The coevolution of trade agreements and investment treaties: Some evidence from network analysis

Nyi Nyi Htwe
Graduate School for International Development and Cooperation, Hiroshima University. 1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8529, Japan.
Minister's Office, Ministry of Planning and Finance, Office building No 1, Nay Pyi Taw 15011, Myanmar
E-mail: nyinyihtwe@hiroshima-u.ac.jp.

Seunghoo Lim, Ph.D., MPA
Graduate School of International Relations, International University of Japan. 777 Kokusai-cho, Minami Uonuma-shi, Niigata, 949-7277, Japan. Email: lim@iuj.ac.jp.

Makoto Kakinaka, Ph.D.
Graduate School for International Development and Cooperation, Hiroshima University. 1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8529, Japan. E-mail: kakinaka@hiroshima-u.ac.jp.

Abstract: Regional trade agreements (RTAs) and bilateral investment treaties (BITs) are expected to promote trade and investment relationships. One critical feature of such agreements is the network, so the multiplex coevolution of RTAs and BITs should be captured by the dynamics of their two networks. Although many studies have examined the roles of RTAs and BITs, most studies do not account for crucial network properties. This study explores how RTAs and BITs coevolve by applying a stochastic actor-oriented model of multiplex network evolution. In particular, we examine the roles of (i) cross-network dyadic interinfluences and (ii) within- and cross-network preferential attachments to discuss the dynamic relationships between RTAs and BITs. The results are as follows. First, our estimation supports cross-network dyadic interinfluences. Countries that sign a BIT are willing to establish an RTA, while those that sign an RTA are reluctant to establish a BIT. Second, concerning preferential attachments, countries prefer to sign BITs with partners that have more RTA and BIT links. However, countries tend to form RTAs with partners that have more BIT links but are reluctant to form RTAs with those that have more RTA links. We discuss possible justifications for these results, including arguments regarding the benefits and costs associated with the formation of RTAs and BITs.

Keywords: trade agreements; investment treaties; social network analysis; multiplex coevolution.

1 Introduction

As globalization prevails, countries around the world have connected with each other through global trade and investment relationships. In the last few decades, many countries have engaged in international agreements, and trade agreements and investment treaties among countries have drastically increased, leading to the promotion of trade and investment. Concerning regional trade agreements (RTAs), which became widespread after the 1990s, Crawford and Laird (2001) estimate that 76 percent of World Trade Organization (WTO) members participated in at least one RTA in 1998 and that currently, all WTO members participate in at least one RTA.[1] For investment treaties, there were 385 bilateral investment treaties (BITs) before 1989, and the number of BITs has grown considerably, to 2,181 in 2002 and 2,946 in 2018 (UNCTAD, 2003, 2018). The increasing trend of both RTAs and BITs shows the importance of international integration in the context of trade and investment for the economic development of countries.

The primary objective of an RTA is to reduce the costs of trade, such as tariff and non-tariff barriers, as well as promote trade-related facilitation of exports and imports, such as regulatory reforms, for trade liberalization (Krueger, 1999; Pomfret & Sourdin, 2009). At the same time, the fundamental purpose of a BIT is to reduce the cost of foreign direct investment (FDI) to promote FDI. In general, developing countries have an incentive to sign BITs to attract FDI from developed countries, while developed countries often initiate BITs for the purpose of legally protecting their investments (Elkins et al., 2006; Neumayer & Spess, 2005). Given these arguments, international agreements, particularly RTAs and BITs, have played a crucial role in promoting globalization. The main objective of this study is to examine the formation patterns of RTAs and BITs and derive important implications regarding their formation patterns.

[1] One hundred twenty-three bilateral and multilateral RTAs were notified to the General Agreement on Tariffs and Trade (GATT). Since the WTO was established in 1995, more than 300 RTAs were notified to the WTO Secretariat (Leal-Arcas, 2010).

One crucial aspect is that since trade and direct investment are closely related under the prevalence of trading activities by multinational corporations (MNCs), countries would consider trade and investment policies together, not separately. This implies that the formation of RTAs and the formation of BITs are interconnected. Thus, investigating the relations between these two agreements is important to understand the dynamic nature of countries' trade and investment policies as well as ongoing globalization. In addition, international agreements have been formed or dissolved through the interactions of participants. Governments make decisions regarding which partners they form a relationship with and how they approach their potential partners depending on their own and their partners' characteristics as well as the regional and whole network structures of international relations. International agreements have network properties, which are defined as a combination of two or more actors that repeatedly interact, exchange relations, and resolve disputes between actors (Podolny and Page, 1998), so possible network-related characteristics should be incorporated to discuss the dynamic movements of international agreements.

Evolving networks are common in a wide variety of social sciences. Snijders (2001) explains that the basic idea of social network evolution is that the actors in the network evaluate the network structure and obtain a pleasant configuration of relations. The most conventional network-related characteristics include triadic closures and preferential attachments. In addition, once multiple networks exist, the issue of multiplex coevolution may emerge so that these networks relate to other networks' configurations. In this study, the two networks of RTAs and BITs can coevolve because trade and investment relationships are crucial for policy coordination. To understand the coevolution of RTAs and BITs as crucial forms of cooperation among states, this study emphasizes the following two main hypotheses: (i) cross-network dyadic interinfluences and (ii) within- and cross-network preferential attachments. Specifically, the cross-network dyadic interinfluences from RTAs (BITs) to BITs (RTAs) imply that the presence of RTAs (BITs) between countries promotes the formation of BITs (RTAs) between these countries. Within-network preferential attachments are effects within the same network, which suggests that a country tends to form RTAs (BITs) with states with more RTAs (BITs). Cross-network preferential attachments are effects across different networks, which propose that a country tends to form RTAs (BITs) with states with more BITs (RTAs).

Given the argument that the emergence of RTAs and BITs is crucial for examining the topography of globalization, several studies have examined the causes and consequences of these agreements by applying conventional econometric methods, such as regression and matching (Buthe & Milner, 2008; Tobin & Busch, 2010; Vicard, 2011, for RTAs and Busse et al., 2010; Elkins et al., 2006; Neumayer et al., 2005, for BITs). However, most of these studies do not consider important network properties, such as coevolution, triadic closures, and preferential attachments, in a comprehensive manner, as they are difficult to examine under conventional econometric methods. To achieve the analysis of interconnections between the two international networks, this paper employs a social network framework. Social network analysis constructs the structure of a network composed of nodes that are linked to each other by specific types of connections. Recognizing countries as nodes in the network and the ties of RTAs and BITs as connections, this study examines the dynamic patterns of the formation of RTAs and BITs, particularly cross-network dyadic interinfluences and within- and cross-network preferential attachments, by applying a stochastic actor-oriented model (SAOM).[2] The SAOM, introduced by Snijders (2001) and Snijders et al. (2010), comprises a stochastic modelling environment for the analysis of longitudinal network data and is designed to disentangle complex processes affecting network formation from the impacts of networks on the actors' attributes.[3]

[2] SAOMs have recently become a popular network analysis tool in various social science fields (Chuluun, 2017; Kim et al., 2002; Mahutga, 2006; Prell et al., 2016; Rossem, 1996; Saban et al., 2010). To model the endogenous mechanisms of network formation, there are two important classes of statistical models, i.e., the exponential random graph model (ERGM) and the stochastic actor-oriented model (SAOM). Both models have been applied to analyze binary networks, in which the likelihood of a tie to exist or come about depends on its embedding in the configurations or substructures of other ties within the network. Although the two models share similar properties, they differ in their details. Intuitively, the ERGM is regarded as 'tie-based,' while the SAOM is regarded as 'actor-oriented.' For a detailed explanation, see (Stadtfeld et al., 2017).

[3] It should be noted that although SAOMs mitigate some of the endogeneity issues, they do not address all causal inferences, including problems of unobservable variables, which may be one crucial issue in regression analysis. Goldthorpe (2000) suggests that future studies should move from association to causation. However, SAOMs allow for

In the contexts of international relations and international economics, several works apply the SAOM to evaluate the evolution of international trade networks, such as trade agreements and bilateral trade flows, in relation to other economic and political factors, such as democratization, carbon trade imbalance, and nontrade agendas (Lovrić et al., 2018; Manger et al., 2012; Manger & Pickup, 2016; Milewicz et al., 2016; Prell & Feng, 2016). Despite the growing number of studies on trade networks, empirical works on investment networks in the framework of network analysis are relatively scarce.[4] Moreover, no empirical studies have examined the interconnections of trade-investment agreements with the consideration of their network properties. Thus, this study is the first attempt to examine the dynamic patterns of the networks of RTAs and BITs with the use of SAOM, which enables us to evaluate the roles of within- and cross-network properties.

2 Trade agreements and investment treaties

2.1 Trade agreements

International trade agreements, both bilateral and plurilateral, are expected to achieve trade liberalization with the free flow of goods and services between member countries.[5] Although the scope and coverage areas differ among agreements, the fundamental purpose of the trade agreements is to eliminate tariff and non-tariff barriers to trade (Missios et al., 2016; Saucier & Tariq, 2017).

---

the analysis of a longitudinal design to address some issues related to causality, such as selection-influence problems (Lomi et al., 2011; Ripley et al., 2019).

[4] An exception may include the work of Saban et. al. (2010), which analyzes the proliferation of BITs applying a social networks approach.

[5] According to the WTO, regional trade agreements (RTAs) and preferential trade agreements (PTAs) are two prominent features of international trade. PTAs are unilateral trade preferences (non-reciprocal agreements), and RTAs are reciprocal full-fledged trade agreements (Liu, 2010). Under the WTO classification, any trade agreements with two or more participants are regarded as RTAs, which implies that RTAs include both bilateral and multilateral agreements. On the other hand, a PTA is characterized as a unilateral trade privilege that is granted by developed nations for the products of the developing and least-developed world, such as the Generalized System of Preferences (GSP) and other non-reciprocal schemes that are granted a waiver under UN General Council. As one of the reviewers pointed out, it should be noted that many developing countries may be only available to form only PTAs because they lack basic trade links and cannot really deal with the economic adjustment costs of bilateral liberalization. According to the WTO, there are 34 PTAs provided by 23 countries as of May 2019. Since PTAs can still be considered reciprocal in the sense of a SAOM, we believe that the formation of PTAs can be incorporated into the model to understand the whole picture of trade agreement networks. Although we admit such arguments, this study follows the works of Baltagi et al. (2008) and Jean and Bureau (2016) and considers only RTAs since our interest is reciprocal network formation. The analysis of the evolution of RTAs and PTAs (agreements under GATT Article 24 and the 'Enabling Clause') in the framework of SAOMs is left for future research.

Leal-Arcas (2010) states that participants in an RTA offer more favourable conditions in trade-related matters to each other than to non-members, even within the WTO. Whalley (1996) explains that some countries, particularly small countries, attempt to engage in trade agreements with large countries to obtain secure market access from the partner (e.g., Canada-US FTA), while others use trade agreements as a tool to support their internal political reforms. The WTO allows its members to violate the basic rule of most favoured nation (MFN) treatment only for RTAs, so WTO members can enjoy special treatment by implementing an RTA that targets only its participating members.[6] Thus, countries have still attempted to participate in RTAs to obtain benefits from country-specific special treatment.

In this study, data for RTAs are taken from Mario Larch's Regional Trade Agreements Database, which is based on the WTO's Regional Trade Agreements Gateway (Egger et al., 2011; Egger & Larch, 2008).[7] RTAs are composed of mainly the following two parts: free trade agreements (FTAs) and customs unions (CUs). FTAs and CUs share similar characteristics, such as the elimination of tariff and non-tariff barriers on goods and services traded among the member countries, although there are some distinctions between them.[8] FTAs are more common than CUs because 90 percent of existing trade agreements are FTAs (Freund & Ornelas, 2010). According to

[6] Under the MFN treatment rule, if a WTO member gives special treatment to any country within or outside the WTO, every other member has to receive the same treatment. However, especially for RTAs, the WTO allows its members to give special treatment to those participating in RTAs, regardless of the RTA members' participation in the WTO.

[7] This study considers only bilateral RTAs. The inclusion of multilateral RTAs in bilateral relations may lead to a misleading interpretation since the objective of our study is to examine reciprocal relations with the characteristics of individual countries and country-pairs. Menon (2007) discusses that bilateral RTAs are not equally regarded as multilateral deals, at least in practice. In addition, Milewicz et. al. (2016) argue that treating multilateral agreements as their constituent dyads in a framework of one-mode networks poses methodological problems when the actors' choices to join multilateral agreements are analyzed, so that multilateral agreement networks should be modelled as two-mode networks. Since our main interest is on countries' choices to form reciprocal agreements, our analysis is based on one-mode networks with bilateral RTAs and BITs, rather than multilateral agreements. Moreover, for RTAs (and BITs in a later section), the two dates are applied as the dates of signature and entry into force. Some studies use the date of signature as the starting date of the agreement between two countries since they assume that signing an agreement is evidence of their willingness to follow the commitments (Elkins et al., 2006; Saban et al., 2010). However, other studies use the date of entering into force as the starting date of the agreement since some agreements have existed without entering into force even though they were signed (Jean et al., 2016; Kinne, 2013). This study uses the latter date as the starting date of the agreement.

[8] FTAs eliminate tariffs and measures that have equivalent effects for traded products between the member countries, but the member countries are not required to have a common policy regarding tariffs and such measures. CUs are a free trade union with a common policy regarding tariffs and measures that have equivalent effects.

the WTO, 124 notifications of RTAs related to the trade of goods were received by the General Agreement on Tariffs and Trade (GATT) during the period from 1948 to 1994.[9] Since the WTO was formed in 1995, the number of RTAs related to the trade of goods and services has increased drastically. Table 1 presents the evolution of RTAs over the period from 1990 to 2010 in our sample and shows that the number of RTAs increased from 13 in 1990 to 152 in 2010.[10] This fact supports the argument that enormous numbers of RTAs have been implemented, although RTAs had already started much earlier than the 1990s (Baltagi et al., 2008; Dur et al., 2014).

[Table 1 here]

2.2 Investment treaties

BITs are agreements between two governments for their investors to guarantee rules of expropriation, dispute settlements and ensure fair, equitable and non-discriminatory treatment while allowing market access for foreign investors (Berger et al., 2013; Egger & Pfaffermayr, 2004; Elkins et al., 2006).[11] The primary objective of signing a BIT is to eliminate investment risks, which secures and promotes cross-border investments. By signing BITs, developing countries receive more FDI from the developed world, while developed countries expect legal protection for their investors (Neumayer et al., 2005). BITs improve the credibility of the host government's commitment by providing private firms with the right to pursue legal remedies (Elkins et al., 2006). Since developed countries are important sources of foreign capital, developing countries often attempt to sign BITs to attract FDI under legal obligation. On the other hand, the abundant resources, such as cheap labour and raw materials, in developing countries attract MNCs, and thus, MNCs lobby for the governments

[9] GATT was signed in 1947. The WTO succeeded GATT, and 75 existing GATT members became founding members of the WTO in 1995.
[10] As explained in a later section, the EU is treated as a single country in our study.
[11] Similar to RTAs, international investment agreements (IIAs) also include multilateral and bilateral investment treaties. This study focuses on bilateral agreements since our study examines an individual country's motivation and behavior to form bilateral agreements in the framework of network analysis.

of developed countries to sign a BIT to secure their FDI. Thus, both developing and developed countries have an incentive to sign BITs, and currently, BITs play an important role in international cooperation among countries (Saban et al., 2010). Moreover, Falvey and Foster-McGregor (2018) state that the existence of a BIT between two countries enhances private investment not only from the partner country but also from outside of the two countries.

This study takes information on investment treaties from the United Nations Conference on Trade and Development (UNCTAD). The dataset comprises two components, as follows: (i) bilateral investment treaties and (ii) treaties with investment provisions. The former group comprises agreements between two countries for the promotion and protection of investments, while the latter group comprises other types of agreements that are not counted as the former, not focusing only on the investment as usual investment treaties but including investment obligations as a part of the agreement.[12] Although these two agreements are classified separately, they share similar functions of investment promotion and protection. Thus, this study defines BITs as both bilateral investment treaties and treaties with investment provisions in the UNCTAD database. The first BIT, which entered into force in 1962, was signed between Germany and Pakistan in 1959. Since then, the number of BITs has increased, particularly after the early 1990s. Table 1 presents the trend of BITs over the period from 1990 to 2010 in our sample and shows that the number of BITs increased from 82 in 1990 to 924 in 2010. Compared with RTAs, BITs are more prevalent in terms of the number of agreements.[13] As of 2010, the density of BITs is much higher than that of RTAs (0.086 for BITs and 0.014 for RTAs).

2.3 Social network analysis of trade agreements and investment treaties

[12] Under the terminology of UNCTAD, international investment agreements (IIAs) comprise the following two components: bilateral investment treaties (BITs) and treaties with investment provisions (TIPs). TIPs can be divided into the following three types: (i) broad economic treaties that include obligations commonly found in BITs, (ii) treaties with limited investment-related provisions, and (iii) treaties that contain only "framework" clauses, such those on cooperation in the area of investment and/or for a mandate for future negotiations on investment issues.

[13] As explained in a later section, this study assumes that the EU is treated as a single country. The BIT network consists of BITs excluding treaties with investment provisions (TIPs) in Table 1.

It is widely acknowledged that trade and FDI are important driving forces for economic growth. Thus, many countries have established RTAs and BITs with their partners to promote trade flows and FDI. Some studies have discussed the consequences of RTAs and BITs mainly on trade flows and FDI (Baier & Bergstrand, 2007; Berger et al., 2013; Kerner, 2009; Medvedev, 2012; Neumayer et al., 2005). At the same time, several works have examined the determinants of RTAs and BITs (Baier & Bergstrand, 2004; Bergstrand & Egger, 2013; Vicard, 2011). However, most studies generally evaluate the roles of RTAs and BITs separately, although these two agreements are interrelated due to the close trade-investment relationship under the prevalence of trading activities by multinational corporations (Tobin et al., 2010). In addition, the dynamic interactions of member countries form or dissolve international agreements, such as RTAs and BITs. Governments' decisions about the partners with which they make relational ties depend on their own and their partners' characteristics as well as the regional and whole network structures of international agreements. Thus, possible network-related characteristics should be incorporated to capture the complex features of international agreements.

Several studies employ social network analysis to discuss the network evolution of trade agreements (flows) and BITs (Askari et al., 2018; Chyzh, 2016; Kim & Shin, 2002; Lovrić et al., 2018; Mahutga, 2006; Rossem, 1996; Saban et al., 2010; Zhou et al., 2016). Among them, recent works applied the SAOM to evaluate the dynamic patterns of the formation of international agreements. For example, Kinne (2013) develops a network explanation for how countries achieve bilateral international cooperation, including trade agreements, and suggests that countries tend to create bilateral agreements if they share agreements with common third parties (triadic closures) and accede more agreements (preferential attachments). Manger and Pickup (2016) confirm the coevolution of RTAs and democracy, and Manger et al. (2012) show that RTAs spread endogenously because of structural arbitrage effects in the RTA network. Moreover, Milewicz et al. (2016) examine bilateral and plurilateral preferential trade agreements (PTAs) and nontrade issues (NTIs), including human rights, democracy, the environment, corruption, and labour standards and suggest that the countries' choices to commit to bilateral or plurilateral PTAs and to PTAs with NTIs are highly interdependent. However, no past works have studied the dynamic interconnection of RTAs and BITs. Thus, differently from the existing literature, this study incorporates the possible network-related characteristics associated with the two international agreements of RTAs and BITs into the models to discuss the coevolution of RTAs and BITs.

3 Hypotheses

To discuss the dynamic relationships between RTAs and BITs, we apply a social network framework and propose the following two main sets of hypotheses related to network-related properties: (i) cross-network dyadic interinfluences and (ii) within- and cross-network preferential attachments.

3.1 Cross-network dyadic interinfluences

Cross-network dyadic interinfluences in this study mean that the existence of one type of relational tie between countries encourages or discourages another type of relational tie between those countries. Specifically, this paper evaluates the cross-network dyadic interinfluences between RTAs and BITs. Figure 1 illustrates that the presence of an agreement (RTA or BIT) between country i (initiator of an agreement) and country j promotes, or increases, the probability of the formation of another agreement (BIT or RTA) between them. In general, international agreements provide various economic and political benefits. Signing a cross-border agreement is a strong commitment, which would derive higher credibility for the governments, both locally and regionally (Dreher & Voigt, 2011). With credibility, the involved countries could enjoy direct or substantive benefits from the specific matters that the agreements target as well as indirect benefits from obtaining information about economic and other related issues of their partners (Kinne, 2013).

RTAs and BITs may enhance the country's welfare by promoting cross-border trade and FDI, although there may be unfavourable effects on some sectors. More relevantly, RTAs and BITs complement each other due to the close trade-investment relationship. RTAs primarily encourage firms, particularly multinational corporations, to promote trade by expanding their overseas business and to increase the scope of the economy, not only in terms of trade but also in other sectors, such as finance, infrastructure, and information technology. This business expansion often requires direct investment and related financial transactions, and BITs thus play a role in securing such transactions (Elkins et al., 2006). This sequence suggests cross-network effects from RTAs to BITs, i.e., RTAs are expected to promote the formation of BITs. On the other hand, the primary objective of BITs is to reduce the risk of investment and to promote FDI. FDI and its associated cross-border financial flows incorporate global supply chains with trade flows of intermediate products, which leads to the need for further trade liberalization. In fact, FDI by multinational corporations often targets exports of final or intermediate products to the investing country. Since RTAs are vital to reduce tariff and non-tariff barriers, governments are persuaded to strengthen their competitive position by signing RTAs. Moreover, Tobin and Busch (2010) discuss that BITs set a stage ahead of RTAs. These arguments suggest the presence of cross-network effects from BITs to RTAs, i.e., BITs are expected to promote the formation of RTAs.

[Figure 1 here]

It should be noted that international agreements also entail costs, which can be classified into several types of costs, such as start-up and subsequent costs (Milewicz et al., 2016).[14] Start-up costs capture the countries' resistance to obtaining approval or consensus from public or political institutions. Initiating an agreement entails negotiation costs and information costs, which are

[14] Milewicz et. al. (2016) discuss the costs of PTAs and classify the costs into the following three types: start-up, subsequent, and shared costs. Shared costs are related to transitivity with shared third partners. When countries have the same third partners, the cost of the formation of additional agreements, such as nontraded issues, is reduced.

associated with asymmetric information between countries, but the most important start-up costs may relate to the substantive parts of the agreement. International agreements often cause governments to face strong resistance from specific interest groups or the public because they expect that such agreements will yield an unequal distribution of substantive costs and benefits among industries.[15] In addition, the formation of international agreements also requires the government to change related regulations, which can also be included in the start-up costs. Moreover, trade- and investment-related agreements may reduce tariff revenues and investment-related fees, which are a significant portion of public revenue in some developing countries. These tendencies would be more substantial for RTAs than BITs. RTAs have often attracted the public's attention because people believe that the reduction of tariff and non-tariff barriers will have a direct effect on their life conditions. For example, agricultural farmers and organizations in some countries, such as Japan and South Korea, have resisted trade liberalization to protect their industrial rents.

However, once a country establishes an international agreement with its partner, the start-up costs associated with another agreement would be reduced. The earlier agreements may reduce negotiation and information costs as well as substantive costs by helping the governments obtain public consensus more easily due to the previously established relation. Thus, the existence of an RTA (BIT) tie between countries inspires an additional agreement, a BIT (RTA), between them.[16] This is also important to evaluate whether RTAs and BITs are substitutes or complements in terms of

[15] International agreements have often induced conflicts among groups in a country, which may indicate that governments face the difficulty of obtaining a public consensus. For example, there was a broad domestic protest in Japan against the Trans-Pacific Partnership Agreement (TPP) (Naoi & Urata, 2013). Japan's agricultural issues are serious in negotiations to obtain a consensus for FTAs if other countries tend to export more agricultural products to Japan (Honma, 2006). At the same time, international economic agreements make more credible commitments to the governments, especially for developing countries (Buthe & Milner, 2014).

[16] Tobin et al. (2010) analyze how the existence of a BIT influences the formation of an RTA in the context of North-South trade and show that a developing country that has signed a BIT with a developed country is more likely to sign an RTA with the same country. Our study extends the analysis in mainly two directions. First, we examine the coevolution of RTAs and BITs with the consideration of network properties. Second, RTAs and BITs are not restricted to North-South relations, but they have appeared between developed countries as well as between developing countries (Elkins et al., 2006). Thus, we incorporate all RTAs and BITs into the models to understand the general trends of the dynamic features of the two international agreements.

economic integration. If they are complements, the existence of one agreement inspires another agreement. Then, our hypotheses related to the cross-network dyadic interinfluences are as follows:

Hypothesis 1a (cross-network dyadic interinfluence from RTAs to BITs): A country pair with an RTA is more likely to enter into a BIT.

Hypothesis 1b (cross-network dyadic interinfluence from BITs to RTAs): A country pair with a BIT is more likely to enter into an RTA.

3.2 Within- and cross-network preferential attachments

The term 'preferential attachment,' initiated by Barabasi and Albert (1999), implies that people with many common friends are more likely to become acquainted than those with few or none (Newman, 2001), and it has widely been discussed in the field of network analysis. In the process of preferential attachments, an actor with more connections than other actors will increase its connectivity at a higher rate, and thus, the initial difference in the connectivity between two actors will increase further as long as the network grows, which is often called a 'cumulative advantage' (Barabasi et al., 1999). The attractiveness of a country in the network can be characterized by its degree centrality. Kinne (2013) emphasizes information and externalities mechanisms in the context of international cooperation. High-degree or highly popular targets may reveal information about countries' capacities to achieve institutional compliance and convey trustworthiness and reliability more credibly than their low-degree or less popular counterparts. For externalities, partnerships with high-degree countries may provide greater rewards because forming a relational tie to a high-degree country engenders indirect ties with and improves prospects for direct cooperation with its numerous partners. Thus, high-degree countries would attract further relational ties endogenously. Our interest is on the endogenous effects related to the two networks of RTAs and BITs. Similar to the discussion about international cooperation, preferential attachments could play an important role in the formation of RTAs and BITs.

With ongoing economic integration with global supply chains, many firms, particularly multinational corporations, import intermediate inputs or capital goods for exports and engage in FDI and various financial transactions, which call for RTAs and BITs. A country's trade and investment relational ties could reflect its own reliability and capability to implement institutional commitments in international cooperation, so that the benefit from establishing an agreement depends on the potential partner's popularity, and countries with more connections may attract further relational ties. At the same time, a country's costs, including start-up and substantive costs, for establishing an agreement also depend on the potential partner's popularity, partly because the negotiation processes reflect the country's and its potential partners' economic and political power. Importantly, the benefits and costs of establishing an agreement depend on a country's target agreement (RTA or BIT formation) as well as the type of its potential partner's density or popularity (RTA-popular or BIT-popular partner), i.e., within- and cross-network preferential effects matter for the formation of RTAs and BITs. Given the above arguments, we propose four hypotheses related to within- and cross-network preferential attachments, as follows:

Hypothesis 2a (within-network preferential attachment of BITs): A country is more likely to form a BIT with a more popular country in the network of BITs.

Hypothesis 2b (within-network preferential attachment of RTAs): A country is more likely to form an RTA with a more popular country in the network of RTAs.

Hypothesis 3a (cross-network preferential attachment from RTAs to BITs): A country is more likely to form a BIT with a more popular country in the network of RTAs.

Hypothesis 3b (cross-network preferential attachment from BITs to RTAs): A country is more likely to form an RTA with a more popular country in the network of BITs.

The first two hypotheses correspond to within-network preferential attachments, and the last two correspond to cross-network preferential attachments. Figures 2 and 3 illustrate that country i prefers to form a BIT or an RTA with a popular country j_1 rather than a less popular country j_2 in the network of BITs or RTAs.

[Figure 2 here]

[Figure 3 here]

4 Model specification and data

To examine the countries' decisions in the two coevolving networks of RTAs and BITs with within-network and across-network interdependencies, this study applies the SAOM, which is used to analyse panel network data and illustrate the evolution of networks among actors over time as a result of the actors' choices. The SAOM estimates the relative importance of factors that affect the networks over time, i.e., the structure of the networks and characteristics of countries affecting the probability that the countries will choose to create or dissolve relational ties. The background of the network evolution assumes that each actor in the network will determine its configuration to satisfy a higher utility by forming new ties or terminating existing ties.[17] Recent works prove the fitness of network analysis in various fields, especially regarding the network of political alliances and trade agreements (Kinne, 2013; Mahutga, 2006; Manger et al.,2012; Milewicz et al., 2016). In this study, the network structure is non-directed. Each country optimizes its choices of RTAs and BITs with other countries. Our SAOM disentangles the processes of the 'RTA network' and 'BIT network'

[17] SAOMs have four main assumptions (Snijders et al., 2010; Milewicz et al., 2016). The first assumption is that time is continuous so that tie changes build up incrementally from one wave to the next, although variables are observed at discrete time points. The second assumption is that tie changes reflect the actors' preferences regarding their local network, such that the preferences are expressed in an objective function, and the relative contribution of each effect is estimated from a simulated series of tie changes between waves. The third assumption is that only one randomly selected actor can consider a tie change in one of the networks at each step in the simulation. The initiator of a bilateral agreement cannot be identified, so the model is specified as a multinomial choice of one and the binomial agreement of the other. The fourth assumption is a Markov process that requires that each change depends only on the state of the network at that particular wave.

models over time by accounting for the endogenous features of the networks and exogenous features involving attributes.[18]

The actor-oriented approach characterizes the international system as a collection of networks evolving from the interdependent decisions of countries, allowing for the functional form of the statistical estimator directly from theoretically driven assumptions about the utility functions of countries. Let $X = (x_{ij})$ denote an $n \times n$ matrix representing an RTA network, and let $Y = (y_{ij})$ denote an $n \times n$ matrix representing a BIT network, where x_{ij} and y_{ij} are dichotomous variables representing the RTA and BIT ties between countries i and j, respectively. Our analysis is based on a panel study of the two networks, which are observed over time T = $(t_1, \cdots, t_M)$ with $M \geq 2$. Both RTAs and BITs are treated as non-directed network ties. The RTA and BIT networks are specified as codependent variables; i.e., both networks serve as dependent variables as well as independent variables.

The network objective function determines the probabilities of a relational tie change in the network given that a country has an opportunity to change its relational tie. The country makes decisions based on the objective of maximizing its utility after considering the current structures of the networks and the distributions of monadic and dyadic covariates. If a country proposes a relational tie, its potential partner chooses to confirm or reject the proposal depending on the utility maximization problem.[19] In this study, the utility of country i is captured by the two objective functions of the RTA and BIT networks with random components, which are, respectively, defined as a linear combination of a set of endogenous network influences and exogenous covariates, as follows:

$$f_i^X(\beta, x, y) = \sum_k \beta_k^X S_{ki}^X(x, y), \qquad (1)$$

[18] The estimation process involves a computer simulation in which the observed data serve as inputs, and the two models are estimated simultaneously with the use of the Method of Moments option (Ripley et al., 2018). We estimate the SAOMs by using version 1.1-232 of the Simulation Investigation for the Empirical Network Analysis (SIENA) software program in R.
[19] The model assumes that a country considers possible actions and the corresponding changes in its utility once afforded an opportunity to make a choice and then chooses the best action that is expected to maximize its utility.

$$f_i^Y(\beta, x, y) = \sum_k \beta_k^Y S_{ki}^Y(x, y), \quad (2)$$

where x and y are the given observations of the RTA and BIT networks, respectively; the functions $S_{ki}^X(x, y)$ and $S_{ki}^Y(x, y)$ represent the model-specified network influences and relevant exogenous covariates of country i, which are often called the 'effects' in the network literature; and $\beta^X = (\beta_0^X, \cdots, \beta_L^X)$ and $\beta^Y = (\beta_0^Y, \cdots, \beta_L^Y)$ are the corresponding parameters in the two objective functions, which represent the importance of various effects. A positive (negative) β_k^X estimate indicates that the corresponding $S_{ki}^X(x, y)$ effect encourages (discourages) RTAs, and a positive (negative) β_k^Y estimate indicates that the corresponding $S_{ki}^Y(x, y)$ effect encourages (discourages) BITs. Similar to multinomial logistic regression, the estimate for a given effect is the log odds ratio of the probability that country i will choose to form the corresponding tie, given that the only difference is a one-unit change in the effect of interest (Ripley et al., 2019).

[Table 2 here]

Table 2 presents the mathematical expressions for all the effects in the model. To evaluate Hypotheses 1a and 1b, we incorporate cross-network dyadic interinfluences, which capture the effect of a tie in the RTA network on the formation of a BIT and the effect of a tie in the BIT network on the formation of an RTA. Concerning Hypothesis 2a, the model includes the effect of the indegree popularities of country i's partner countries in the same network, which captures the within-network preferential attachments. Our measure of the indegree popularity of country i's partner country j is based on the weighted value by the logs of country j's partners' real GDPs. This specification suggests that the indegree popularities reflect not only the number of relational ties but also the economic sizes of the potential partner countries. To evaluate Hypothesis 2b, the model captures the cross-network preferential attachments by including the effect of the indegree popularity of country i's partner country j in a different network, which are also weighted by the logs of the real GDPs of country j's partners. It should be noted that the cross-network dyadic interinfluences and preferential attachments are the effects associated with the multiplex RTA and BIT networks, while the within-network preferential attachments are the effects associated with each of the RTA and BIT networks.

Following conventional network models, the model incorporates additional endogenous network effects by including the density (outdegree) and transitive tie effects. The outdegree effects are the most basic in network analysis. In a decision-theoretic approach, this effect reflects the balance of benefits and costs of an arbitrary relational tie such that if the costs are larger (smaller) than the benefits for a country to establish a relational tie to an arbitrary other country, the parameter value is negative (positive). The tendency towards triadic closures or transitive ties is well acknowledged as a distinct feature in most networks in the sense that friends of friends become friends. Several studies, such as Manger et al. (2012) and Kinne (2013), emphasize the importance of triadic closure effects in the context of RTAs, although no extensive studies have existed on these effects in the context of BITs. Chen and Joshi (2010) suggest that the probabilities of engaging in an RTA for two countries rely heavily on the existence of a common third country connected to both countries with pre-existing RTAs. Kinne (2013) states that unclosed triads generate issue-specific negative externalities that materially deteriorate the two countries' status quo relationship, pressuring them to cooperate with one another directly.[20] A positive parameter on the triadic closure effect suggests that the benefits of an agreement with the third country dominate the costs, so that the country has an incentive to do so. In contrast, a negative parameter on the triadic closure effect implies that the country prefers to be central in the network, rather than to connect with the third countries and form a transitive tie (Stadtfeld et al., 2017).[21]

[20] Kinne (2013) explains issue-specific negative externalities generated by unclosed triads in the case of RTAs. RTAs create negative externalities when reduced tariffs cause trade diversions from more efficient nonmember producers to less efficient RTA members (Bagwell & Staiger, 1997).

[21] One plausible implication of triadic closures is that when country h has a relational tie (reciprocal agreement) with countries i and j, country i considers whether it will form a relational tie with country j or with another country k that has no relational tie with countries h and j. The former choice is referred to as a triadic closure or transitive tie. The latter can be recognized as a centralization because country i may intend to obtain the central position among three countries i, h,

Our model incorporates several dyadic and monadic covariate effects in the model. As dyadic covariate effects, this study considers bilateral trade flow, political alliance, and geographical distance. A bilateral trade flow is calculated as the log of the sum of bilateral exports and imports, and our political alliance variable is a binary variable that captures broad measures covering defence, neutrality, nonaggression pacts, and entente. Bilateral trade flow and political alliance capture the degrees of trade and political connections between two countries, respectively. Trade would be a strong determinant of the formation of economic agreements, and countries select themselves into RTAs based on existing trade (Baier & Bergstrand, 2007; Manger & Pickup, 2016). In addition, political alliances generally reflect capability aggregation, political friendship, and political compatibility (Cranmer et al., 2012). Countries involved in political alliances tend to form RTAs because they can internalize the security externalities of trade (Tobin & Busch, 2010). Moreover, the likelihood of pairs of countries forming RTAs and BITs is higher when they are close in distance that could capture trade costs (Baier & Bergstrand, 2004; Bergstrand & Egger, 2013; Manger & Pickup, 2016). Furthermore, our model includes a binary variable of a multilateral RTA, which equals one if two countries are members of the same multilateral RTA and zero otherwise, into the objective function related to the RTA decision.[22]

The model also controls for monadic covariate effects by including the log of real GDP, the log of real GDP per capita, and political stability for both objective functions. Real GDP and real GDP per capita capture a country's size of economy and income level, respectively. In the context of a general equilibrium model of world production, consumption, trade, and FDI, Bergstrand and Egger (2013) discuss the determinants of RTAs and BITs and show that economic size (real GDP)

---

and k by choosing to form a relational tie with country k, rather than to favor a cognitive balance of the economic power by choosing to form a relational tie with country j (triadic closure).

[22] Our binary dyadic measure of multilateral RTAs assumes that each of the members connects with other members, i.e., multilateral RTAs are decomposed into their constituent dyads. Although the number of bilateral RTAs is larger than that of multilateral RTAs, the number of dyadic ties related to multilateral RTAs is larger since typical multilateral RTAs, such as ASEAN trade agreements, are signed by several member countries. In addition, if two countries sign more than one multilateral agreement, we treat the case as only one multilateral agreement since our interest is on whether they are connecting or not, regardless of the number of multilateral agreements between them (Saban et al., 2010).

and political stability are significant determinants of RTAs and BITs. Manger et al. (2012) mention that the relative economic development, defined as income per capita, between two countries determines the patterns of RTA formation. In addition, given that the primary targets of BITs and RTAs are respectively to enhance FDI and trade flows, we include the ratio of FDI net inflow to GDP in the objective function of the BIT decision and the ratio of trade flows (exports plus imports) to GDP, which is often called trade openness or dependency, in the objective function of the RTA decision. The model includes these monadic variables of a country (ego)'s potential partners (alter) and their interactions with the corresponding variables of the country itself (ego × alter) to evaluate the monadic covariate effects as well as the possible heterogeneity of the effects.

The information on RTAs is taken from Mario Larch's Regional Trade Agreements Database, and the information on BITs is taken from the UNCTAD International investment agreements (IIAs) database. One crucial issue of our network analysis is how to treat the EU in the model, i.e., whether the EU should be treated as a single actor. The EU had no competence over investment until the Treaty of Lisbon, and the member countries could thus sign investment treaties individually, which has increased the number of potential BITs. On the other hand, EU member countries do not sign individual RTAs because they are not permitted to do so legally. Since 1958, the Commission of the European Communities has negotiated all trade agreements on behalf of the member states (Manger et al., 2012). This suggests that it is not appropriate to treat EU member countries as individual actors, given their legal status in trade policy and the EU's common external commercial policy. Given this argument, we treat the EU as a single country, following the work of Manger et al. (2012).[23] For BITs, we need to correctly treat the EU as such for RTAs. To do so, we assume that the EU has a

[23] As one of the reviewers pointed out, we treat the EU as a single country. Manger et al. (2012) point out this issue and consider the EU as a single actor. They suggest that treating EU member countries separately not only ignores this issue but also inflates the number of trade agreements, and that the EU is itself a member of the WTO that is the only supranational association. They also state that including EU members as separate countries also increases the risk of the overestimation of network effects that are driven only by the uniquely dense integration among EU members. In our study, this particular problem applies only to the EU, not to other country groups with multilateral RTAs, like the North American Free Trade Agreement (NAFTA), Trans-Pacific Partnership Agreement (TPPA), and ASEAN Free Trade Area (AFTA).

BIT tie with a partner if at least two out of the major three EU members (France, Germany, and Britain) have a BIT tie with the country.

Another crucial issue related to the data construction is how to treat BITs and the case of RTAs that include BIT-like clauses. Many treaties with investment provisions (TIPs) in the UNCTAD database that are not BITs are in fact RTAs with a sub-chapter related to investment, and such TIPs play a role similar to that of BITs.[24] This causes a problem. Two bilateral ties of RTAs and BIT-like clauses (TIPs) attached with the RTAs are not in different networks, but they are actually in a single agreement that represents a tie in the RTA network and a tie in the BIT network. In our dataset, the number of bilateral RTAs is 152 in 2010, among which 74 RTAs include investment clauses, while 78 RTAs do not. Although we admit that the non-separability of the two ties makes the evaluation of our hypotheses challenging, we attempt to mitigate this problem by estimating SAOMs with the use of different specifications for the BIT network and to confirm whether or not the estimated models with each of the specifications derive the consistent results. As the first specification, we consider BITs in the UNCTAD database as ties in the BIT network. In this specification, the BIT network does not include TIPs, so we ignore BIT-like investment clauses when estimating SAOMs. As the second specification, we consider BITs and TIPs in the UNCTAD database as ties in the BIT network. In this specification, the BIT network includes TIPs attached to RTAs. Thus, some BIT ties and RTA ties overlap in the two networks, although they are included in a non-separable single agreement of an RTA and a BIT-like investment clause.[25]

[24] The UNCTAD database includes ‘pure’ investment treaties (BITs) and other treaties with investment provisions (TIPs). Although TIPs primarily target non-investment issues, they play a role similar to that of ‘pure’ BITs in promoting and securing foreign investment and cross-border financial transactions. Some studies, such as Tobin and Busch (2010) and Bergstrand and Egger (2013), focus on ‘pure’ investment treaties to examine the causes and consequences of BITs. However, the exclusion of TIPs from the BIT network may be misleading concerning a country’s motivation for forming a BIT tie with its potential partners.

[25] In the UNCTAD database, some TIPs are attached to RTAs, and others are attached to non-RTAs, such as the EU-Turkmenistan Partnership Cooperation Agreement, Peru-Thailand Framework Agreement on Closer Economic Partnership, and Egypt-US Investment Development Agreement. The second specification is to regard all TIPs, irrespective of RTAs and non-RTAs, as ties in the BIT network. We further consider the third specification, where the BIT network consists of BITs and TIPs attached to non-RTAs in the UNCTAD database. In this case, the BIT network does not include TIPs attached to RTAs, so that we can avoid the duplication of TIPs attached to RTAs in both of the two networks. Although all three specifications of the BIT network cannot completely solve the problem of a single

With the EU as a single country, the model estimation uses the longitudinal data covering 147 countries over the period from 1990 to 2010 (21 waves). Each of our dependent variables of the non-directed RTA and BIT networks comprises an $N \times N \times T$ array with the number of countries, N, and the number of the sample periods, T, where a value of one indicates an RTA (BIT) in force between a dyad in a given period and zero otherwise. For dyadic covariates, data on bilateral trade flows and political alliances are obtained from the UN Comtrade database and the Correlates of War Project, respectively.[26] The data on geographical distance, colonial relationship, and common language are taken from CEPII's GeoDist database. For monadic covariates, the data on real GDP, real GDP per capita, trade openness, and FDI net flow are obtained from the World Development Indicators (WDI). Political stability is measured by the political risk index, which is obtained from the International Country Risk Guide (ICRG).[27]

5 Results

Figures 4 and 5 show digraphs of the RTA and BIT networks in 1990 and 2010, respectively. The sizes of nodes (countries) indicate degree centrality or the number of existing RTAs or BITs, with large nodes indicating high levels of degree centrality. First, it is observed that the BIT network was denser than the RTA network in both 1990 and 2010. Second, although the RTA network has become denser since 1990, many countries did not participate in RTAs in 2010. Third, the density of the BIT network has increased more rapidly, so most countries were involved in BITs in 2010. The recent rapid globalization can be verified by the prevalence of RTAs and BITs since the 1990s. In

agreement, we estimate SAOMs by using each of the three BIT specifications and check whether all estimated SAOMs provide consistent results. If all models provide consistent results, we may be able to claim that the results are reliable.

[26] Our bilateral trade flow is the sum of exports and imports such that the export of one country is the import of another country. To avoid asymmetry, we follow Helpman et al. (2008) and calculate the trade flow based on the unidirectional import values.

[27] In our dataset, we treat the EU as a single country. For monadic variables (GDP, per capita GDP, trade openness, FDI, and political stability), we recalculated the aggregate values or average values over EU countries. For dyadic variables, bilateral trade flows are aggregated over EU countries. The distance between the EU and its partner is measured by the geographical distance between the center of the EU (Paris) and the capital city of the partner. The approach for constructing the political alliance variable for the EU and its partner follows that of BITs. By reconstructing the data, we can effectively turn the EU into a single country with only bilateral, binary relations with other actors.

particular, more BITs than RTAs have been formed among countries, which may reflect the lower substantive and setup costs for BITs than RTAs. Fourth, the feature of centrality has become more apparent in 2010, so that some countries take a central position in the RTA and BIT networks.[28]

[Figure 4 here]

[Figure 5 here]

[Figure 6 here]

The degree of change in the network or the network stability between two consecutive waves can be measured by the Jaccard index or similarity coefficient. Our data show that the Jaccard index ranges from 0.61 to 0.96 for RTAs and from 0.78 to 0.97 for BITs, which satisfies the recommendation of Ripley et al. (2019) that the index should preferably be higher than 0.3 for SAOMs to be suitable. Our Jaccard index indicates less significant changes in the network, particularly BITs, between successive waves. Since relatively small changes would bias the model estimates towards the null hypothesis of no change in the network over time (Prell & Feng, 2016), the high Jaccard index implies the low likelihood for detecting significant tendencies in network dynamics, making our tests conservative. In addition, the overall maximum convergence ratios are smaller than 0.41 for all models, which implies the convergence of the algorithm (Ripley et al., 2019). Furthermore, we use the RSiena package to confirm the fit of the models by comparing the observed values with the average values of the simulated, auxiliary statistics for the ends of the periods (Ripley et al., 2019). Table 3 presents the estimated results of our multiplex SAOMs. The first two columns show the results of the multiplex SAOMs where the BIT network does not include TIPs, and the last two columns show the results of the multiplex SAOMs where the BIT network includes all TIPs. To confirm the empirical validity of our results, we also estimate the models by using the

[28] Figures 4 and 5 present bilateral links of RTAs and BITs, respectively. In our specification, multilateral links of RTAs are incorporated into the models as exogenous dyadic covariates. Figure 6 shows digraphs of the multilateral RTA network in 1990 and 2010.

three-year non-overlapping data during the period from 1990 to 2010 (7 waves), instead of the annual data (21 waves) in the baseline estimation (Table 4).[29]

5.1 Main effects

The estimated parameters capture the countries' decisions to formulate a bilateral RTA or BIT network. Beginning with the main effects related to the cross-network dyadic interinfluences between RTAs and BITs in Hypotheses 1a and 1b, the estimated results are consistent, irrespective of the models with different specifications for BITs. The estimated parameters in the BIT and RTA equations are significantly negative and positive, respectively. The presence of a BIT tie between countries inspires the formation of an additional RTA. In contrast, the presence of an RTA tie between countries discourages them from forming an additional BIT. Based on the results in the first two columns of Table 3, the presence of a BIT between two countries increases the probability that they form an RTA by a factor of $e^{1.4376} = 4.21$, or 321 percent, while the presence of an RTA between two countries decreases the probability that they form a BIT by a factor of $e^{-1.2992} = 0.27$, or -73 percent. Our analysis supports Hypothesis 1b but fails to support Hypothesis 1a, i.e., countries that sign BITs are likely to establish RTAs, but those that sign RTAs are less likely to establish BITs. Whether or not countries form an additional tie depends on how the presence of a tie would reduce the substantive costs, including the start-up costs, and how the additional tie would increase the economic benefits. Our results showing the negative cross-network dyadic interinfluence from RTAs to BITs suggest that once two countries established an RTA, the increase in the

[29] For additional robustness checks, we estimate the SAOMs with additional dyadic controls, the colonial relationship (Colony) and the sharing of common language (Common language), and report the estimated results based on the annual data (21 waves) and the three-year non-overlapping data (7 waves) in Tables A1 and A2 in the appendix, respectively. The way of constructing the dyadic colony and common language variables for the EU and its partner follows that described for BITs. For further robustness checks, we estimate the SAOMs with the revised BIT network that consists of BITs and TIPs attached with non-RTAs (see footnote 25 for the details of this specification of the BIT network). The estimated results are shown in Tables A3 and A4 in the appendix. The estimated results of these modified SAOMs are generally consistent with our baseline results in Tables 3 and 4.

economic benefits associated with BITs would be relatively small, so that they do not need to form a BIT. This is in line with the argument of Tobin et al. (2010) that a BIT sets a stage ahead of an RTA.

[Table 3 here]

[Table 4 here]

Concerning the preferential attachment effects, the analysis shows that the estimated parameters are significantly positive for the within-network preferential attachment effects of BITs, which supports Hypothesis 2a. On the other hand, the estimated parameters are negative for the within-network preferential attachment effects of RTAs, which fails to support Hypothesis 2b.[30] Based on the results in the first two columns of Table 4, a one-unit increase in the within-network preferential attachment effect increases the probability of a BIT by a factor of $e^{0.1063} = 1.11$, or 11 percent, and decreases the probability of an RTA by a factor of $e^{-0.2191} = 0.80$, or -20 percent. In addition, the estimated parameter is significantly positive for the cross-network preferential attachment effect from the RTA network to the BIT formation and for the cross-network preferential attachment effect from the BIT network to the RTA formation. The results support Hypotheses 3a and 3b. The results in the first two columns of Table 3 reveal that a one-unit increase in the cross-network preferential attachment effect from the RTA network to BIT formation increases the probability of BIT formation by a factor of $e^{0.0903} = 1.09$, or 9 percent, and a one-unit increase in the cross-network preferential attachment effect from the BIT network to RTA formation increases the probability of RTA formation by a factor of $e^{0.0271} = 1.03$, or 3 percent.

Regarding the formation of a BIT, a country is likely to form a BIT with partners that have formed more BITs and RTAs, called BIT- and RTA-popular partners (Hypotheses 2a and 3a). As

[30] The estimated parameters are negative but insignificant for the within-network preferential attachment effects of RTAs in the annual data setting (Table 3). However, these parameters are significantly negative in the three-year non-overlapping data setting (Table 4).

mentioned by Kinne (2013), highly popular countries could convey trustworthiness and reliability more credibly than less popular counterparts. BIT- and RTA-popularities are generally a signal of credibility for countries, and BIT- and RTA-popular countries have information about their partners' economic, financial, regulatory, and political conditions. Forming a BIT with such a popular partner allows a country to improve its own credibility and to obtain various information about not only the partner but also the partner's partners. In addition, the start-up cost of a BIT is generally small, particularly when the partners are highly credible in the international community. Thus, a country would have an incentive to promote private investment flows by forming a BIT with BIT- and RTA-popular partners.

Concerning the formation of an RTA, it is expected that countries are more likely to form an RTA with a more popular country in terms of RTAs and BITs, partly because forming an RTA with RTA- and BIT-popular partners provides the benefits of sharing information about the partners as well as the partners' partners. However, the analysis shows that a country is likely to form an RTA with BIT-popular partners (Hypothesis 3b) but is reluctant to form an RTA with RTA-popular partners (Hypothesis 2b). Our results against Hypothesis 3b are in contrast with the finding of Kinne (2013), which shows the preferential attachment effects in the trade agreement network.[31] One possible interpretation of counter-arguments against H2b may be related to the costs associated with RTA formation. Some countries, particularly developing countries with less negotiating and bargaining power, are often required to protect some specific domestic industries due to strong resistance against international economic agreements, particularly RTAs, from the public or specific interest groups that attempt to protect their rents or benefits. Signing an RTA often requires regulatory reforms towards deregulation to meet the international regulatory standards, including tariff and non-tariff regulations, which may yield unfavourable effects on some specific industries. This tendency may become more substantial when a country forms an RTA with an RTA-popular

[31] Kinne (2013) treats the EU members as different individual actors. Although the sample periods are different between Kinne's (2013) study and ours, our analysis suggests that the effect of the within-network preferential attachments of RTAs depends on whether or not the EU is treated as a single country.

country. Since the RTA-popular country and other countries connected with it through RTAs have already established their regulatory standards related to trade activities, including lower tariffs, a new country that will be a possible entrant may face difficulty in radically adjusting its regulatory conditions to the already determined regulatory standards. Thus, countries would be reluctant to form RTAs with RTA-popular countries. Another possible interpretation could be related to the argument that preferential attachment is a primary mechanism shaping a 'core-periphery' structure of the network (Sun & Liu, 2016; Guimera & Amaral, 2004; Barrat et al., 2005). Accounting for the EU as a single actor, our results against H2b suggest a lower tendency for core-periphery evolution in the RTA network. These arguments imply that some countries do not prefer to form an RTA with RTA-popular countries to be balanced or to avoid the core-periphery structure among countries.

5.2 Other effects

Our models control for endogenous network effects and exogenous dyadic and monadic covariate effects. The results show that the estimated parameters of triadic closure effects are significantly positive and negative in the RTA and BIT equations, respectively. The clear evidence of positive triadic closure effects for RTA formation coincides with the findings of Manger et al. (2012) and Chen and Joshi (2010). The presence of the common third country plays an important role in RTA formation, which suggests that countries prefer triadic closures for the cognitive balance of economic and trade power among countries. In contrast, the negative triadic closure effects for BIT formation can be interpreted as a situation where a country prefers the central position generated by forming a BIT with a new partner that has no BIT with any of its BIT partners rather than the cognitive balance generated by directly forming to the existing edges (Stadtfeld et al., 2017).

Concerning exogenous monadic covariate effects, we find several clear findings. First, countries tend to form BITs and RTAs with partners with large real GDPs, i.e., large-sized economies. By using the Canada-U.S. Free Trade Agreement (CUSTA) as an example, Whalley

(1996) mentions that countries search for RTAs with large partners as a way of obtaining more access to large-sized markets. In addition, countries with large-sized economies have more incentive to form BITs. Second, countries prefer to form international agreements, particularly RTAs, with relatively low-income partners. Moreover, low-income countries are more likely to form a BIT to attract FDI from multinational corporations, since BITs provide a protection mechanism for multinational corporations operating business in developing countries with weak institutions (Busse et al., 2010). Third, countries prefer to form BITs and RTAs with politically stable partners. Fourth, countries are likely to form RTAs with partners with high trade dependency and openness.

Our analysis also shows several clear results related to exogenous dyadic covariate effects. First, large bilateral trade flows between two countries do not encourage them to form an RTA but encourage them to form a BIT. Forming an RTA may not be required when two countries have already established a close trade relationship. Second, when two countries have participated in the same multilateral RTA, an additional bilateral RTA would not be needed for them. Third, when two countries have participated in the same political alliance, they are more likely to form an RTA. The existing political alliances are closely associated with the countries' motivation to sign an RTA. Fourth, two countries are more likely to form a BIT and an RTA when they are geographically close to each other.

6 Conclusion

The formation of RTAs and BITs is an important policy agenda for policymakers to promote international trade and direct investment as well as to shape international relations, including economic and political relations. This study examined the multiplex coevolution of RTAs and BITs to understand the trade-investment relationships among countries under ongoing globalization. Since the nature of international agreements is to form networks, we discussed how network-related properties, particularly (i) within-network dyadic interinfluences and (ii) within- and cross-network preferential attachments, relate to the multiplex coevolution of RTAs and BITs by applying SAOMs in a social network framework. Although SAOMs do not address all the causal inferences that are crucial issues in the regression models, they allow for the analysis of a longitudinal design to address some issues related to causality, such as selection-influence problems (Goldthorpe, 2001; Lomi et al., 2011; Ripley et al., 2019).

The estimation results supported the cross-network dyadic interinfluences from BITs to RTAs but failed to support those from RTAs and BITs, suggesting that a BIT sets a stage ahead of an RTA. Our analysis also showed preferential attachment effects within and across the two networks of RTAs and BITs. Countries prefer to sign a BIT with their popular partners that have more RTA and BIT links with other countries, partly since the start-up cost of a BIT is relatively small. On the other hand, countries tend to form RTAs with their popular partners that have more BIT links. However, they do not prefer to form RTAs with those that have more RTA links, which suggests the anti-core-periphery evolution of the RTA network. The start-up cost of an RTA with an RTA-popular partner would be substantial because of the strong resistance from specific interest groups or the public, although it provides benefits through the positive externalities associated with participation in common trading systems. This finding implies that the cost of an RTA with an RTA-popular partner dominates the benefit of the RTA.

Our empirical analysis provided some important results regarding the multiplex formation of RTAs and BITs to understand ongoing processes of economic integration in a globalized world. In closing, it is appropriate to mention the limitations of our study for possible future research. First, our study focused on bilateral agreements for trade and investment to discuss the formation of bilateral reciprocal agreements with multilateral RTAs that are treated as exogenous. However, recent studies, such as Milewicz et al. (2016), have emphasized the importance of plurilateral or multilateral agreements in a framework of two-mode networks with two types of nodes (i.e., countries and plurilateral agreements). In fact, plurilateral agreements, such as the ASEAN Free

Trade Area (AFTA), the North American Free Trade Agreement (NAFTA), and the European Economic Area (EEA), have played crucial roles in promoting trade relations among global supply chains with the prevalence of cross-border transactions by multinational corporations. Applying two-mode network analysis would help us understand the trade-investment relationships among countries in a more comprehensive manner. Second, our model considered only reciprocal agreements, particularly trade agreements, without consideration of the PTAs that the WTO classifies as unilateral privileges typically granted by developed countries for developing and least-developed countries. Because many developing countries lack basic trade links and face difficulty in dealing with the adjustment costs of bilateral liberalization processes, they may be available to form only PTAs. To comprehensively understand the evolution of trade agreement networks, the formation of such agreements must be incorporated into the framework of network analysis. Although we admit some unsolved problems, we believe that the current study is an important first step in understanding the multiplex coevolution of RTAs and BITs.

References

Askari, M., Shirazi, H., & Aghababaei Samani, K. (2018). Dynamics of financial crises in the world trade network. *Physica A*, *501*, 164–169.

Bagwell, K., & Staiger, R. W. (1997). Multilateral Tariff Cooperation during the Formation of Free Trade Areas. *International Economic Review, 38*(2), 291–319.

Baier, S. L., & Bergstrand, J. H. (2004). Economic determinants of free trade agreements. *Journal of International Economics*, *64*, 29–63.

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members ' international trade ? *Journal of International Economics*, *71*, 72–95.

Baltagi, B. H., Egger, P., & Pfaffermayr, M. (2008). Estimating regional trade agreement effects on FDI in an interdependent world. *Journal of Econometrics Journal*, *145*, 194–208.

Barabasi, A.-L., & Albert, R. (1999). Emergence of Scaling in Random Networks. *Science*, *286*, 509–513.

Barrat, A., Barthelemy, M., & Vespignani, A. (2005). The effects of spatial constraints on the evolution of weighted complex networks. *Journal of Statistical Mechanics: Theory and*

Experiment, 2005(05), P05003.

Berger, A., Busse, M., & Nunnenkamp, P. (2013). Do trade and investment agreements lead to more FDI ? Accounting for key provisions inside the black box. *International Economics and Economic Policy*, *10*, 247–275.

Bergstrand, J. H., & Egger, P. (2013). What determines BITs ? *Journal of International Economics*, *90*(1), 107–122.

Busse, M., Königer, J., & Nunnenkamp, P. (2010). FDI promotion through bilateral investment treaties: More than a bit? *Review of World Economics*, *146*(1), 147–177.

Buthe, T., & Milner, H. V. (2008). The Politics of Foreign Direct Investment into Developing Countries: Increasing FDI through International Trade Agreements? *American Journal of Political Science*, *52*(4), 741–762.

Buthe, T., & Milner, H. V. (2014). Foreign direct investment and institutional diversity in trade agreements: Credibility, commitment, and economic flows in the developing world, 1971-2007. *World Politics*, *66*(1), 88–122.

Chen, M. X., & Joshi, S. (2010). Third-country effects on the formation of free trade agreements. *Journal of International Economics*, *82*(2), 238–248.

Chuluun, T. (2017). Global portfolio investment network and stock market comovement. *Global Finance Journal*, *33*, 51–68.

Chyzh, O. (2016). Dangerous liaisons : An endogenous model of international trade and human rights. *Journal of Peace Research*, *53*(3), 409–423.

Cranmer, S. J., Desmarais, B. A., & Kirkland, J. H. (2012). Toward a network theory of alliance formation. *International Interactions*, 38(3), 295-324.

Crawford, J.-A., & Laird, S. (2001). Regional Trade Agreements and the WTO. *North American Journal of Economics and Finance*, *12*, 381–390.

Dreher, A., & Voigt, S. (2011). Does membership in international organizations increase governments' credibility? Testing the effects of delegating powers. *Journal of Comparative Economics*, *39*(3), 326–348.

Dur, A., Baccini, L., & Elsig, M. (2014). The design of international trade agreements : Introducing a new dataset. *The Review of International Organizations*, *9(3)*, 353–375.

Egger, P., & Larch, M. (2008). Interdependent preferential trade agreement memberships: An empirical analysis. *Journal of International Economics*, *76*(2), 384–399.

Egger, P., Larch, M., Staub, K. E., & Winkelmann, R. (2011). The trade effects of endogenous preferential trade agreements. *American Economic Journal: Economic Policy*, *3*(3), 113–143.

Egger, P., & Pfaffermayr, M. (2004). The impact of bilateral investment treaties on foreign direct investment. *Journal of Comparative Economics*, *32*, 788–804.

Elkins, Z., Guzman, A. T., & Simmons, B. A. (2006). Competing for Capital : The Diffusion of Bilateral Investment Treaties, 1960-2000. *International Organization*, *60*(4), 811–846.

Falvey, R., & Foster-McGregor, N. (2018). North-South foreign direct investment and bilateral investment treaties. *The World Economy*, 2–28.

Freund, C., & Ornelas, E. (2010). Regional Trade Agreements. *Annual Review of Economics*, *2*, 139–166.

Goldthorpe, J. H. (2001). Causation , Statistics , and Sociology. *European Sociological Review*, *17*(1), 1–20.

Guimera, R., & Amaral, L. A. N. (2004). Modeling the world-wide airport network. *The European Physical Journal B - Condensed Matter and Complex Systems*, 38(2), 381–385

Helpman, E., Melitz, M., & Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *Quarterly Journal of Economics*, *123*(2), 441–487.

Honma, M. (2006). WTO negotiations and other agricultural trade issues in Japan. *World Economy*, *29*(6), 697–714.

Jean, S., & Bureau, J. C. (2016). Do regional trade agreements really boost trade? Evidence from agricultural products. *Review of World Economics*, *152*(3), 477–499.

Kerner, A. (2009). Why Should I Believe You? The Costs and Consequences of Bilateral Investment Treaties. *International Studies Quarterly*, *53*, 73–102.

Kim, S., & Shin, E.-H. (2002). A Longitudinal Analysis of Globalization and Regionalization in International Trade: A Social Network Approach. *Social Forces*, *81*(2), 445–468.

Kinne, B. J. (2013). Network Dynamics and the Evolution of International Cooperation. *American Political Science Review*, *107*(4).

Krueger, A. O. (1999). Are Preferential Trading Arrangements Trade Liberalizing or Protectionist? *Journal of Economic Perspectives*, *13*(4), 105–124.

Leal-Arcas, R. (2010). Proliferation of Regional Trade Agreements: Complementing or Supplanting Multilateralism. *Chicago Journal of International Law*, *11*(2), 597–630.

Liu, X. (2010). Testing Conflicting Political Economy Theories: Full-Fledged versus Partial-Scope Regional Trade Agreements. *Southern Economic Journal*, *77*(1), 78–103.

Lomi, A., Snijders, T. A. B., Steglich, C. E. G., & Torló, V. J. (2011). Why are some more peer than others? Evidence from a longitudinal study of social networks and individual academic performance. *Social Science Research*, *40*(6), 1506–1520.

Lovrić, M., Da Re, R., Vidale, E., Pettenella, D., & Mavsar, R. (2018). Social network analysis as a tool for the analysis of international trade of wood and non-wood forest products. *Forest Policy* *and Economics*, *86*, 45–66.

Mahutga, M. C. (2006). The Persistence of Structural Inequality ?: A Network Analysis of International Trade , 1965-2000. *Social Forces*, *84(4)*, 1863-1889.

Manger, M. S., & Pickup, M. A. (2016). The Coevolution of Trade Agreement Networks and Democracy. *Journal of Conflict Resolution*, *60*(1), 164–191.

Manger, M. S., Pickup, M. A., & Snijders, T. A. B. (2012). A Hierarchy of Preferences : A Longitudinal Network Analysis Approach to PTA Formation. *Journal of Conflict Resolution*, *56*(5), 853–878.

Medvedev, D. (2012). Beyond Trade: The Impact of Preferential Trade Agreements on FDI Inflows. *World Development*, *40*(1), 49–61.

Menon, J. (2007). Bilateral trade agreements. *Asian-Pacific Economic Literature*, *21*(2), 29–47.

Milewicz, K., Hollway, J., Peacock, C., & Snidal, D. (2016). Beyond Trade: The Expanding Scope of the Nontrade Agenda in Trade Agreements. *Journal of Conflict Resolution*, *62*(4), 743–773.

Missios, P., Saggi, K., & Murat, H. (2016). External trade diversion, exclusion incentives and the nature of preferential trade agreements. *Journal of International Economics*, *99*, 105–119.

Naoi, M., & Urata, S. (2013). Free trade agreements and domestic politics: The Case of the trans-pacific partnership agreement. *Asian Economic Policy Review*, *8*(2), 326–349.

Neumayer, E., & Spess, L. (2005). Do Bilateral Investment Treaties Increase Foreign Direct Investment to Developing Countries ? *World Development*, *33*(10), 1567–1585.

Newman, M. E. J. (2001). Clustering and preferential attachment in growing networks. *Physical Review E - Statistical Physics, Plasmas, Fluids, and Related Interdisciplinary Topics*, *64*(2), 4.

Podolny, J. M., & Page, K. L. (1998). Network Forms of Organization. *Annual Review of Sociology*, *24*(1), 57–76.

Pomfret, R., & Sourdin, P. (2009). Have Asian trade agreements reduced trade costs? *Journal of Asian Economics*, *20*(3), 255–268.

Prell, C., & Feng, K. (2016). The evolution of global trade and impacts on countries ' carbon trade imbalances. *Social Networks*, *46*, 87–100.

Ripley, R. M., Snijders, T. A. B., Boda, Z., & Preciado, A. V. P. (2019). Manual for RSiena.

Ripley, R. M., Snijders, T. A. B., Preciado, P., Schweinberger, M., & Steglich, C. (2018). Manual for RSiena.

Rossem, R. Van. (1996). The World System Paradigm as General Theory of Development : A Cross-National Test. *American Sociological Review*, *61*(3), 508–527.

Saban, D., Bonomo, F., & Stier-Moses, N. E. (2010). Analysis and models of bilateral investment treaties using a social networks approach. *Physica A*, *389*(17), 3661–3673.

Saucier, P., & Tariq, A. (2017). Do preferential trade agreements contribute to the development of trade ? Taking into account the institutional heterogeneity. *International Economics*, *149*, 41–56.

Snijders, T. A. B. (2001). The Statistical Evaluation of Social Network Dynamics. *Sociological Methodology, 31*(1), 361–395.

Snijders, T. A. B., Bunt, G. G. Van De, & Steglich, C. E. G. (2010). Introduction to stochastic actor-based models for network dynamics. *Social Networks, 32*, 44–60.

Stadtfeld, C., Hollway, J., & Block, P. (2017). Dynamic network actor models: Investigating coordination ties through time. *Sociological Methodology*, *47*(1), 1–40.

Sun, Y., & Liu, K. (2016). Proximity effect, preferential attachment and path dependence in inter-regional network: a case of China's technology transaction. *Scientometrics*, 108(1), 201-220.

Tobin, J. L., & Busch, M. L. (2010). A bit is better than a lot: Bilateral investment treaties and preferential trade agreements. *World Politics*, *62*(1), 1–42.

UNCTAD. (2003). *World Investment Report 2003*. *UNCTAD* (Vol. 1).

UNCTAD. (2018). *World Investment Report 2018*. *UNCTAD* (Vol. 1).

Vicard, V. (2011). Determinants of successful regional trade agreements. *Economics Letters*, *111*(3), 188–190.

Whalley, J. (1996). Why Do Countries Seek Regional Trade Agreements? *The Regionalization of the World Economy*, *I*, 63–90.

Zhou, M., Wu, G., & Xu, H. (2016). Structure and formation of top networks in international trade , 2001 – 2010. *Social Networks*, *44*, 9–21.

Table 1. The evolution of RTAs and BITs

	BITs		RTAs	
	Number of ties	Density	Number of ties	Density
1990	82	0.0076	13	0.0012
1991	99	0.0092	14	0.0013
1992	113	0.0105	14	0.0013
1993	135	0.0126	23	0.0021
1994	167	0.0156	24	0.0022
1995	214	0.0199	30	0.0028
1996	274	0.0255	37	0.0034
1997	355	0.0331	41	0.0038
1998	413	0.0385	46	0.0043
1999	463	0.0431	48	0.0045
2000	522	0.0486	53	0.0049
2001	580	0.0540	61	0.0057
2002	638	0.0595	70	0.0065
2003	681	0.0635	77	0.0072
2004	718	0.0669	87	0.0081
2005	753	0.0702	97	0.0090
2006	798	0.0744	106	0.0099
2007	821	0.0765	111	0.0103
2008	850	0.0792	133	0.0124
2009	900	0.0839	145	0.0135
2010	924	0.0861	152	0.0142

Note: BITs and RTAs include only bilateral agreements over 147 sample countries. The Jaccard coefficient ranged from 0.784 to 0.969 for the BIT network and 0.609 to 0.958 for the RTA networks. BITs in this table do not include TIPs.

Table 2. All effects summarized

	Descriptions	Effects $S^X_{ki}(x,y)$ / $S^Y_{ki}(x,y)$
Main network effects		
H1a	Cross-network dyadic interinfluences from RTAs to BITs	$\sum_j y_{ij}x_{ij}$
H1b	Cross-network dyadic interinfluences from BITs to RTAs	$\sum_j x_{ij}y_{ij}$
H2a	Within-network preferential attachments of BITs	$\sum_j y_{ij} \sum_h y_{hj}v_h$
H2b	Within-network preferential attachments of RTAs	$\sum_j x_{ij} \sum_h x_{hj}v_h$
H3a	Cross-network preferential attachments from RTAs to BITs	$\sum_j x_{ij} \sum_h y_{hj}v_h$
H3b	Cross-network preferential attachments from BITs to RTAs	$\sum_j y_{ij} \sum_h x_{hj}v_h$
Endogenous network effects		
	Degree (density) of RTAs	$\sum_j x_{ij}$
	Degree (density) of BITs	$\sum_j y_{ij}$
	Triadic Closure of RTAs	$\sum_j x_{ij}\max_h(x_{ih}x_{hj})$
	Triadic Closure of BITs	$\sum_j y_{ij}\max_h(y_{ih}y_{hj})$
Monadic covariates		
	Covariate alter	$\sum_j x_{ij}\, w_j$
	Covariate ego x alter	$w_i \sum_j x_{ij}\, w_j$
Dyadic covariates		
	Covariate effect	$\sum_j x_{ij}(z_{ij} - \bar{z})$

Notes: x_{ij}: RTA tie between countries i and j, y_{ij}: BIT tie between countries i and j, v_h: log of real GDP in country h, w_h: monadic covariate in country h, z_{ij}: dyadic covariate between countries i and j.

Table 3. Coevolution of RTAs and BITs (annual data with 21 waves)

		Model 1		Model 2	
		BIT	RTA	BIT and all TIPs	RTA
H1a	Cross-network dyadic interinfluences from RTAs to BITs	-1.2992***		-1.3710***	
		(0.4023)		(0.4454)	
H1b	Cross-network dyadic interinfluences from BITs to RTAs		1.4376***		1.4397***
			(0.3651)		(0.3373)
H2a	Within-network preferential attachments of BITs	0.0864***		0.0815***	
		(0.0200)		(0.0259)	
H2b	Within-network preferential attachments of RTAs		-0.1223		-0.1176
			(0.0785)		(0.0749)
H3a	Cross-network preferential attachments from RTAs to BITs	0.0903***		0.0639***	
		(0.0185)		(0.0152)	
H3b	Cross-network preferential attachments from BITs to RTAs		0.0271***		0.0340***
			(0.0100)		(0.0104)
	Degree (density)	0.0279	-6.5775***	-0.1270	-6.7822***
		(1.7595)	(0.6915)	(1.3974)	(0.6905)
	Triadic Closure (BIT)	-0.2008*		-0.2223*	
		(0.1105)		(0.1161)	
	Triadic Closure (RTA)		1.8400***		1.7899***
			(0.4739)		(0.4529)
	Monadic covariates				
	GDP alter	0.4760***	0.9790***	0.5240***	0.9332***
		(0.0611)	(0.1723)	(0.0768)	(0.1634)
	GDP ego x alter	0.0958***	0.0439	0.1202***	0.0399
		(0.0272)	(0.0318)	(0.0368)	(0.0314)
	Per capita GDP alter	-0.1079	-0.5963**	-0.1301	-0.5971**
		(0.0913)	(0.2473)	(0.0954)	(0.2466)
	Per capita GDP ego x alter	-0.0670**	0.1278	-0.0617**	0.1200
		(0.0300)	(0.0784)	(0.0306)	(0.0769)
	Trade openness alter		0.0115***		0.0109***
			(0.0025)		(0.0025)
	Trade openness ego x alter		-0.0001		-0.0001
			(0.0001)		(0.0001)
	FDI alter	-0.0085		-0.0054	
		(0.0362)		(0.0320)	
	FDI ego x alter	0.0013*		0.0012*	
		(0.0007)		(0.0007)	
	Political stability alter	0.0334***	0.0935**	0.0336***	0.0905**
		(0.0119)	(0.0366)	(0.0121)	(0.0366)
	Political stability ego x alter	-0.0004	0.0034**	0.0003	0.0033**
		(0.0005)	(0.0014)	(0.0005)	(0.0015)
	Dyadic covariates				
	Bilateral trade	0.1366***	-0.0035	0.1483***	-0.0049
		(0.0223)	(0.0338)	(0.0223)	(0.0333)
	Political alliance	0.0536	1.0798***	-0.1267	0.9707***
		(0.1845)	(0.373)	(0.2027)	(0.3708)
	Distance	-0.8877***	-1.2925***	-0.8937***	-1.3314***
		(0.1224)	(0.2313)	(0.1593)	(0.2298)
	Multilateral trade agreements		-0.6632*		-0.6844*
			(0.3611)		(0.3702)
	Maximum convergence ratio	0.344		0.4104	

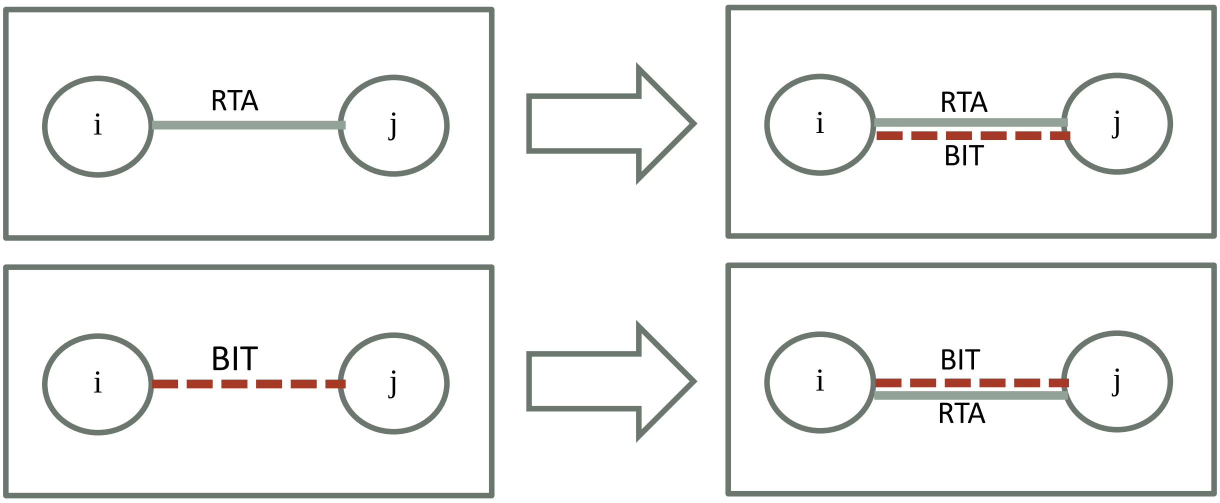
Notes: The BIT network consists of BITs excluding TIPs in model 1, while it consists of BITs and all TIPs in model 2.
* *P*< .10. ** *P*< .05. *** *P*< .01.

Table 4. Coevolution of RTAs and BITs (3-year non-overlapping interval data with 7 waves)

		Model 3		Model 4	
		BIT	RTA	BIT and all TIPs	RTA
H1a	Cross-network dyadic interinfluences from RTAs to BITs	-1.3291*** (0.4910)		-1.6336*** (0.5304)	
H1b	Cross-network dyadic interinfluences from BITs to RTAs		1.3956*** (0.4506)		1.4030*** (0.4326)
H2a	Within-network preferential attachments of BITs	0.1063*** (0.0351)		0.0903*** (0.0348)	
H2b	Within-network preferential attachments of RTAs		-0.2191*** (0.0787)		-0.2191*** (0.0837)
H3a	Cross-network preferential attachments from RTAs to BITs	0.1078*** (0.0329)		0.0754*** (0.024)	
H3b	Cross-network preferential attachments from BITs to RTAs		0.0368*** (0.0134)		0.0391*** (0.0144)
	Degree (density)	1.1074 (6.8635)	-7.1802*** (0.9458)	0.6687 (4.0554)	-7.1625*** (0.8886)
	Triadic Closure (BIT)	-0.2721 (0.1864)		-0.2871* (0.1689)	
	Triadic Closure (RTA)		2.6020*** (0.6004)		2.5834*** (0.5851)
	Monadic covariates				
	GDP alter	0.4552*** (0.0646)	1.0899*** (0.1842)	0.4937*** (0.0646)	1.0407*** (0.1747)
	GDP ego x alter	0.0952*** (0.0313)	0.0245 (0.0363)	0.1133*** (0.0369)	0.0201 (0.0357)
	Per capita GDP alter	-0.0458 (0.124)	-0.4412 (0.276)	-0.1030 (0.1170)	-0.4499* (0.2679)
	Per capita GDP ego x alter	-0.0657** (0.0322)	0.1449 (0.0973)	-0.0546* (0.0303)	0.1383 (0.0963)
	Trade openness alter		0.0125*** (0.0029)		0.0123*** (0.0028)
	Trade openness ego x alter		-0.0001 (0.0001)		-0.0001 (0.0001)
	FDI alter	0.0051 (0.0406)		0.0073 (0.0353)	
	FDI ego x alter	0.0006 (0.0011)		0.0005 (0.0010)	
	Political stability alter	0.0352*** (0.0134)	0.1020*** (0.0392)	0.0334*** (0.0117)	0.0947** (0.0371)
	Political stability ego x alter	-0.0006 (0.0005)	0.0039** (0.0016)	0.0001 (0.0005)	0.0036** (0.0015)
	Dyadic covariates				
	Bilateral trade	0.1036*** (0.0208)	0.0016 (0.0345)	0.1191*** (0.0211)	0.0014 (0.0339)
	Political alliance	0.0948 (0.2153)	0.4742 (0.4686)	-0.0969 (0.2138)	0.2998 (0.468)
	Distance	-1.0376*** (0.1890)	-1.6070*** (0.3173)	-0.9939*** (0.1860)	-1.6019*** (0.3160)
	Multilateral trade agreements		-0.7015 (0.4555)		-0.6628 (0.4479)
	Maximum convergence ratio	0.1315		0.1806	

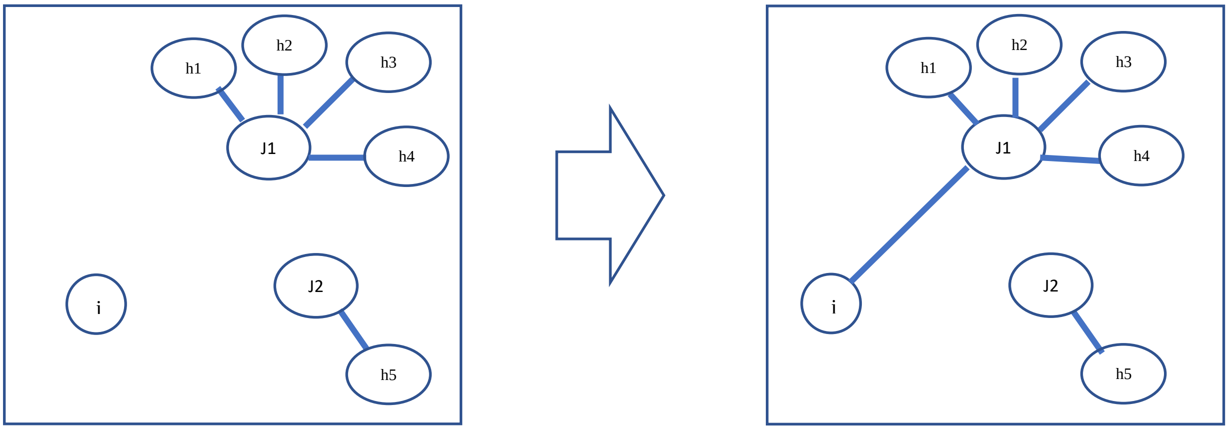
Notes: The BIT network consists of BITs excluding TIPs in model 3, while it consists of BITs and all TIPs in model 4.
* P< .10. ** P< .05. *** P< .01.

Figure 1. Cross-network dyadic interinfluences



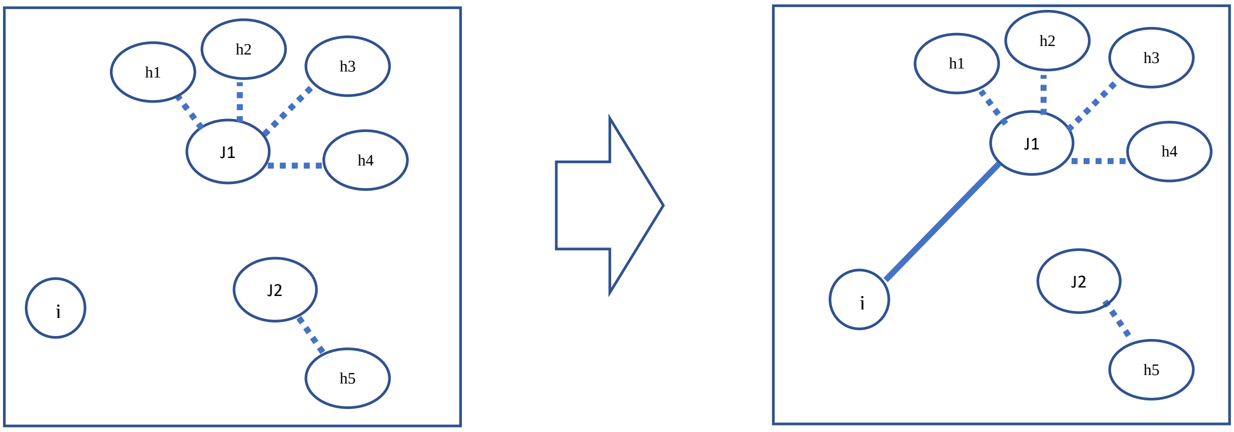
Notes: Solid and dotted lines represent an RTA tie and a BIT tie, respectively.

Figure 2. Within-network preferential attachments

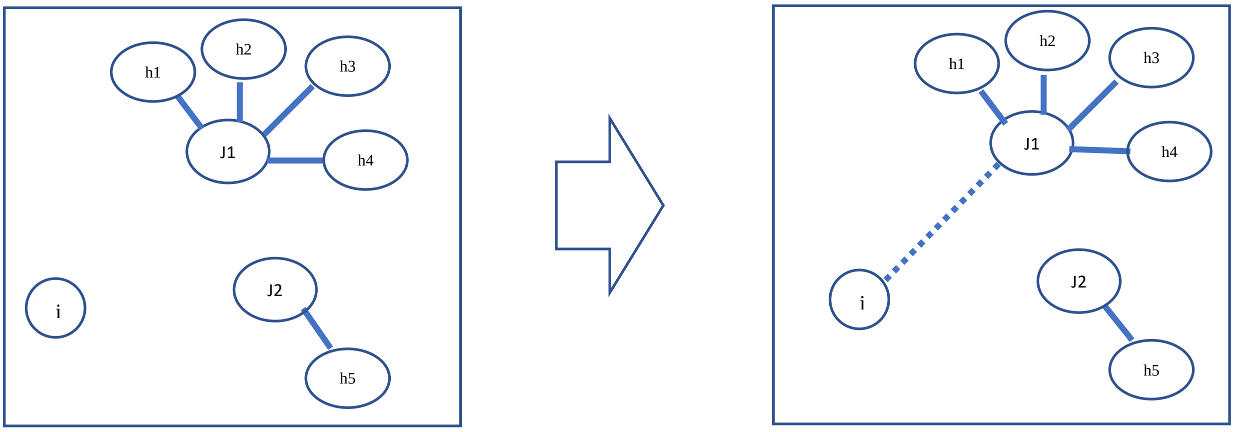


Notes: Solid line represents an RTA tie or a BIT tie.

Figure 3. Cross-network preferential attachments

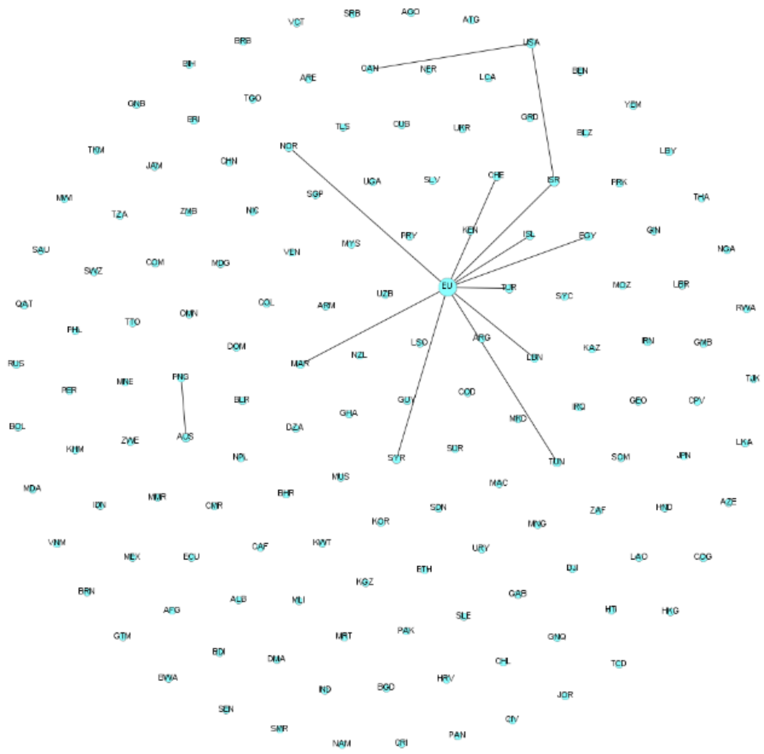


Notes: Solid and dotted lines represent a BIT tie and an RTA tie, respectively.

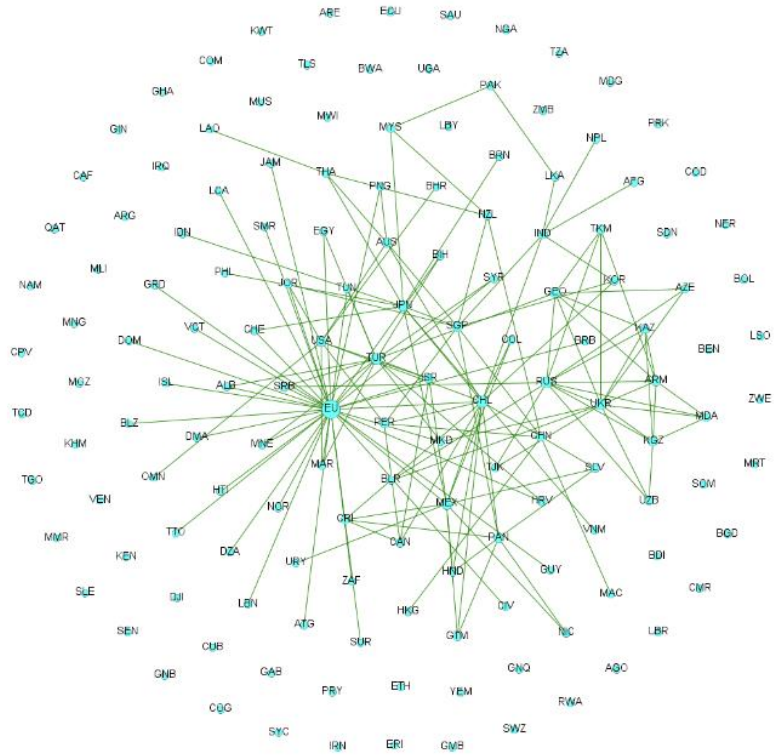


Notes: Solid and dotted lines represent a BIT tie and an RTA tie, respectively.

Figure 4. Digraphs of the RTA networks in 1990 and 2010

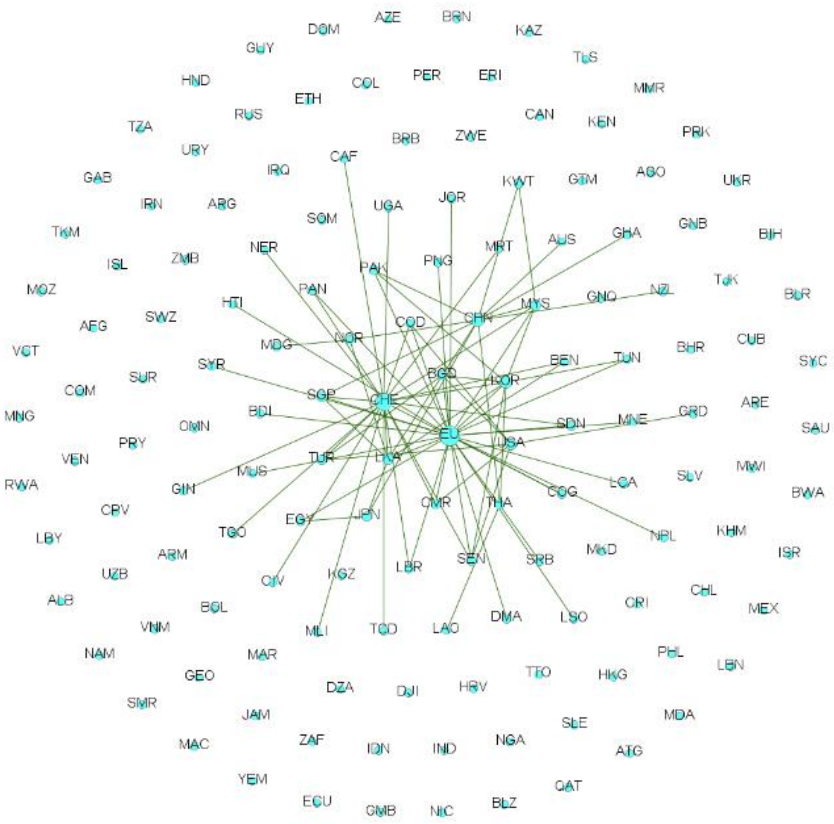


Year 1990

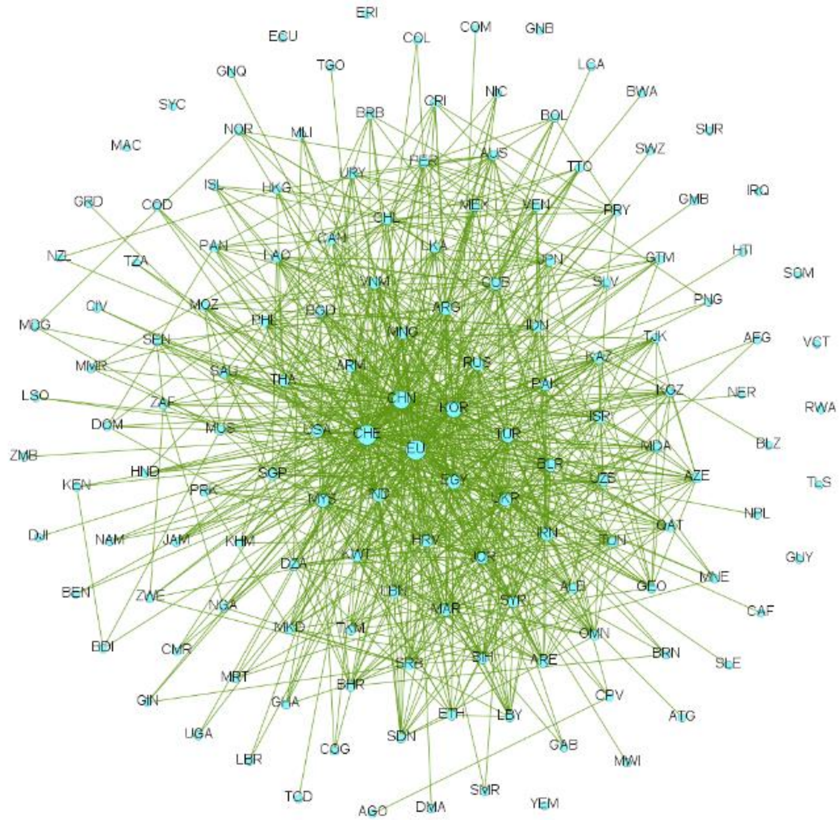


Year 2010

Figure 5. Digraphs of the BIT networks (excluding TIPs) in 1990 and 2010

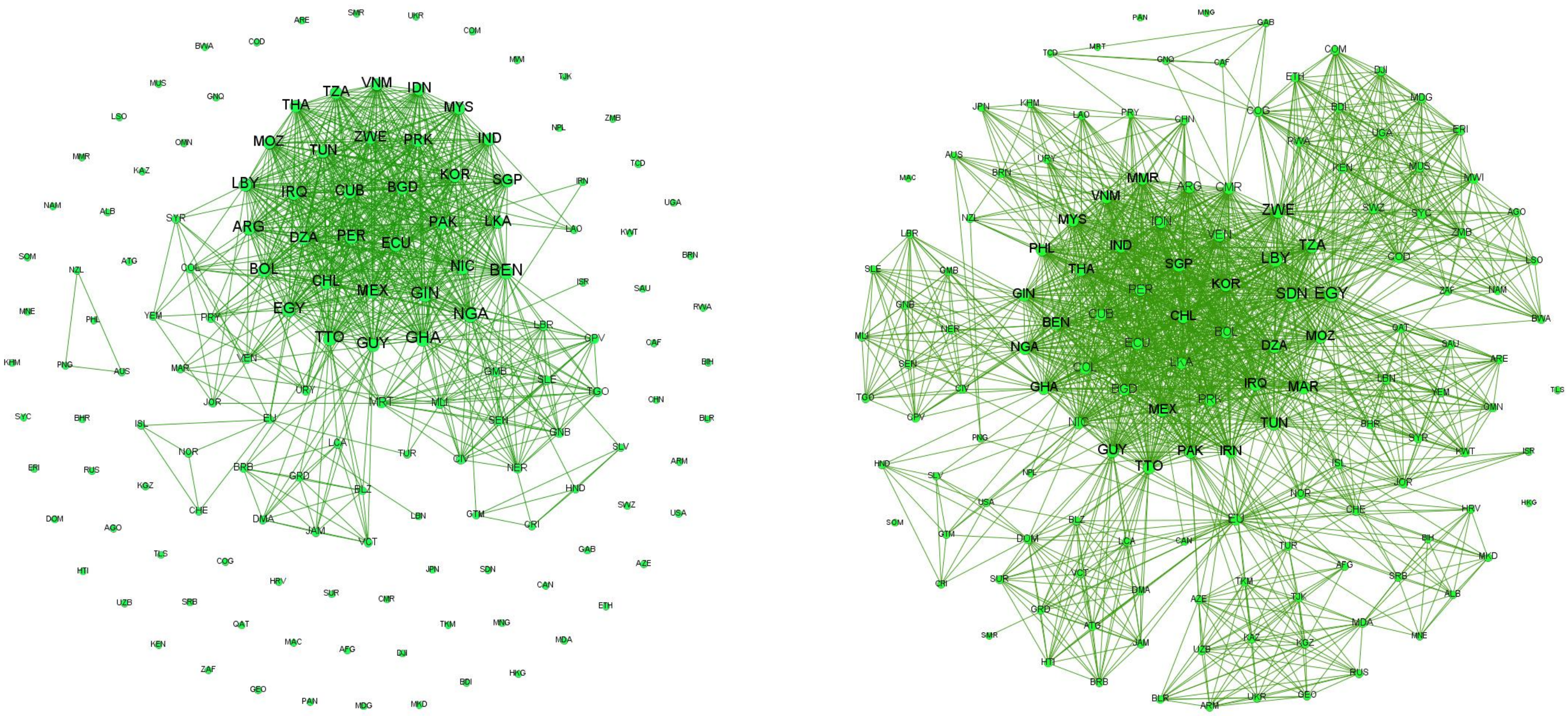


Year 1990



Year 2010

Figure 6. Digraphs of the RTA (multilateral) networks in 1990 and 2010



Year 1990 Year 2010

Appendix

Table A1. Coevolution of RTAs and BITs with additional controls (annual data with 21 waves)

		Model 1		Model 2	
		BIT	RTA	BIT and all TIPs	RTA
H1a	Cross-network dyadic interinfluences from RTAs to BITs	-1.1847***		-1.2548***	
		(0.4043)		(0.4589)	
H1b	Cross-network dyadic interinfluences from BITs to RTAs		1.5082***		1.5061***
			(0.3971)		(0.3551)
H2a	Within-network preferential attachments of BITs	0.0861***		0.0829***	
		(0.0207)		(0.0283)	
H2b	Within-network preferential attachments of RTAs		-0.1321		-0.1260
			(0.0898)		(0.0840)
H3a	Cross-network preferential attachments from RTAs to BITs	0.0936***		0.0666***	
		(0.0186)		(0.0155)	
H3b	Cross-network preferential attachments from BITs to RTAs		0.0229**		0.0346***
			(0.0097)		(0.0107)
	Degree (density)	-1.5040***	-6.3032***	1.0383	-6.9600***
		(0.5217)	(0.6831)	(4.2160)	(0.7378)
	Triadic Closure (BIT)	-0.1787		-0.2095	
		(0.1138)		(0.1285)	
	Triadic Closure (RTA)		1.8023***		1.7706***
			(0.5059)		(0.4691)
	Monadic covariates				
	GDP alter	0.4775***	0.9298***	0.5221***	0.9078***
		(0.0608)	(0.1749)	(0.0784)	(0.1648)
	GDP ego x alter	0.0934***	0.035	0.1207***	0.0329
		(0.0294)	(0.0345)	(0.0396)	(0.0325)
	Per capita GDP alter	-0.1071	-0.6331**	-0.1182	-0.6971**
		(0.094)	(0.2575)	(0.1083)	(0.2724)
	Per capita GDP ego x alter	-0.0713**	0.1149	-0.0649**	0.1122
		(0.0299)	(0.0755)	(0.0306)	(0.0746)
	Trade openness alter		0.0117***		0.0113***
			(0.0024)		(0.0025)
	Trade openness ego x alter		-0.0001		-0.0001
			(0.0001)		(0.0001)
	FDI alter	-0.0067		-0.0045	
		(0.0329)		(0.0326)	
	FDI ego x alter	0.0012**		0.0012*	
		(0.0006)		(0.0007)	
	Political stability alter	0.0348***	0.0956**	0.0332***	0.1045**
		(0.0114)	(0.039)	(0.0122)	(0.0411)
	Political stability ego x alter	-0.0004	0.0034**	0.0004	0.0033**
		(0.0005)	(0.0016)	(0.0005)	(0.0016)
	Dyadic covariates				
	Bilateral trade	0.1344***	-0.0077	0.1527***	-0.0086
		(0.0203)	(0.036)	(0.0225)	(0.0350)
	Political alliance	0.1703	1.0996***	-0.0677	1.0363***
		(0.1909)	(0.3977)	(0.2222)	(0.3887)
	Distance	-0.9385***	-1.0958***	-0.9242***	-1.1891***
		(0.1174)	(0.2298)	(0.1607)	(0.2265)
	Colony	-0.6175*	4.1428***	-0.8111**	4.1347***
		(0.3696)	(1.0814)	(0.4005)	(1.0118)
	Common language	-0.4045***	0.1485	-0.2256	0.1567
		(0.1529)	(0.3447)	(0.1862)	(0.3407)
	Multilateral trade agreements		-0.5012		-0.5114
			(0.3669)		(0.3729)

Notes: The BIT network consists of BITs excluding TIPs in model 1, while it consists of BITs and all TIPs in model 2.
* *P*< .10. ** *P*< .05. *** *P*< .01.

Table A2. Coevolution of RTAs and BITs with additional controls (3-year non-overlapping interval data with 7 waves)

		Model 3		Model 4	
		BIT	RTA	BIT and all TIPs	RTA
H1a	Cross-network dyadic interinfluences from RTAs to BITs	-1.2102** (0.498)		-1.5398*** (0.5354)	
H1b	Cross-network dyadic interinfluences from BITs to RTAs		1.5811*** (0.5187)		1.5253*** (0.4832)
H2a	Within-network preferential attachments of BITs	0.1076*** (0.0389)		0.0927** (0.0376)	
H2b	Within-network preferential attachments of RTAs		-0.2631** (0.1033)		-0.2595*** (0.1002)
H3a	Cross-network preferential attachments from RTAs to BITs	0.1128*** (0.0354)		0.0795*** (0.0244)	
H3b	Cross-network preferential attachments from BITs to RTAs		0.0365** (0.0142)		0.0397*** (0.0152)
	Degree (density)	-0.3949 (1.5252)	-7.4636*** (1.0220)	1.3449 (7.2139)	-7.4431*** (1.008)
	Triadic Closure (BIT)	-0.2635 (0.2073)		-0.2839 (0.1843)	
	Triadic Closure (RTA)		2.8033*** (0.6817)		2.7482*** (0.6726)
	Monadic covariates				
	GDP alter	0.4484*** (0.0615)	1.0921*** (0.2048)	0.4888*** (0.0671)	1.0325*** (0.192)
	GDP ego x alter	0.0949*** (0.0333)	0.0173 (0.0399)	0.1140*** (0.0396)	0.0117 (0.039)
	Per capita GDP alter	-0.0362 (0.1362)	-0.5680* (0.3016)	-0.0908 (0.1224)	-0.568* (0.2971)
	Per capita GDP ego x alter	-0.0707** (0.0321)	0.1403 (0.1005)	-0.0582* (0.0314)	0.1338 (0.0977)
	Trade openness alter		0.0133*** (0.0030)		0.0131*** (0.0030)
	Trade openness ego x alter		-0.0001 (0.0001)		-0.0001 (0.0001)
	FDI alter	0.0068 (0.0396)		0.0076 (0.0339)	
	FDI ego x alter	0.0006 (0.0010)		0.0005 (0.0010)	
	Political stability alter	0.0355*** (0.0133)	0.1213*** (0.0433)	0.0330*** (0.0122)	0.1131*** (0.0411)
	Political stability ego x alter	-0.0006 (0.0005)	0.0040** (0.0017)	0.0001 (0.0005)	0.0037** (0.0017)
	Dyadic covariates				
	Bilateral trade	0.1069*** (0.0209)	-0.0024 (0.0415)	0.1222*** (0.0223)	-0.0014 (0.0393)
	Political alliance	0.2087 (0.2143)	0.4470 (0.5143)	-0.0361 (0.2279)	0.3230 (0.4928)
	Distance	-1.0788*** (0.2023)	-1.4345*** (0.3442)	-1.0252*** (0.1947)	-1.4265*** (0.3137)
	Colony	-0.7572 (0.4923)	5.169*** (1.4278)	-0.7591 (0.4875)	5.0845*** (1.3521)
	Common language	-0.3594* (0.1887)	0.6438 (0.4391)	-0.2141 (0.2062)	0.5843 (0.4209)
	Multilateral trade agreements		-0.5073 (0.4901)		-0.4788 (0.4858)

Notes: The BIT network consists of BITs excluding TIPs in model 3, while it consists of BITs and all TIPs in model 4.
* *P*< .10. ** *P*< .05. *** *P*< .01.

Table A3. Coevolution of RTAs and BITs (annual data with 21 waves)

		Model 5		Model 6	
		BIT Plus TIP attached with non-RTAs	RTA	BIT Plus TIP attached with non-RTAs	RTA
H1a	Cross-network dyadic interinfluences from RTAs to BITs	-1.0687*** (0.3923)		-1.1491*** (0.3766)	
H1b	Cross-network dyadic interinfluences from BITs to RTAs		1.5054*** (0.3943)		1.4096*** (0.3521)
H2a	Within-network preferential attachments of BITs	0.0765*** (0.0207)		0.0760*** (0.0202)	
H2b	Within-network preferential attachments of RTAs		-0.1299 (0.0879)		-0.1163 (0.0736)
H3a	Cross-network preferential attachments from RTAs to BITs	0.0791*** (0.0159)		0.0758*** (0.0159)	
H3b	Cross-network preferential attachments from BITs to RTAs		0.0214** (0.0107)		0.0230** (0.0101)
	Degree (density)	-1.4269*** (0.5005)	-6.366*** (0.6815)	-1.4007*** (0.4824)	-6.3259*** (0.6395)
	Triadic Closure (BIT)	-0.2271** (0.1096)		-0.2481** (0.1083)	
	Triadic Closure (RTA)		1.8205*** (0.4911)		1.800*** (0.4477)
	Monadic covariates				
	GDP alter	0.4578*** (0.0546)	0.9252*** (0.1712)	0.4624*** (0.0549)	0.9281*** (0.1587)
	GDP ego x alter	0.0966*** (0.0282)	0.0330 (0.0338)	0.0972*** (0.0267)	0.0396 (0.0304)
	Per capita GDP alter	-0.0759 (0.1057)	-0.6459** (0.2658)	-0.0848 (0.1004)	-0.5620** (0.2428)
	Per capita GDP ego x alter	-0.0686** (0.0289)	0.1114 (0.0767)	-0.0634** (0.0276)	0.1198 (0.0758)
	Trade openness alter		0.0121*** (0.0024)		0.0114*** (0.0023)
	Trade openness ego x alter		-0.0001 (0.0001)		-0.0001 (0.0001)
	FDI alter	-0.0145 (0.0331)		-0.0151 (0.0324)	
	FDI ego x alter	0.0013** (0.0006)		0.0013** (0.0006)	
	Political stability alter	0.0299*** (0.011)	0.0945** (0.0379)	0.0293*** (0.0108)	0.0831** (0.0345)
	Political stability ego x alter	-0.0001 (0.0005)	0.0032** (0.0015)	-0.0002 (0.0005)	0.0031** (0.0014)
	Dyadic covariates				
	Bilateral trade	0.1320*** (0.0190)	-0.0053 (0.0362)	0.1275*** (0.0192)	0.0022 (0.0327)
	Political alliance	0.1644 (0.1812)	1.0614*** (0.3855)	0.0627 (0.1712)	1.0009*** (0.3576)
	Distance	-0.8600*** (0.1108)	-1.1064*** (0.2179)	-0.8228*** (0.1080)	-1.2269*** (0.2119)
	Colony	-0.6219* (0.3680)	4.1553*** (1.0899)		
	Common language	-0.3538** (0.1470)	0.0802 (0.3226)		
	Multilateral trade agreements		-0.4575 (0.3586)		-0.6217* (0.3471)

Notes: The BIT network consists of BITs and TIPs attached with non-RTAs in both models. Model 5 includes additional controls (Colony and Common language), while model 6 does not include them.
* *P*< .10. ** *P*< .05. *** *P*< .01.

Table A4. Coevolution of RTAs and BITs (3-year non-overlapping interval data with 7 waves)

		Model 7		Model 8	
		BIT Plus TIP attached with non-RTAs	RTA	BIT Plus TIP attached with non-RTAs	RTA
H1a	Cross-network dyadic interinfluences from RTAs to BITs	-1.0557**		-1.1537**	
		(0.4719)		(0.4498)	
H1b	Cross-network dyadic interinfluences from BITs to RTAs		1.5167***		1.3469***
			(0.5066)		(0.4575)
H2a	Within-network preferential attachments of BITs	0.0967***		0.0939***	
		(0.0338)		(0.0296)	
H2b	Within-network preferential attachments of RTAs		-0.2629**		-0.2201**
			(0.1032)		(0.0858)
H3a	Cross-network preferential attachments from RTAs to BITs	0.0956***		0.0903***	
		(0.0263)		(0.0233)	
H3b	Cross-network preferential attachments from BITs to RTAs		0.0339**		0.0356**
			(0.0149)		(0.014)
	Degree (density)	1.4024	-7.3187***	-0.3471**	-7.0908***
		(6.4195)	(1.0386)	(0.1556)	(0.9260)
	Triadic Closure (BIT)	-0.3441**		-0.3493**	
		(0.1709)		(0.1546)	
	Triadic Closure (RTA)		2.8143***		2.6266***
			(0.6913)		(0.5991)
	Monadic covariates				
	GDP alter	0.4349***	1.0616***	0.4398***	1.0605***
		(0.0650)	(0.2033)	(0.0622)	(0.1770)
	GDP ego x alter	0.0998***	0.0147	0.0983***	0.0230
		(0.0333)	(0.0411)	(0.0307)	(0.0348)
	Per capita GDP alter	-0.0168	-0.5632*	-0.0296	-0.4297
		(0.1296)	(0.2982)	(0.1267)	(0.2616)
	Per capita GDP ego x alter	-0.0655**	0.1342	-0.0597*	0.1388
		(0.0310)	(0.0975)	(0.0305)	(0.0961)
	Trade openness alter		0.0134***		0.0125***
			(0.0030)		(0.0029)
	Trade openness ego x alter		-0.0001		-0.0001
			(0.0001)		(0.0001)
	FDI alter	-0.0024		-0.0037	
		(0.0492)		(0.0462)	
	FDI ego x alter	0.0007		0.0007	
		(0.001)		(0.0009)	
	Political stability alter	0.0305**	0.1158***	0.0306**	0.0968***
		(0.0119)	(0.0445)	(0.0120)	(0.0368)
	Political stability ego x alter	-0.0004	0.0039**	-0.0004	0.0038**
		(0.0005)	(0.0018)	(0.0005)	(0.0015)
	Dyadic covariates				
	Bilateral trade	0.1079***	0.0001	0.1037***	0.0034
		(0.0206)	(0.0396)	(0.0200)	(0.0356)
	Political alliance	0.1844	0.3795	0.0876	0.3678
		(0.2141)	(0.5033)	(0.1998)	(0.4760)
	Distance	-0.9914***	-1.4200***	-0.9504***	-1.5918***
		(0.1639)	(0.3375)	(0.1482)	(0.3151)
	Colony	-0.7752*	5.1755***		
		(0.4467)	(1.4030)		
	Common language	-0.3051*	0.5577		
		(0.1769)	(0.4285)		
	Multilateral trade agreements		-0.4767		-0.6670
			(0.4656)		(0.4539)

Notes: The BIT network consists of BITs and TIPs attached with non-RTAs in both models. Model 7 includes additional controls (Colony and Common language), while model 8 does not include them.
* *P*< .10. ** *P*< .05. *** *P*< .01.