abroad when the foreign countries do so, $d\pi_j^i(g)/dT_j^i(g) < 0$. But if the foreign country only raises the tariff on the third country, say k ($k \neq i, j$), and keeps the tariff rates on the other countries constant, then all firms, except those from country k, will experience an increase in profits, i.e., $d\pi_j^i(g)/dT_j^k(g) > 0$ ($k \neq i, j$).

Next we consider the consumers. The aggregate consumption of country i is given by $X_i(g) = x_i^i(g) + \sum_{j \in \mathcal{N} \setminus \{i\}} x_i^j(g)$, where $x_i^i(g)$ is defined in equation (2) and $x_i^j(g) = [\alpha_i - 3(\gamma_j + \tau_i^j + T_i^j(g)) + \sum_{k \in \mathcal{N} \setminus \{j\}} (\gamma_k + \tau_i^k + T_i^k(g))]/4$. Given the inverse demand function $P_i(X_i)$, country i's consumer surplus is characterized as $CS_i(g) = X_i(g)^2/2$. It is clear that consumer surplus is a decreasing function of home-country tariffs, i.e., $dCS_i(g)/dT_i^j(g) < 0$, as tariffs reduce the total quantity of supply and raise the price of the consumption good.

Now consider countries' total welfare function in a given FTA network g. The welfare of country i is the sum of consumer surplus, producer profits and tariff revenue, i.e.,

$$W_i(g) = CS_i(g) + \sum_{j \in \mathcal{N} \setminus \{i\}} \left[\pi_i^i(g) + \pi_j^i(g)\right] + \sum_{j \in \mathcal{N} \setminus \{i\}} \left[T_i^j x_i^j(g)\right] \tag{3}$$

Let $g + g_{ij}$ denote the network obtained by replacing $g_{ij} = 0$ in network g with $g_{ij} = 1$ and $g - g_{ij}$ denote the network obtained by replacing $g_{ij} = 1$ in network g with $g_{ij} = 0$. In any network g, two countries i and j have incentives to form an FTA with each other if

$$W_i(g + g_{ij}) > W_i(g) \quad \textit{and} \quad W_j(g + g_{ij}) > W_j(g).$$

Similarly, a country i has an incentive to unilaterally delete an existing FTA with another country j if

$$W_i(g) < W_i(g - g_{ij}).$$

In the following subsections, we examine countries' incentive to form an FTA in various types of FTA networks. In particular, we identify the parametric conditions in each network under which countries a and b have strict incentives to enter into an FTA. We then compare these conditions across networks. This comparison permits us to evaluate how a and b's incentives to form an FTA vary between empty and non-empty networks, and the role of the third country in influencing these incentives in different network architectures.

2.2 Empty network

We begin with the empty network. In an empty network, two countries (say i and j) will be willing to form an FTA if

$$W_i(g^e + g_{ij}) > W_i(g^e) \quad \text{and} \quad W_j(g^e + g_{ij}) > W_j(g^e). \tag{4}$$

Given equations (1)-(3), these conditions are equivalent to

$$\begin{aligned} & \frac{[X_i(g^e+g_{ij})]^2}{2} + \left[x_i^i(g^e+g_{ij})^2 + x_j^i(g^e+g_{ij})^2\right] + T_i x_i^k(g^e+g_{ij}) \\ > \quad & \frac{[X_i(g^e)]^2}{2} + \left[x_i^i(g^e)^2 + x_j^i(g^e)^2\right] + T_i[x_i^j(g^e) + x_i^k(g^e)], \end{aligned} \tag{5}$$

for country i (and analogously for country j). Note, as reflected in the above inequality, i and j's FTA will not affect their export profit in the third country because of market segmentation; it will, however, affect i and j's consumer surplus, profits in both the home and partner country, and tariff revenue. It is not difficult to see that, as a result of increase in aggregate consumption, i and j's consumer surplus will be unambiguously higher after they enter into an FTA. Their producer surplus, however, can move either way as their firms gain in the export market but lose at home. It will only increase relative to the empty network when firms' profit gain in the export market offsets their loss at home. Finally, tariff revenue will unambiguously fall after the formation of an FTA.

Now define:

$$\psi_{ij} \equiv \frac{6T_j(\alpha_j + \gamma_k - 3\tau_i^j + \tau_j^k - T_j/2) - T_i(3\alpha_i + 7\gamma_k - 9\tau_i^j + 7\tau_i^k + T_i/2)}{18T_j - T_i}, \tag{6}$$

and $\varphi_{ij} \equiv (6T_j + 9T_i)/(18T_j - T_i)$. Simplifying expression (5) gives us the following result:

Lemma 1 *In an empty network, countries a and b will form an FTA only if*

$$\gamma_a < \psi_{ab} + \varphi_{ab} \cdot \gamma_b \quad \textit{and} \quad \gamma_b < \psi_{ba} + \varphi_{ba} \cdot \gamma_a. \tag{7}$$

This indicates that, holding everything else constant, country i will have an incentive to form an FTA with j only if its marginal cost of production is below some threshold value defined (as an affine function) with respect to j's marginal cost. This is analogously true for j. It is easily verified that (7) will be satisfied if the two countries are relatively similar in terms of their marginal costs. Therefore two countries with relatively similar marginal costs will have strict incentives to jointly support an FTA.

Examining the expression of the threshold value also permits us to evaluate the role of the other parameters in countries' decision to form an FTA. For example, a country's incentive to form an FTA increases with the partner country's market size but decreases with its own. As a result, countries with similar market sizes are more likely to enter into an FTA. Transport cost also enters (7). As seen from (6), when T_i and T_j are sufficiently similar ($T_j/2 < T_i < 2T_j$) countries with a lower transport cost are more likely

to experience a welfare increase from an FTA and are therefore more likely to enter into an agreement. This result has been labeled in the literature as the "natural trading partner" hypothesis and is one of the key implications from Krugman (1991b) and Frankel et al. (1995, 1996, 1998).

The effect of third-country characteristics is ambiguous here. While a low-cost third country can adversely affect a country's potential profit gain in the export market after forming an FTA, it can also share a greater amount of profit loss at the country's home market. Only when the latter effect outweighs the former will the two countries' incentives to form an FTA rise with a more efficient third country.

2.3 Exclusive network

Let us now consider an exclusive network, $g^s = g^e + g_{ac}$, where there exists a single FTA between a and c. Similar to section 2.2, we are interested in countries a and b's incentives to form a new agreement starting from this network. If a and b decide to enter into an FTA, the underlying network becomes the hub-and-spoke network $g^e + g_{ac} + g_{ab}$, where a is the hub and b and c are the two spokes. If a and b choose not to link up, the network remains as g^s and a and b continue to impose MFN tariffs on each other.[12]

For a and b to move from g^s to $g^s + g_{ab}$, a and b should both benefit from forming an FTA in network g^s. This requires:

$$W_a(g^e + g_{ac} + g_{ab}) > W_a(g^e + g_{ac}) \quad \text{and} \quad W_b(g^e + g_{ac} + g_{ab}) > W_b(g^e + g_{ac}). \tag{8}$$

Note because $W_a(g^e + g_{ac})$ must be greater than $W_a(g^e)$ for a to have an FTA with c, the first condition in (8) also ensures that a is strictly better off as a hub country in network $g^s + g_{ab}$ than in the empty network g^e, i.e., $W_a(g^e + g_{ac} + g_{ab}) > W_a(g^e)$.

Given equations (1)-(3), simplifying (8) gives us the following result:

Lemma 2 *In an exclusive network $g^s = g^e + g_{ac}$, countries a and b will form an FTA only if*

$$\gamma_a < \psi_{ab} + \varphi_{ab} \cdot \gamma_b + \mu_a(g^s) \quad \textit{and} \quad \gamma_b < \psi_{ba} + \varphi_{ba} \cdot \gamma_a + \mu_b(g^s), \tag{9}$$

where $\mu_a(g^s) \equiv 11T_a^2/(18T_b - T_a)$ and $\mu_b(g^s) \equiv -6T_a^2/(18T_a - T_b)$.

[12] In this and the next sub-section, we assume countries have constant MFN tariff rates. This assumption is relaxed in Appendix A where we allow countries to endogenize their MFN tariff rates in different FTA networks. As to be shown, the results remain qualitatively similar given the setup of this model. We first present the predictions obtained based on the assumption of constant MFN tariff as they help us establish the direct effect of existing FTAs, i.e., how the existing FTAs affect countries' incentives to form new agreements by raising countries' imports from third countries. We then compare this effect in Appendix A with those that are channeled through MFN tariffs.

Once again, the interpretation is similar to that in section 2.2: a country will find it profitable to form an FTA if its marginal cost is below some threshold defined with respect to the partner's marginal cost. The new additive term $\mu_i(g^s)$ in the threshold captures the effect of the third country in an exclusive FTA network on i's incentive to form an FTA. It is clear that the parametric range in which country a is willing to form an FTA with country b is unambiguously larger when starting from network g^s than starting from the empty network (indicated by $\mu_a(g^s) > 0$). The range for b to reciprocate the FTA is, however, unambiguously smaller (indicated by $\mu_b(g^s) < 0$). These points are illustrated in Figure 3. In an empty network, a will enter into an FTA with b only if b's marginal cost is above AA whereas country b will do so only if its marginal cost is below BB. An FTA will therefore be supported by both countries only if the combination of their marginal costs is located between the two lines. In an exclusive network where a already has an FTA with c, both of these lines shift downward. The area that supports the FTA becomes $A'A'OB'B'$.

[Figure 3 about here]

This gives us the following proposition:

Proposition 1 *Country a's incentive to form an FTA with country b is strictly greater in network $g^s(= g^e+g_{ac})$ than in network g^e whereas country b's incentive to reciprocate the FTA is strictly smaller.*

The intuition is straightforward. For country a, the existing FTA with c — and the consequent increase in imports from c — will not affect a's profit gain in b's market (after a links up with b) but will reduce a's potential profit loss at home as compared to the empty network. Furthermore, as a's FTA with c diverts a's trade away from b, the tariff revenue a would lose when it eliminates tariff on b becomes smaller. Given these considerations, a has a greater incentive to form a free trade agreement with b in network g^s.[13]

The effect of a and c's FTA on country b is different. On the one hand, it diverts trade away from b and increases b's loss of being excluded from preferential treatment in both a and c's markets. But on the other hand, it also decreases b's welfare gain from forming the FTA with either a or c by diluting b's potential profit gain in these markets. This is the "concession diversion" effect that has been addressed in Ethier (1998). In our model, the latter effect dominates the former, suggesting that country b's incentive

[13] This result has been anticipated by Krishna (1998), who points out that an FTA is more likely to gain political support when there is a greater volume of imports from third countries.

to form an FTA with a (or c) unambiguously falls in the exclusive network. Therefore, for b to agree to link up, a must have a sufficiently large market size and b must have a sufficiently small marginal cost and low transport cost to export to country a.

To complete the discussion, recall we have shown that country a is strictly better off in network $g^s + g_{ab}$ than in the empty network. Now let us examine country c's welfare in the new network. We find that when

$$\gamma_c < \psi'_{ca} + \varphi'_{ca} \cdot \gamma_a, \tag{10}$$

where $\varphi'_{ca} \equiv (4T_a + 9T_c)/(12T_a - T_c)$ and $\psi'_{ca} \equiv 4T_a(\alpha_a + \gamma_b - 3\tau_a^c + \tau_a^b + T_a) - T_c(3\alpha_c + 7\gamma_b - 9\tau_c^a + 7\tau_c^b + T_c/2)/(12T_a - T_c)$, country c would also be strictly better off in $g^s + g_{ab}$ than in the empty network g^e, i.e., $W_c(g^e + g_{ac} + g_{ab}) > W_c(g^e)$. Condition (10) essentially requires country c's marginal cost to be sufficiently low relative to country a and can be satisfied while we preserve (9).[14]

2.4 Hub-and-spoke network

Suppose the current FTA network is $g^h = g^e + g_{ac} + g_{bc}$ where there are two FTAs, one between a and c and the other between b and c. Country c is the hub of the network; a and b are the two spokes. We examine a and b's incentive to form an FTA, upon which we move from g^h to a complete network g^c.

For countries to move from g^h to g^c, both a and b should benefit from forming a bilateral free trade agreement, i.e.,

$$W_a(g^c) > W_a(g^e + g_{ac} + g_{bc}) \quad \textit{and} \quad W_b(g^c) > W_b(g^e + g_{ac} + g_{bc}). \tag{11}$$

Given equations (1)-(3), simplifying these conditions leads us to the following result:

Lemma 3 *In a hub-and-spoke network $g^h = g^e + g_{ac} + g_{bc}$, countries a and b will form an FTA only if*

$$\gamma_a < \psi_{ab} + \varphi_{ab} \cdot \gamma_b + \mu_a(g^h) \quad \textit{and} \quad \gamma_b < \psi_{ba} + \varphi_{ba} \cdot \gamma_a + \mu_b(g^h), \tag{12}$$

where $\mu_i(g^h) \equiv (11T_i^2 - 6T_j^2)/(18T_j - T_i)$ $(i \neq j,\ i, j = a, b)$.

[14] Note this condition also ensures network $g^s + g_{ab}$ to be a subgame-perfect equilibrium in settings where we allow countries to have farsighted view of network formation. In other words, it ensures that country c has incentives to form an FTA with a even when it foresees the FTA between a and b. Such farsighted network formation games have been considered by Dutta *et al.* (2005) and pose a promising area for future research on regionalism.

Note the term $\mu_i(g^h)$ differs from $\mu_i(g^s)$ and captures the effect of the third country in a hub-and-spoke network on a and b's incentives to form a link. When T_a and T_b are sufficiently similar, i.e. $(\sqrt{6}T_a/\sqrt{11} < T_b < \sqrt{11}T_a/\sqrt{6})$, $\mu_i(g^h) > 0$ suggesting that the parametric space for countries a and b to form an FTA is unambiguously greater in the hub-and-spoke network than in the empty network.[15] This point is illustrated in Figure 4. Lines AA and BB, which represent respectively the two conditions in (7), shift outward in a hub-and-spoke network as compared to an empty network. This shift expands the parametric space in which an FTA is supported by both a and b to the area $A''A''OB''B''$.

[Figure 4 about here]

These results lead us to our next hypothesis:

Proposition 2 *Countries a and b's incentives to form an FTA are strictly greater in network $g^h(= g^e + g_{ac} + g_{bc})$ than in network g^e.*

Note in contrast with exclusive network where the third country c exerts contrary effects on a and b, c affects a and b in a symmetric fashion here. First, by having preferential market access to both a and b, c reduces the two countries' trade with each other. This trade diverting effect raises a and b's incentives to enter into an FTA and boost the trade between them. It also decreases a and b's potential tariff revenue loss when they form an FTA with each other. Third, c's FTAs with a and b decrease the latter two countries' domestic sales. In doing so, they contract the two countries' potential profit loss when they open up to each other. Note this effect was exclusive to country a in network g^s as a is c's only FTA partner, but is now applicable to both a and b. Finally, c's preferential access to a and b dilutes the potential profit gain the two can achieve in each other's market. This effect, however, is dominated in our model, suggesting that country c exerts a positive net effect on a and b's incentives to link up when it is jointly linked to a and b.[16]

3 Data

Before turning to the econometric framework, let us first discuss the data used in the paper. We employ a panel data of 80 countries and 3160 country pairs.[17] For each

[15] As to be shown in Appendix A, this condition can be satisfied for countries with similar market size and similar marginal cost of production, both of which are required for an FTA to be jointly supported.

[16] Again, similar to Section 2.3, when country c's marginal cost is sufficiently low it is strictly better off in the new network g^c than the empty network. This also means that it will have an incentive to link up with a and b even when it foresees the FTA between them.

[17] The country coverage is mainly determined by the availability of labor cost data.

of the 3160 country pairs, we obtain their FTA status between 1991 and 2005. These information, taken from the Tuck Trade Agreements Database and the WTO Regional Trade Agreements Database, are used to construct the dependent variable of the empirical analysis (that is, countries' decision to enter into an FTA at a given time) and to identify countries' existing FTA partners. Because there is little time variation in these data, every three years is viewed as one time period.[18]

Following the theoretical model, we consider three types of network. Specifically, we identify, for each country pair and each time period, three groups of third countries: (i) those that do not have an FTA with the country pair, (ii) those that have an FTA with one of the countries, and (iii) those that have an FTA with both. When groups (ii) and (iii) consist of one or more countries, the country pair is considered to be part of an exclusive network and a hub-and-spoke network respectively. Not surprisingly, these two types of network can coexist for some country pairs. Consider, for example, Germany (or any other EU member) and Mexico. This country pair is not only part of an exclusive FTA network (in which third countries like the U.S. are linked to Mexico but not Germany) but also part of a hub-and-spoke network (in which Israel is linked to both Germany and Mexico). In Section 4, we examine how third countries in each network affect countries' incentives to form FTAs.

For each considered country, we take into account three main economic attributes: market size (α), marginal cost of production (γ), and transport cost (τ).[19] Specifically, we use countries' GDP as a proxy for market size and obtain the data from the World Development Indicators (WDI). To measure the marginal cost of production, we obtain each country's average real unit labor cost where each industry is weighted by its output share. This variable captures not only countries' real wage rate but also their different levels of labor productivity. We collected the labor cost and output data from several sources including the World Bank Trade and Production Database, the UNIDO, International Labor Organization (ILO) and the U.S. Bureau of Labor Statistics (BLS) and ultimately used the data provided by the World Bank as it covers the largest number of countries. We have also followed Baier and Bergstrand (2004) and Magee (2003) and considered countries' difference in factor endowment ratio as an alternative measure. The results were qualitatively similar. Finally, we use the distance between each country pair's capital cities as a proxy for transport cost and obtain the data from the City Distance

[18] For example, FTAs that were implemented between 1991 and 1993 are considered to enter into force in the same period.

[19] Ideally, we would also like to include countries' lagged MFN tariff rates. There are, however, a large number of missing values in the tariff data. Including this variable would substantially reduce the sample size. To address the potential bias that can arise without this variable, we adopt in Section 5.2 country-time and partner-time fixed effects to control for all time-variant country-specific characteristics.

Calculator provided by VulcanSoft. Table 1 summarizes the descriptive statistics of the explanatory variables for the country pairs that have an FTA and those that do not.

[Table 1 about here]

4 Econometric framework and results

Effect of FTA networks

Now let us outline the main hypotheses obtained from the theoretical model and examine them individually. First, recall Lemmas 1-3 which predict that

$$g_{ij}(g) = 1 \text{ only if } \psi_{ij} + \varphi_{ij} \cdot \gamma_j - \gamma_i + \mu_i(g) > 0 \text{ and } \psi_{ji} + \varphi_{ji} \cdot \gamma_i - \gamma_j + \mu_j(g) > 0. \quad (13)$$

Our first hypothesis directly follows the above conditions and describes the effect of country-pair characteristics on the decision to form an FTA.

Hypothesis 1 *Countries are more likely to form an FTA when they have (i) larger and similar market sizes, (ii) sufficiently similar marginal costs, and (iii) lower transport cost.*

Note this hypothesis is also the main hypothesis of Baier and Bergstrand (2004) and Magee (2003). It has not yet taken into account the effect of existing FTA networks, i.e., $\mu_i(g)$ and $\mu_j(g)$.

To test this hypothesis, we use the following baseline equation:

$$\Pr(\Delta g_{ijt} = 1) = \Phi\left(X'_{ijt-1}\beta + \varepsilon_{ijt}\right). \quad (14)$$

where $\Delta g_{ijt} \equiv g_{ijt} - g_{ijt-1}$ is the binary dependent variable that takes the value 1 if countries i and j enter into an FTA in period t and 0 otherwise,[20] $\Phi(.)$ is the cumulative probability function, X'_{ijt-1} is a vector of explanatory variables, and ε_{ijt} the residuals.[21]

[20] For country pairs that reached an FTA before 1991 (such as the FTA between the U.S. and Israel), $g_{ijt} = 1$ throughout the entire sample period. For these countries, Δg_{ijt} is denoted as missing and will not be included in the sample. They are, however, taken into account when we construct the explanatory variables that represent the existing FTA networks.

[21] We adopt in this section a fixed-effect Logit model that controls for all time-variant factors. We also considered Cox proportional hazards model and found the results were largely similar. Probit model is not used here because of the incidental parameter problem that would arise with the use of fixed effect. Alternative estimators that control for the potential omitted variables are considered in Section 5.

Note all the explanatory variables are lagged by one period to mitigate the concern of endogeneity.

Specifically, we follow Baier and Bergstrand (2004) and consider a similar specification for $X'_{ijt-1}\beta$:

$$\begin{aligned} X'_{ijt-1}\beta &= \beta_0 + \frac{1}{2}\beta_1(\alpha_{it-1} + \alpha_{jt-1}) + \beta_2|\alpha_{it-1} - \alpha_{jt-1}| + \beta_3|\gamma_{it-1} - \gamma_{jt-1}| \\ &\quad +\beta_4|\gamma_{it-1} - \gamma_{jt-1}|^2 + \beta_5\tau_{ij} + \frac{1}{2}\beta_6 \sum_{l=i,j} \overline{\gamma}_{\text{row},t-1} + \frac{1}{2}\beta_7 \sum_{l=i,j} \overline{\tau}_{\text{row},l}. \end{aligned}$$

The X_{ijt-1} vector consists of the following country-pair characteristics. It includes, first, the country pair's average market size, measured by GDP, with the expectation that countries' average market size is positively correlated with their probability to enter into an FTA, i.e., $\beta_1 > 0$. It also includes the country pair's difference in GDP as hypothesis 1 suggests that countries with similar market sizes are more likely to link up, i.e., $\beta_2 < 0$. In addition, the vector incorporates countries' difference in marginal production cost, both in absolute value and squared term. It is expected that countries are more likely to form an FTA when their dissimilarity in costs is within an intermediate range, i.e., $\beta_3 > 0$ and $\beta_4 < 0$. The effect of distance is also captured in $X'_{ijt-1}\beta$ and is expected to be negative. Finally, X_{ijt-1} includes third countries' average marginal cost and average remoteness to the country pair even though the effect of these variables is ambiguous in Section 2.[22]

Before estimating equation (13), let us first take a preliminary look at the statistics reported in Table 1. The statistics there suggest that as compared to the rest of the world countries that have an FTA have, on average, larger and more similar market sizes. They also tend to have smaller difference in unit labor costs and smaller distance. All of these characteristics are consistent with the hypothesis.

[Table 1 about here]

Now let us proceed to estimate equation (13). The third column of table 2 reports the estimates. The evidence broadly supports hypothesis 1.[23] Countries with larger and similar market size are significantly more likely to enter into an FTA, as indicated by the parameters of $(\alpha_{it-1} + \alpha_{jt-1})/2$ and $|\alpha_{it-1} - \alpha_{jt-1}|$ (a 100% increase in countries' average GDP leads to 0.5 percentage point increase in the probability).[24] Countries are also more

[22] We follow Baier and Bergstrand (2004) and take into account whether the country pair is in the same continent. If they are, we use their average distance to the rest of the world as a measure of remoteness. Otherwise, we assume the value to be 0.

[23] The second column of Table 2 (and the following tables) summarizes our hypotheses.

[24] These elasticity estimates discussed in the text are derived based on the fixed-effect Logit coefficients reported in the tables.

likely to form an FTA when their difference in marginal cost is within an intermediate range. Distance is found to have an adverse impact: countries that are 100% closer in distance are 2 percentage points more likely to enter into an FTA, suggesting that natural trading partners are more likely to benefit from FTAs. Finally, countries are more likely to enter into agreements when the rest of the world has relatively competitive unit labor costs.

[Table 2 about here]

Next we introduce the effect of FTA networks in the estimations. We begin with exclusive FTA networks. Proposition 1 of Section 2 predicts that countries have more incentive to form new FTAs when they already have exclusive FTA partners; the incentive for other countries to reciprocate the FTA is, however, strictly lower. This is reflected in (9) and (12) with $\mu_a(g^s = g^e + g_{ac}) > 0$ and $\mu_b(g^s = g^e + g_{ac}) < 0$.

As discussed in Section 2.3, this result implies that, as compared to the empty network, an FTA will only be jointly supported in exclusive networks if the country that is currently isolated (i.e., country b in Section 2.3) has a sufficiently small market size and a low production cost relative to the country that has existing FTA partners and the two countries are sufficiently close. The reason is twofold. First, when countries have a relatively small market size and low cost, they are more likely to derive a positive welfare gain from an FTA even when their partner is already linked to third countries. Second, these countries' willingness to form an FTA are more likely to be reciprocated by their relatively large and inefficient partners when the latter's incentive is enhanced by the externality from an exclusive network. In the absence of such externalities, the FTA would not generate adequate benefits for the latter countries as their gain in export market would not be sufficiently large to offset their loss in home-market profit and tariff revenue.

These results are summarized in hypothesis 2.

Hypothesis 2 (exclusive network) *Countries i and j are more likely to form an FTA in an exclusive network $g^s = g^e + g_{ik}$ when country i's market size and marginal cost are sufficiently large relative to country j and the two countries are sufficiently proximate.*

To test this hypothesis, we add a new vector of variables to the existing specification, $X^{s\prime}_{ijt-1}\beta^s \cdot I(g^s_{ijt-1})$ where $I(g^s_{ijt-1})$ is an indicator variable that equals to 1 if countries i

and j belong to an exclusive FTA network in which i is exclusively linked to some third countries. $X^{s\prime}_{ijt-1}\beta^s$ is given by

$$X^{s\prime}_{ijt-1}\beta^s = \beta^s_0 + \beta^s_1\left(\alpha_{it-1} - \alpha_{jt-1}\right) + \beta^s_2\left(\gamma_{it-1} - \gamma_{jt-1}\right) + \beta^s_3\tau_{ij},$$

where the first right-hand-side term is a constant, the second represents the (relative) market-size difference between i and j, the third measures the (relative) marginal-cost difference between the two, and the last the distance. In contrast with $X'_{ijt-1}\beta$ where i and j enter the equation symmetrically and the two countries' absolute difference in market size and marginal cost is examined, the terms in $X^{s\prime}_{ijt-1}\beta^s$ measure the extent by which i's market size and production cost exceeds j's. While the expected sign of β^s_0 is ambiguous, hypothesis 2 suggests that $\beta^s_1 > 0$, $\beta^s_2 > 0$ and $\beta^s_3 < 0$.[25]

The summary statistics reported in Table 1 offer preliminary insights on this hypothesis. As compared to the rest of the world, a greater percentage of countries that have an FTA belong to an exclusive network. Furthermore, in this group those that have exclusive FTA partners tend to have a relatively larger market size and higher unit labor cost and countries tend to be geographically closer to each other.

Now let us incorporate the new vector of variables in the estimation. The estimating equation now becomes:

$$\Pr(\Delta g_{ijt} = 1) = \Phi\left(X'_{ijt-1}\beta + X^{s\prime}_{ijt-1}\beta^s \cdot I(g^s_{ijt-1}) + \varepsilon_{ijt}\right). \tag{15}$$

The fourth column of table 2 reports the estimates.[26]

It is evident that exclusive FTA networks exert a significant effect on countries' incentive to form an FTA. As compared to the empty network, countries' probability to link up is on average 0.5 percentage point higher in exclusive networks. This is especially true when the country with exclusive FTA partners has a sufficiently large market size relative to the one without or has a relatively larger unit labor cost.[27]

[25] It is noteworthy that in some cases both countries i and j have exclusive FTA partners. When that is the case, we weigh each country by their number of exclusive FTA partners. We also considered two other treatments. They include (i) weighing each country by the total market size of their exclusive FTA partners and (ii) restricting the definition of exclusive networks to cases where only one of the countries has existing FTA partners. The results were not significantly different.

[26] While our theory has mainly focused on the role of FTA networks and does not explicitly address the effect of customs union, we controlled for the latter in the empirical analysis by either including a dummy for each existing Customs Union (and the characteristics of CU members) or treating them as a whole. The results were largely similar. The results reported here were obtained based on the former. The estimates suggest that Customs Union members have a greater probability to form new FTAs with nonmembers but other member countries' attributes do not play a significant role. These results were suppressed in the tables but are available from the authors.

[27] When countries both have exclusive FTA partners, this result (and analogously for the following results) indicates that countries are more likely to link up when the country with a larger number of

These results are also illustrated in Figures 5-7. The solid curves in Figures 5-7 plot the kernel density of countries' probability to link up in an empty network. The dashed curves represent the cases in which countries have exclusive FTA partners. It is evident in Figures 5 and 6 that countries' probability to form an FTA is greater in exclusive networks when the country with exclusive links has a larger market size and higher unit labor cost than the country without. When the reverse is true, i.e., the country with exclusive links has a smaller market size and lower unit labor cost, the probability density curve is indistinguishable from the one in the empty network. This is also true for countries with greater proximity versus those that are relatively distant. Given an exclusive network, the former has a significantly greater probability to form an FTA than the latter; in fact, the latter's likelihood density curve is similar to countries in the empty network.

[Figures 5-7 about here]

Finally, we incorporate the predictions on the hub-and-spoke network into the econometric specification. Recall in Section 2.4 we predicted that countries' incentive to form an FTA unambiguously increases when they are mutually linked to a third country. This is represented in equations (11) and (12) by $\mu_i(g^h) > 0$ and $\mu_j(g^h) > 0$ and gives us our next hypothesis:

Hypothesis 3 (hub-and-spoke network) *Countries i and j are more likely to form an FTA in a hub-and-spoke network $g^h = g^e + g_{ik} + g_{jk}$ than in the empty network.*

To test this hypothesis, we include an indicator variable, $I(g^h_{ijt-1})$, in equation (14). This indicator variable equals to 1 when countries i and j share mutual FTA partners at period $t-1$ and 0 otherwise. The summary statistics of this variable reported in table 1 suggests that as compared to the rest of the world the percentage of countries that share mutual FTA partners is greater for the group of countries that have an FTA.

The econometric specification now becomes:

$$\Pr(\Delta g_{ijt} = 1) = \Phi\left(X'_{ijt-1}\beta + X^{s\prime}_{ijt-1}\beta^s \cdot I(g^s_{ijt-1}) + \beta^h \cdot I(g^h_{ijt-1}) + \varepsilon_{ijt}\right), \tag{16}$$

where the parameter of $I(g^h_{ijt-1})$, denoted by β^h, is expected to be positive.

The estimates are reported in the last column of table 2. The results suggest that countries are significantly more likely to form an FTA when they are both linked to a

exclusive FTA parnters has a sufficiently large market size and labor cost relative to the one with fewer partners.

common country. The likelihood, on average, increases by 2 percentage points. Comparing this effect with that of exclusive FTA networks suggests that third countries provide a stronger stimulus to countries' incentives to link up when they are connected to both of them.[28] This finding is also illustrated in Figure 8. The density curve of the probability to form an FTA is shifted significantly rightward when countries share mutual FTA partners.

[Figure 8 about here]

Effect of third-country characteristics

So far we have established the effect of third countries on countries' incentive to form an FTA in various FTA networks. But does the effect vary with third-country characteristics? The theoretical framework employed in this paper, albeit standard in the regionalism literature, does not have direct predictions in this respect because of its linearities in both cost and demand. But it is not difficult to see that third-country characteristics can affect the extent of the effect when there are non-linearities present. We hence explore this issue empirically in the remainder of this section.

Similar to the country-pair characteristics, we take into account three third-country attributes: (i) total market size, (ii) average unit labor cost and (iii) average distance to its partner country in the country pair. In particular, we calculate, in an exclusive network $g^s = g^e + g_{ik}$, the cost difference between country k and country j, i.e., $\gamma_{kt-1} - \gamma_{jt-1}$ (where $g_{kj} = 0$). As discussed in Section 2.2, country j is more likely to link up with country i when its marginal cost of production is relatively lower. This means that country k will be less likely to dampen country j's incentive to form an FTA with i in network g^s when it is relatively less competitive than country j. The reason is straightforward: Less efficient third countries are less capable of diluting country j's potential profit gain in i's market.

[Table 3 about here]

The estimates in table 3 confirm the above hypothesis. Exclusive networks are more likely to raise countries' incentive to form an FTA when the third countries have relatively higher unit labor costs. This is also true when third countries have relatively larger

[28] We also interacted $I(g^h_{ijt-1})$ with the vector of explanatory variables, i.e., X_{ijt-1}, and examined how the effect of country-pair characteristics may vary in a hub-and-spoke network. We found that all the interaction terms have a positive and significant paramter, suggesting that, at every given level of X_{ijt-1}, being part of a hub-and-spoke network raises countries' probability to enter an FTA.

market size and are relatively proximate. A similar result is also found for countries in the hub-and-spoke networks. The spoke countries are significantly more likely to link up when the hub country is less competitive than the spokes. The effect of market size and distance is, however, insignificant in this case.

5 Sensitivity analysis

In this section, we present a number of sensitivity analyses and examine the robustness of the results. First, we consider alternative country characteristics measure. Specifically, we follow Baier and Bergstrand (2004) and Magee (2003) and use countries' differences in factor endowment ratio as a proxy for production cost differences. This allows us to investigate the effect of FTA networks in the exact framework as Baier and Bergstrand (2004). It also expands the number of countries included in the sample because of the greater coverage of factor endowment data.

We then address two econometric concerns that can arise in the analysis. First, one may argue that there exist omitted variables that affect countries' decision to enter into an FTA. To address this issue, we employ various fixed effects in our estimations below. The other econometric issue concerns the causal effect of existing FTAs. One may argue that countries self-select into their existing FTA networks because of their expectation of future FTAs. For example, a country may strategically form an FTA with another country's existing FTA partner in the hopes of linking up with that country in a later period. We adopt two strategies to address this concern.

5.1 Alternative country characteristics

First, we re-estimate equations (13)-(15) using countries' differences in capital-labor ratio to capture countries' differences in production costs.[29] Baier and Bergstrand (2004) finds, both theoretically and empirically, that countries whose differences in capital-labor ratio are within an intermediate range are more likely to experience trade creation after forming an FTA and therefore more likely to enter into an agreement. We adopt their measures here and examine the effect of FTA networks in the same specification.[30]

[29] It is worth noting that while factor endowment ratio captures countries' comparative advantage in the spirit of Heckscher-Ohlin-Vanek (HOV) framework, it does not take into account countries' differences in factor productivity (see, Trefler, 1993; Davis and Weinstein, 2001; Maskus and Nishioka, forthcoming, for studies in this area). This, in part, motivated the paper to consider real unit labor cost in Section 4 as an alternative measure.

[30] An important theoretical contribution by Levy (1997) pointed out another mechanism through which countries' difference in factor endowment ratio can affect countries' probability to have bilateral free trade agreements. He shows, in a formal political economy model, that a bilateral free trade agreement will only be supported by a country if the capital-labor ratio of the integrated economy raises the median voter's

To construct a country's capital stock, we assume a depreciation rate (δ) of 7% and calculate the annual capital stocks based on the perpetual inventory method as outlined in Leamer (1984).[31] To measure labor endowment, we use the size of total labor force. Both of these data are taken from the World Development Indicators. We then calculate each country pair's absolute difference in capital-labor ratio and their difference from the rest of the world.

As shown in the third column of Table 4, the results are qualitatively similar to those reported in Table 2 and existing studies. Specifically, countries are more likely to form an FTA when their difference in factor endowment ratio is within an intermediate range. This is consistent with our result in Section 4 where we find that countries with intermediate difference in unit labor costs have a greater probability to enter into FTAs. Furthermore, we find that countries are less likely to have FTAs when their factor endowment ratio is relatively different from the rest of the world. Again, this result has been formally predicted by Baier and Bergstrand (2004).

[Table 4 about here]

The effect of FTA networks remains similar. Exclusive FTA networks are more likely to stimulate countries' incentive to form FTAs when the two countries' factor endowment ratio (and market size) is sufficiently different — more specifically, when the country with exclusive FTA partners has a sufficiently large capital-labor ratio (and market size) relative to the one without. This suggests that labor-abundant countries are more likely to be willing to link up with countries that already have FTAs. Hub-and-spoke networks, on the other hand, continue to exert a significant and positive effect as shown in Section 4.

5.2 Omitted variables

Next we address the potential concern of omitted variables using a number of fixed effects. In the third column of table 5, we include a country-pair fixed effect in a linear probability model to capture the effect of all time-invariant country-pair factors such as common language and colonial ties.[32] As shown, the estimates are qualitatively similar to those

welfare relative to autarky. He also finds that bilateral agreements between countries with similar factor endowments are likely to undermine countries' political support for further multilateral trade liberalization.

[31] The initial value of capital stocks is taken from far enough in the past so that the impact of the initial value on the estimated time series is small.

[32] Once again, probit model is not used here to avoid the incidental parameter problem that arises in the presence of fixed effects. Fixed-effect logit model is not an option either, because it functions as conditional logit model and excludes all the groups (for example, country pairs in the case of a country-pair fixed effect) that have a constant value of the dependent variable. This would restrict our sample to country pairs that formed an FTA in the sample period.

reported in table 2.[33] Both country-pair characteristics and FTA networks remain to have a significant and expected impact on countries' incentives to form FTAs.

Next, we address the potential concern that a country's unobserved characteristics, such as its trade integration policy, may drive both its current FTA network and its incentives to form future FTAs. To do so, we include country-period and partner-period fixed effects in addition to the country-pair dummies. The results are reported in the last column of Table 5. Again, we find significant network effects even though the effect of other variables becomes less important.

[Table 5 about here]

5.3 The causal effect of FTA networks

To address the issue of causality between existing and future FTAs, we first take a quasi-natural experimental approach by only considering the effect of plurilateral agreements on the probability of two countries forming a bilateral FTA. Two rationales motivate this approach. First, relative to the decision to establish a bilateral FTA between two individual countries, it is less likely that the decision to establish a plurilateral agreement, such as the FTAs between the EU and other countries and the ASEAN, is determined by an individual country's incentive to reach a future FTA with an outsider. Second, many plurilateral agreements, such as the ASEAN and ANDEAN FTAs, have a long history and may hence be considered predetermined.

Since this approach does not consider the effect of bilateral agreements, country pairs that only have bilateral FTA partners are excluded in the analysis. Table 6 reports the results. We find that the effect of existing hub-and-spoke network remains largely similar to the previous estimates but plurilateral exclusive FTA partners tend to exert, on average, an adverse effect on countries' probability to form new agreements. This is not surprising given that countries' potential profit gain in a foreign market is expected to decrease in that market's number of preferential trade partners. This adverse effect is, however, smaller when the third countries have relatively high unit labor cost, a result that is consistent with hypothesis 2.

[Table 6 about here]

Next we use a propensity-score matching technique as an alternative strategy to dis-

[33] Note that the estimates in the linear probability model have different interpretations than those directly reported by the logit model. They represent the marginal effect of the explanatory variables on the probability, i.e., the change in the probability for an infinitesimal change in each explanatory variable.

entangle the causal effects.[34] We focus, in particular, on the causality between countries' sharing a mutual FTA partner (i.e., treatment variable) and their decision to form an agreement (i.e., outcome variable). While one may also question the causal effect of existing exclusive FTA networks, this concern is mitigated when we include country-time fixed effect (in Table 5) which controls for all time-variant country-specific factors such as trade integration policy.

The objective of the propensity-score matching method is to match — for each country (say, i) — a potential FTA partner (j) with whom i shares a mutual FTA partner (i.e., treated group) with another nation (m) (i.e., control group). The matching criteria is that the two pairs (i and j versus i and m) are sufficiently similar in main characteristics and the propensity to share a mutual FTA partner, except the latter pair does not actually have one. The two pairs' decisions to form an FTA in the next period are then compared. If the former pair is found to be significantly more or less likely to sign an FTA than its match pair, we consider the difference as the average treatment effect on the treated (ATT) of having mutual FTA partners. The details of implementing this approach are described below.[35]

When two countries, say i and j, both have an FTA with a third country k at period t, it indicates that $g_{ikt} = g_{jkt} = 1$ and i and j belong to a hub-and-spoke network g^h_{ijt}. Our task here is to estimate this possibility in the following model:

$$\Pr\left[I(g^h_{ijt}) = 1 \middle| Z_{ijt-1} \right] = \Pr\left\{ \max_{k \neq i,j} (g_{ikt} \cdot g_{jkt}) = 1 \middle| Z_{ijt-1} \right\} = \Phi(Z'_{ijt-1}\delta) \qquad (17)$$

where $\Phi(.)$ is the cumulative distribution function and Z_{ijt-1} is a vector of country-pair explanatory variables including country-period and partner-period dummies. The results are mostly intuitive. Countries with a larger average GDP and a greater similarity in unit labor costs are more likely to share a mutual FTA partner. This probability is also higher when countries are geographically closer to each other and to the rest of the world.

Based on the first-stage estimates, we calculate each country pair's propensity score of being linked to a mutual FTA partner, $\Pr[I(g^h_{ijt}) = 1]$. For each country i and period t, we find a match m for each potential FTA partner j such that country i has a mutual FTA partner with j but not with the match m. Furthermore, the match m is chosen to

[34] This technique is proposed in the seminal work of Rosenbaum and Rubin (1983) and has become increasingly popular in recent empirical research along with other matching estimators developed to estimate average treatment effects. Baier and Bergstrand (forthcoming), for example, apply the matching method to evaluate the effect of free trade agreements on trade flows.

[35] This approach was implemented using the procedure described in Becker and Ichino (2002).

minimize the distance in propensity scores, i.e.,

$$m(i,j,t) = \arg\min_{l} \left| \Pr(I(g^h_{ijt}) = 1) - \Pr(I(g^h_{ilt}) = 1) \right|, \tag{18}$$

where $l \neq i, j$ and $I(g^h_{ilt}) = 0$.[36]

Now we are ready to establish the causal effect of having mutual FTA partners. In particular, we examine whether the difference in matched country pairs' decision to form an FTA in the next period, i.e., $\Delta g_{ij(t+1)} - \Delta g_{im(t+1)}$, is attributable to the difference in their actual status of sharing mutual FTA partners, i.e., $I(g^h_{ijt}) - I(g^h_{imt})$. Table 7 reports the estimates. We find that country pairs that actually share mutual FTA partners are significantly more likely to reach an agreement than their matches.

[Table 7 about here]

6 Interpreting the results

In this section, we follow Baier and Bergstrand (2004) and examine how well the estimates predict the actual data. To do so, we obtain the fitted probabilities of two countries forming an FTA in a given period based on estimates reported in the last column of Table 5.[37] In the context of qualitative choice models, higher predicted probabilities of signing an FTA are associated with greater potential welfare gains. We first consider the country pairs whose predicted probabilities of entering into an FTA in a given period exceed 0.5. We find 181 (or 59%) of the 304 pairs that established an FTA between 1991 and 2005 satisfy this criteria when they signed the agreement.

However, to the remaining 123 (or 41%) of the 304 pairs, the predicted probabilities in the period when the agreements were formed are less than 0.5. This suggests that the welfare gains from forming these FTAs are not sufficiently large or their timing was not optimal. Among this group of countries, Chile, Egypt, Jordan, Morocco, and South Africa committed to particularly more agreements than predicted.

Our results also predict that 94 (4%) of the 2313 country pairs in our sample that did not have an FTA before 2005 would derive a sufficient welfare gain from signing a bilateral agreement in 2005. These countries include, for example, Mexico, Israel, China, Singapore, Algeria, and most EU members. We notice that 30 (32%) of these 94 country pairs have indeed either signed an agreement in 2006 or entered negotiations.[38]

[36] In addition to the nearest neightbor matching described above, we also considered the radius matching and found the results remain qualitatively similar.

[37] Note different from Baier and Bergstrand (2004) who predict countries' probability of sharing an FTA by 1996, our predictions also concern the timing of FTAs.

[38] The free trade agreements that were signed in 2006 are obtained from Tuck Trade Agreements Data-

7 Conclusion

We investigate in this paper the effect of existing FTA networks on countries' incentive to form new FTAs. While the existing literature has provided important insights on the country-pair determinants of FTAs, the potential externalities exerted by existing FTA partners remain largely underinvestigated. We show, both theoretically and empirically, that such externalities play an important role in countries' decision to enter into FTAs. Furthermore, the extent of these externalities is crucially conditional on the architecture of the network and the attributes of third countries.

First, we show that exclusive FTA networks pose opposing effects on countries' incentives to form an agreement. Countries that are currently linked to third countries have a stronger motive to form new links whereas those that are currently isolated have a weaker incentive to reciprocate. This is not surprising given that the former's potential profit loss in the home market from forming a new FTA is now shared with its FTA partners whereas the latter's potential profit gain in the export market is diluted. An FTA will therefore only be jointly supported if the former country has a sufficiently large market size and a relatively high marginal cost of production so that other countries can still receive sufficient gains from linking up with them in spite of the presence of their preferential trade partners. This hypothesis is broadly confirmed by the empirical evidence. Exclusive FTA networks are more likely to stimulate new FTAs when the country with exclusive FTA partners has a relatively larger market size and higher unit labor cost. This is similarly true when third countries' unit labor costs are relatively higher.

We also examine the effect of hub-and-spoke networks in which two countries share a mutual FTA partner. We show that while the hub (third) country dilutes the spoke countries' potential profit gain in each other's market, it also shares their potential profit loss at home. The theory predicts that the latter effect outweighs the former, leading to a positive net effect on countries' incentive to form FTAs. This hypothesis is supported empirically. We find a significant and positive network effect from the hub-and-spoke networks. Countries are more likely to form an FTA when they share mutual FTA partners. The results also remain largely robust when we address the potential concerns of omitted variables and reverse causality between existing and future FTAs using, respectively, fixed effects and matching techniques.

While this analysis has taken the step to analyze third-country effects in countries' incentives to form new FTAs, it can be extended in two directions. First, it can be extended to explore countries' decision to link up with more than one partner at a time.

base. Those that are currently in the process of negotiation are complied from online sources including www.bilaterals.org.

It is possible that these links are not beneficial to the country individually but would be if they were formed jointly. This type of externality has not been examined in the literature and poses an interesting area for future research. Second, while this paper has partly addressed the potential reverse causality between existing and future FTAs, this topic can be further exploited both theoretically and empirically. Studies that allow countries to take a far-sighted view of network formation will deepen our understanding of how FTAs evolve over time.

References

[1] Aghion, Philippe, Pol Antras, and Elhanan Helpman (2007) "Negotiating Free Trade," *Journal of International Economics* 73: 1-30.

[2] Baldwin, R. (1999) "A Domino Theory of Regionalism," in J. Bhagwati, P. Krishna, and A. Panagariya, eds., Trading Blocs: Alternative Approaches to Analyzing Preferential Trading Agreements (Cambridge, MA: MIT Press): 479–502.

[3] Baier, Scott L., and Jeffrey H. Bergstrand (2004) "Economic Determinants of Free Trade Agreements," *Journal of International Economics* 64 (1): 29-63.

[4] Baier, Scott L., and Jeffrey H. Bergstrand (2007) "Do free trade agreements actually increase members' international trade?" *Journal of International Economics* 71: 72-95.

[5] Baier, Scott L., Jeffrey H. Bergstrand and Peter Egger (2007) "The New Regionalism: Causes and Consequences," *Économie internationale* 109: 9-29.

[6] Baier, Scott L., and Jeffrey H. Bergstrand (forthcoming) "Estimating the Effects of Free Trade Agreements on Trade Flows using Matching Econometrics," *Journal of International Economics*.

[7] Bhagwati, J. and A. Panagariya (1996) "The Theory of Preferential Trade Agreements: Historical Evolution and Current Trends," *American Economic Review Papers and Proceedings* 86: 82–7.

[8] Bond, E., R. Riezman, and C. Syropoulos (2004) "A Strategic and Welfare Theoretic Analysis of Free Trade Areas," *Journal of International Economics* 64: 1–27.

[9] —— and C. Syropoulos (1996) "The Size of Trading Blocs: Market Power and World Welfare Effects," *Journal of International Economics* 40: 411–37.

[10] Davis, Donald and David Weinstein (2001). "An Account of Global Factor Trade", *American Economic Review* 91: 1423-53.

[11] Dutta, Bhaskar, Sayantan Ghosal and Debraj Ray (2005) "Farsighted Network Formation", *Journal of Economic Theory*, 122, 143-164.

[12] Estevadeordal, Antoni, Caroline Freund, and Emanuel Ornelas (2008) "Does Regionalism Affect Trade Liberalization towards Non-Members?", *Quarterly Journal of Economics* 123 (4): 1531–1575.

[13] Ethier, W. J. (1998) "Reciprocity, Nondiscrimination, and a Multilateral World," Mimeo.

[14] Frankel, J.A. (1997) Regional Trading Blocs. Institute for International Economics, Washington, DC.

[15] Freund, Caroline (2000) "Different Paths to Free Trade: The Gains from Regionalism," *Quarterly Journal of Economics* 115 (4): 1317-41.

[16] Furusawa, T. and H. Konishi (2007) "Free Trade Networks," *Journal of International Economics* 72 (2): 310-335.

[17] Goyal S. and S. Joshi (2006) "Bilateralism and Free Trade," *International Economic Review* 47: 749–778.

[18] Grossman, Gene and Elhanan Helpman (1994) "Protection for Sale", *American Economic Review* 84 (4): 833-50.

[19] Leamer, E.E. (1984). *Sources of International Comparative Advantage: Theory and Evidence*. Cambridge MA: MIT Press.

[20] Levy, Philip (1997) "A Political-Economy Analysis of Free Trade Agreements", *American Economic Review* 87(4): 506-519.

[21] Limao, Nuno (2006). "Preferential Trade Agreements as Stumbling Blocks for Multilateral Trade Liberalization: Evidence for the U.S." *American Economic Review* 96 (3): 896-914.

[22] Krishna, Pravin (1998) "Regionalism and Multilateralism: A Political Economy Approach," *Quarterly Journal of Economics* 113(1): 227-251.

[23] Krishna, Pravin (2004) "The Economics of Preferential Trade Agreements," in James Harrigan ed., Handbook of International Trade (Economic and Legal Analysis of Laws and Institutions, Basil Blackwell)

[24] Krugman, Paul (1991) "Is Bilateralism Bad" in Helpman, E., and A. Razin (ed.), International Trade and Trade Policy, MIT Press, Cambridge, 9-23.

[25] Magee, Chris (2003). "Endogenous Preferential Trade Agreements: An Empirical Analysis." *Contributions to Economic Analysis and Policy* 2, no. 1. Berkeley Electronic Press.

[26] Maskus, Keith and Shuichiro Nishioka (forthcoming) "Development-Related Biases in Factor Productivities and the HOV Model of Trade", *Canadian Journal of Economics*.

[27] Ornelas, Emanuel (2005a). "Trade Creating Free Trade Areas and the Undermining of Multilateralism." *European Economic Review* 49 (7): 1717-35.

[28] Ornelas, Emanuel (2005b). "Endogenous Free Trade Agreements and the Multilateral Trading System." *Journal of International Economics* 67 (2): 471-97.

[29] Saggi, Kamal (2006) "Preferential Trade Agreements and Multilateral Tariff Cooperation," *International Economic Review* 47: 29-57.

[30] Trefler, Daniel (1993) "International Factor Price Differences: Leontief was Right!", *Journal of Political Economy* 101: 961-87.

[31] Yi, S. S. (1996) "Endogenous Formation of Customs Unions under Imperfect Competition: Open Regionalism Is Good," *Journal of International Economics* 41: 153–77.

[32] —— (2000) "Free-Trade Areas and Welfare," *Review of International Economics* 8: 336– 47.

Appendix

A. endogenous MFN tariff

In Section 2, we have assumed countries' MFN tariffs remain constant across networks. We explore here the case in which countries may adjust their MFN tariff rates after they form FTAs. Similar to Section 2, we begin with an empty network. It is not difficult to see that countries' optimal tariff rate in network g^e is given by

$$T_i^*(g^e) \equiv \arg\max W_i(g^e) = \frac{3\alpha_i - \gamma_i - \sum_{j\neq i}(\gamma_j + \tau_i^j)}{10}, \tag{19}$$

where $i = a, b, c$.

Now suppose a has formed an FTA with c; this leads to an exclusive network $g^s = g^e + g_{ac}$. Country a's MFN tariff in this network is

$$T_a^*(g^s) \equiv \arg\max W_a(g^s) = \frac{3\alpha_a - \gamma_a - 9(\gamma_b + \tau_{ba}) + 7(\gamma_c + \tau_{ca})}{21}. \tag{20}$$

Comparing equation (20) with (19) suggests that $T_a^*(g^s)$ is strictly lower than $T_a^*(g^e)$ iff $33\alpha_a + 69(\gamma_b + \tau_{ba}) > 11\gamma_a + 91(\gamma_c + \tau_{ca})$. The latter condition is relatively minor and is satisfied if a's market size is not too small and c's marginal cost is not too high relative to b.[39] Note country b's optimal MFN tariff rate is not affected by the FTA between a and c and remains the same as its tariff rate in g^e.

We then re-examine the conditions in (9) and find that for all $T_a(g^s) \leq T_a(g^e)$,

$$\begin{aligned}
\psi_{ab}(T_a(g^s)) + \varphi_{ab}(T_a(g^s)) \cdot \gamma_b + \mu_a(g^s, T_a(g^s)) &> \psi_{ab}(T_a(g^e)) + \varphi_{ab}(T_a(g^e)) \cdot \gamma_b \\
\psi_{ba}(T_a(g^s)) + \varphi_{ba}(T_a(g^s)) \cdot \gamma_a + \mu_b(g^s, T_a(g^s)) &< \psi_{ba}(T_a(g^e)) + \varphi_{ba}(T_a(g^e)) \cdot \gamma_a.
\end{aligned}$$

This suggests that when country a lowers its MFN tariff rate after forming an FTA with c, a has stronger incentives to form an FTA with b. Country b's incentive to reciprocate the FTA is, however, weakened. The intuition is straightforward. At a lower MFN tariff rate, a will experience a smaller loss in its home-market profit and tariff revenue when it links up with b. Country b, on the other hand, will experience a smaller gain in export profit. Our previous result, described in Proposition 1, remains unchanged.

Now let us consider a hub-and-spoke network. In this case, both a and b have incentives to lower their external tariff to the level given in (20).[40] This has two effects on countries

[39] Note this result has also been obtained in previous studies such as Saggi (2006) and was referred to as the tariff complementarity effect by Bagwell and Staiger (1997a, 1997b).

[40] Note a country's optimal external tariff when it is the spoke of a hub-and-spoke network is identical to its optimal external tariff in an exclusive network where it has an exclusive FTA partner. This is because in this model the partner country's tariff level does not affect a country's decision on its own tariff.

a and b's incentives to grant each other preferential treatment. On the one hand, they become less motivated to obtain preferential access to each other's market as the partner country lowers its MFN tariff. But on the other hand, they also expect a smaller loss in the home market for both home-market profit and tariff revenue because of their own lower MFN tariff rate. We find that when the two countries' MFN tariff rates are sufficiently similar, the latter effect dominates the former and the conditions in (12) continue to hold, i.e., for $i, j = a, b$

$$\begin{aligned} & \psi_{ij}(T_i(g^h), T_j(g^h)) + \varphi_{ij}(T_i(g^h), T_j(g^h)) \cdot \gamma_j + \mu_i(g^h, T_i(g^h), T_j(g^h)) \\ > \quad & \psi_{ij}(T_i(g^e), T_j(g^e)) + \varphi_{ij}(T_i(g^e), T_j(g^e)) \cdot \gamma_j. \end{aligned}$$

The result outlined in Proposition 2 therefore remains true.

B. the case of N countries

We now show that restricting ourselves to the 3-country model does not involve any essential loss of generality. Our results on the incentives of countries a and b to form an FTA as a function of the current network architecture remains robust when we generalize the model to the case of $N > 3$ countries. We focus here on the results regarding the exclusive FTA network.[41]

We begin with the empty network. Starting from the empty network, a has a strict incentive to form an FTA with b if:

$$\gamma_a < \psi_{ab} + \varphi_{ab} \cdot \gamma_b \tag{21}$$

where we now have:

$$\begin{aligned} \psi_{ab} \quad \equiv \quad & 1/(2N^2T_b - (N-2)T_a) \cdot [2NT_b(\alpha_b + \sum_{k \neq a,b} \gamma_k - N\tau_a^b + \sum_{k \neq a,b} \tau_b^k + (N-4)T_b/2) \\ & -T_a(3\alpha_a + (N+4) \sum_{k \neq a,b} \gamma_k - (N+1)^2\tau_a^b + (N+4)\tau_a^k + (N^2 - 17/2)T_a)] \end{aligned}$$

and

$$\varphi_{ab} = 1/(2N^2T_b - (N-2)T_a) \cdot [(N(N+1) - 3)T_a + 2NT_b].$$

A similar expression holds for country b. Therefore, as in Lemma 1, country a is willing to form an FTA with b if its marginal cost is below some threshold with respect to b's marginal cost (and likewise for b).

[41] The results on the hub-and-spoke network can be analogously derived.

Now consider the incentives of a and b to form an FTA when they are part of some exclusive network g. Let $\mathcal{N}_a(g) = \{i \ ; \ g_{ia} = 1 \text{ in } g\}$ denote the set of FTA partners of country a in the network g and $n_a(g)$ denote the number of countries in this set. Likewise, $\mathcal{N}_b(g)$ denotes b's FTA partners in the network g and $n_b(g)$ denotes the number of countries with which b has an FTA. Without loss of generality, we assume that $n_a(g) > n_a(g)$.

We can then show that a has a strict incentive to form an FTA with b if:

$$\gamma_a < \psi_{ab} + \varphi_{ab} \cdot \gamma_b + \mu(g) \tag{22}$$

where:

$$\mu(g) = \frac{[5n_a(g) + 2Nn_a(g)]T_a^2 - 2Nn_b(g)T_b^2}{2N^2T_b - (N-2)T_a}$$

Therefore, a's incentives to form an FTA with b are stronger starting from the exclusive network g as compared to the empty network. The reason is straightforward. Having FTA with third countries allows country a to reduce the adverse impact of allowing b into its market. This effect increases with a's number of FTA partners. Country b's existing FTAs, on the other hand, reduce a's gain in b's market. But since b has a smaller number of FTA partners than a, the latter effect is offset by the former.

Based on the same reason, the incentives of b to reciprocate the FTA with a are weaker in network g than in the empty network. While country b's existing FTAs reduce b's home-market losses from linking up with a, country b's gains abroad are more severely affected by the larger number of countries that have preferential access to a's market. Our results in Proposition 1 therefore remain unchanged.

Table 1: Summary statistics

	Country pairs without FTA obs=11565				Country pairs with FTA obs=1110			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
decision to form an FTA	0	0	0	0	0.27	0.44	0	1
average GDP	25.36	1.55	20.94	29.69	25.41	1.35	20.97	29.35
difference in GDP	25.41	1.99	17.00	30.00	25.36	1.88	16.29	30.00
difference in unit labor cost	0.76	1.58	0.000	14.34	0.64	1.19	0.000	14.23
squared difference in unit labor cost	3.08	19.56	0.000	205.68	1.83	13.81	0.000	202.64
third countries' unit labor cost	-1.60	0.19	-1.93	-1.40	-1.55	0.16	-1.92	-1.40
distance	8.97	0.61	3.74	9.89	8.14	0.86	4.95	9.82
remoteness	0.99	2.80	0	9.31	2.17	3.85	0	9.31
exclusive network dummy	0.89	0.30	0	1	0.87	0.33	0	1
$\times$ country-pair diff. in GDP	0.14	1.95	-8.32	8.64	0.48	1.84	-4.43	7.10
$\times$ country-pair diff. in unit labor cost	0.14	1.11	-14.02	10.94	0.27	0.96	-12.81	8.75
$\times$ country-pair distance	8.03	2.81	0	9.89	7.19	2.79	0	9.82
hub-and-spoke network dummy	0.05	0.23	0	1	0.17	0.38	0	1

Table 2: Network effects in the formation of FTAs

Dependent variable: decision to form an FTA	H_0	no network effect	exclusive network	exclusive & hub-spoke networks
country-pair average GDP	+	0.40***	0.42***	0.33***
		(0.08)	(0.08)	(0.08)
country-pair *abs.* diff. in GDP	–	-0.18***	-0.20***	-0.16***
		(0.06)	(0.06)	(0.06)
country-pair *abs.* diff. in unit labor cost	+	0.23**	0.27*	-0.06
		(0.12)	(0.16)	(0.15)
country-pair sq. diff. in unit labor cost	–	-0.02*	-0.02*	0.001
		(0.01)	(0.01)	(0.01)
country-pair distance	–	-1.33***	-1.45***	-1.33***
		(0.12)	(0.27)	(0.26)
third countries' relative unit labor cost	+/–	-6.96***	-6.02***	-1.68*
		(2.14)	(2.07)	(0.85)
third countries' distance	+/–	-0.01	0.001	0.04*
		(0.02)	(0.01)	(0.02)
exclusive network dummy	+/–		-0.62	-1.18
			(2.38)	(2.27)
× country-pair diff. in GDP	+		0.07***	0.07***
			(0.03)	(0.03)
× country-pair diff. in unit labor cost	+		0.10*	0.09*
			(0.06)	(0.05)
× country-pair distance	–		0.14	0.19
			(0.30)	(0.29)
hub-and-spoke network dummy	+			1.16***
				(0.15)
controls for customs union		no	yes	yes
number of observations		12675	12675	12675
Log-likelihood		-1190.7	-1183.9	-1140.3

Notes: (i) Standard errors are reported in the parentheses and clustered at the country pair level; (ii) ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.

Table 3: Effect of third-country characteristics

Dependent variable: decision to form an FTA	H_0	exclusive network	exclusive & hub-spoke networks
exclusive network dummy	+/–	-0.43	-1.92
		(2.33)	(2.41)
× country-pair diff. in GDP	+	0.08***	0.08***
		(0.03)	(0.03)
× country-pair diff. in unit labor cost	+	0.07*	0.12*
		(0.04)	(0.07)
× country-pair distance	–	0.25	0.45
		(0.29)	(0.31)
× third countries' GDP	+/–	0.16***	0.09***
		(0.03)	(0.03)
× third countries' relative unit labor cost	+	0.18***	0.56***
		(0.09)	(0.19)
× third countries' distance	+/–	-0.73***	-0.55***
		(0.10)	(0.11)
hub-and-spoke network dummy	+		4.68
			(4.64)
× third countries' GDP	+/–		-0.18
			(0.12)
× third countries' relative unit labor cost	+/–		0.95***
			(0.32)
× third countries' distance	+/–		0.17
			(0.36)
full set of controls		yes	yes
number of observations		12675	12675
Log-likelihood		-1141.1	-1035.9

Notes: (i) Standard errors are reported in the parentheses and clustered at country pair level; (ii) ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.

Table 4: Sensitivity analysis: alternative measure of differences in production cost

Dependent variable: decision to form an FTA	H_0	no network effect	exclusive network	exclusive & hub-spoke networks
country-pair average GDP	+	0.44***	0.42***	0.33***
		(0.10)	(0.10)	(0.10)
country-pair *abs.* diff. in GDP	–	-0.10	-0.09	-0.04
		(0.08)	(0.08)	(0.08)
country-pair *abs.* diff. in K/L	+	1.89***	1.67***	1.72***
		(0.28)	(0.28)	(0.28)
country-pair sq. diff. in K/L	–	-0.62***	-0.64***	-0.68***
		(0.08)	(0.09)	(0.09)
country-pair distance	–	-1.26***	-1.06***	-0.92***
		(0.09)	(0.32)	(0.35)
third countries' relative K/L	+/–	-1.14***	-1.10***	-0.87***
		(0.18)	(0.19)	(0.18)
third countries' distance	+/–	0.01	0.02	0.04*
		(0.02)	(0.01)	(0.02)
exclusive network dummy	+/–		1.94	1.91
			(2.71)	(2.95)
× country-pair diff. in GDP	+		0.11***	0.11***
			(0.03)	(0.03)
× country-pair diff. in K/L	+		0.52***	0.48***
			(0.09)	(0.10)
× country-pair distance	–		-0.17	-0.17
			(0.32)	(0.35)
hub-and-spoke network dummy	+			1.01***
				(0.15)
controls for customs union		no	yes	yes
number of observations		18693	18693	18693
Log-likelihood		-1221.4	-1207.9	-1178.1

Notes: (i) Standard errors are reported in the parentheses and clustered at the country-pair level; (ii) ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.

Table 5: Sensitivity analysis: omitted variables

Dependent variable: decision to form an FTA	H_0	country-pair FE	country-pair & -time FE
country-pair average GDP	+	0.06***	-0.04
		(0.02)	(0.03)
country-pair *abs.* diff. in GDP	–	-0.003	-0.001
		(0.004)	(0.004)
country-pair *abs.* diff. in unit labor cost	+	0.01**	0.02**
		(0.005)	(0.01)
country-pair sq. diff. in unit labor cost	–	-0.001*	-0.001*
		(0.000)	(0.000)
country-pair distance	–	—	—
third countries' relative unit labor cost	+/–	0.13	44.09
		(0.13)	(34.73)
third countries' distance	+/–	—	—
exclusive network dummy	+/–	0.37***	0.36***
		(0.09)	(0.11)
× country-pair diff. in GDP	+	0.006***	0.002**
		(0.001)	(0.001)
× country-pair diff. in unit labor cost	+	0.003*	0.004*
		(0.002)	(0.002)
× country-pair distance	–	-0.04***	-0.04***
		(0.001)	(0.01)
hub-and-spoke network dummy	+	0.11***	0.09***
		(0.01)	(0.01)
controls for customs union		yes	yes
number of observations		12675	12675
R square		0.07	0.24

Notes: (i) Standard errors are reported in the parentheses and clustered at country pair level; (ii) ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.

Table 6: Sensitivity analysis: the effect of plurilateral agreements on bilateral FTAs

Dependent variable: decision to form a bilateral FTA	H_0	no country-pair/time FE	country-pair & -time FE
plurilateral exclusive network dummy	+/–	-0.11**	-0.13**
		(0.05)	(0.05)
× country-pair diff. in GDP	+	-0.0001	0.000
		(0.000)	(0.000)
× country-pair diff. in unit labor cost	+	0.001*	0.001*
		(0.000)	(0.000)
× country-pair distance	–	0.01	0.01
		(0.01)	(0.01)
plurilateral hub-and-spoke network dummy	+	0.02***	0.03***
		(0.006)	(0.01)
Full set of controls		yes	yes
number of observations		11197	11197
R square		0.04	0.11

Notes: (i) Standard errors are reported in the parentheses and clustered at country pair level; (ii) ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.

Table 7: Sensitivity analysis: propensity-score matching

Dependent variable: decision to form an FTA	H_0	matched by $\Pr[I(g^h_{ijt-1}) = 1]$
Average treatment effect on the treated (ATT)	+	0.11***
		(0.01)
number of observations		2678

Notes: (i) Bootstrapped standard errors are reported in the parentheses; (ii) ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.