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Bilateral Investment Treaties and Entrepreneurship: A Social Network Analysis

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Abstract: This paper empirically investigates the effects of bilateral investment treaties (BITs) on entrepreneurship through the lens of social network analysis (SNA), focusing on two key network characteristics: centrality and brokerage. We begin by developing a set of hypotheses regarding how a country's position within the BIT network influences entrepreneurial activity. These hypotheses are tested using a panel dataset of 102 countries spanning 2006–2018. We also examine how these relationships are moderated by economic development and trade integration, and whether they vary across different types of entrepreneurship—including formal vs. informal, male vs. female, and domestic vs. international entrepreneurship. Our findings indicate that centrality has a positive effect on entrepreneurship, while brokerage exerts a negative influence. Moreover, both economic development and trade integration are found to weaken these effects. We also observe differential impacts of BIT network structure across the various entrepreneurship subgroups.

Keywords: BITs network; Entrepreneurship; Centrality; Brokerage; Economic development; Trade integration

JEL Classifications: F21, L26, F63, F15

Data Availability statement: The code necessary to produce the results in the paper are provided can be found here: https://osf.io/qznue/. Data will be provided when the paper is published. We have written the code so that it will be push-button-replicable once the data are provided.

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1. Introduction

Bilateral Investment Treaties (BITs) are agreements between two countries designed to promote mutually beneficial investment flows (Saban et al., 2010). By entering into a BIT, countries not only establish a direct investment relationship but also become part of a broader network of similarly structured treaties. Membership in this network can yield benefits beyond those of the individual agreement, particularly for countries with weaker institutions. For these countries, BIT participation may support improvements in domestic governance and institutional quality over time, as the treaties often promote transparency, legal safeguards, and policy stability—factors that facilitate investment integration. However, the extent of these benefits depends on each country's institutional framework and commitment to reform. While BITs do not ensure comprehensive liberalization or reform, countries more integrated into the BIT network tend to maintain stronger institutional environments, which can, in turn, influence new firm formation.

The number of BITs has expanded dramatically over time, from 385 in 1989 to 2,943 by 2020 (UNCTAD, 2021). This proliferation has contributed to the formation of a dense global network of investment treaties, moving beyond a purely dyadic perspective. For example, if Country A signs a BIT with Country B, and Country B signs one with Country C, then Country A may establish indirect investment links with Country C through B's intermediary role. If A and C also sign a BIT, a tightly connected triplet forms. Repeated across many such instances, a complex and interconnected BIT network emerges. While many studies have examined the determinants of BIT formation (Bergstrand and Egger, 2013; Htwe et al., 2020), this study is the first to empirically investigate the relationship between BITs and entrepreneurship through the lens of social network analysis (SNA).

SNA conceptualizes networks as comprising nodes (countries) connected by ties (BITs) (Htwe et al., 2020). BITs do not operate in isolation but are embedded in a broader,

interdependent structure. Most countries maintain multiple, overlapping investment ties. Even when two countries are not directly linked by a BIT, they may benefit indirectly through their partners' connections—a "friend of a friend" effect—impacting investment via supply chains or informational spillovers (Herman, 2022; Morales et al., 2019). By analyzing BITs as a network, this approach captures the heterogeneity of individual treaties within a more integrated, systemic framework. Although BITs remain bilateral in nature, countries can leverage their positions within the BIT network to achieve outcomes that resemble—but are not equivalent to—those of multilateral investment agreements.

Prior research shows that failing to account for a country's position in the network can lead to biased estimates (Dueñas and Fagiolo, 2013; Herman, 2022). Network position is not only a function of direct and indirect ties but also confers informational advantages (Gulati and Gargiulo, 1999). These advantages shape the information a country can access and disseminate, both within the network and to potential new partners. As such, conventional indicators—such as the number of BITs a country holds or binary variables indicating the presence of a BIT between two countries—may obscure underlying dynamics (Dueñas and Fagiolo, 2013).

Although trade networks have been extensively studied (Lovrić et al., 2018), applying SNA to international investment remains relatively new (Htwe et al., 2020; Saban et al., 2010). This study advances the literature by exploring how BIT network structures influence entrepreneurial activity, focusing specifically on the asymmetric effects of network centrality and brokerage. Countries occupying central positions in supranational networks benefit from enhanced information access and resource acquisition. Conversely, those in brokerage positions may experience distrust or even resistance from other network members.

This paper begins by formulating hypotheses regarding how two core SNA concepts—centrality and brokerage—influence new firm formation. It then introduces hypotheses about how these effects are moderated by levels of economic development and trade integration.

These propositions are tested using a panel dataset of 102 countries from 2006 to 2018. Finally, the paper explores heterogeneity in the results by comparing the estimated effects on formal versus informal entrepreneurship, male versus female entrepreneurship, and domestic versus international entrepreneurship.

2. Theory and hypothesis development

2.1 BITs network and entrepreneurship

Research on the relationship between BIT networks and entrepreneurship presents mixed findings. Since Schumpeter (1949), investment integration has been seen as a mechanism for expanding market scale and creating new opportunities for entrepreneurs. It is also argued to enhance entrepreneurial activity by promoting standardized and transparent business environments (Kirzner, 1973), and by counteracting protectionist forces that can undermine market efficiency and competitive advantage (Coyne and Williamson, 2012). Conversely, other scholars suggest that investment integration may inhibit entrepreneurship by shifting demand away from domestic producers and intermediaries toward foreign firms (Abolhassani and Danakol, 2019).

We argue that these conflicting findings may stem, in part, from a failure to account for countries' varying positions within their respective BIT networks. Like individuals, countries are embedded in networks characterized by diverse and overlapping relationships, which often serve as valuable sources of information about foreign market opportunities (Inekwe, 2021). From a broader network perspective, international business activity emerges from ongoing interorganizational interactions between firms and their network partners. Firms typically learn about foreign market opportunities through these relationships (Ellis, 2000), and one of the most immediate benefits of network ties is the facilitation of sales or marketing objectives in new foreign markets (Harris and Wheeler, 2005). By conceptualizing countries as nodes within a network, and BITs as the links connecting them, we incorporate two key structural features

likely to shape outcomes in global trade and investment: centrality and brokerage (Pan, 2018; Htwe et al., 2020).

2.1.1 Centrality

Countries with high network centrality—that is, those with a large number of BIT partners—are more likely to develop familiarity and sustained interaction with other members of the network (Freeman, 1979). Centrality within the BIT network may offer a more nuanced explanation of international investment integration than simple counts of BITs (Reyes et al., 2010). Highly central countries are better positioned to achieve institutional compliance, making them appear more trustworthy and reliable to international investors compared to less central countries (Elkins et al., 2006). This dynamic is especially important for domestic entrepreneurs with global aspirations, as centrality enhances access to larger markets, more stable investment environments, and a broader range of investment opportunities.

Entrepreneurs in highly central countries can reach other network members through relatively short paths, reducing search and communication costs. This lowers barriers to entry and encourages domestic entrepreneurs to launch new ventures. From the perspective of foreign entrepreneurs, partnering with a high-centrality country offers additional advantages by generating indirect access to that country's broader network of BIT partners (Kinne, 2013). Taken together, these considerations lead to the following hypothesis:

Hypothesis 1a: Centrality of BITs network positively impacts country-level entrepreneurship.

2.1.2 Brokerage

Another key aspect of network position is brokerage. Triads—sets of three interconnected countries—serve as the fundamental building blocks of the BIT network. The accumulation and evolution of these triadic relationships give rise to cohesive subgroups within the broader network (Luke, 2015). Within such structures, a broker country occupies a position that connects otherwise unlinked subgroups, thereby gaining access to diverse parts of the network

and exerting strategic control over these connections. Brokerage positions are often dynamic and transitory, reflecting the shifting nature of inter-country ties (Burt, 2002).

Countries with high brokerage in the BIT network control the flow of information and resources across distinct subgroups (Scott, 2016), and may leverage this position for unilateral advantage (Grabher, 1993). As a result, they are sometimes viewed with suspicion, which can undermine their credibility as neutral intermediaries (Lin et al., 2009). For domestic entrepreneurs, this reputational risk can restrict perceived market opportunities and deter new venture creation. For foreign entrepreneurs, negative stereotypes associated with high-brokerage countries can reduce investment confidence and willingness to engage. Collectively, these factors are expected to inhibit entrepreneurial activity in countries occupying high brokerage positions (Guiso et al., 2009). This leads to the following hypothesis:

Hypothesis 1b: Brokerage of BITs network negatively impacts country-level entrepreneurship.

2.2 BIT networks, economic conditions, and entrepreneurship

2.2.1 The impact of BITs on entrepreneurship depends on economic development

Recent literature has drawn attention to the role of unequal bargaining power in shaping the outcomes of BITs (Wagner, 2016; Seiermann, 2018). Less developed countries typically exhibit lower levels of institutional quality and governance (Keefer & Knack, 1997). Due to their weaker negotiating positions, BITs involving these countries are more likely to reflect the higher institutional standards of their more economically developed partners. In this way, BITs can serve as conduits for institutional reform in less developed economies, with potential downstream benefits for entrepreneurial activity. Therefore, while network centrality is generally expected to promote entrepreneurship, its positive effects are likely to be especially pronounced in less developed countries.

Just as economic development is expected to moderate the benefits of centrality, we also expect it to influence the disadvantages associated with brokerage. As noted earlier, brokerage countries may be less constrained in pursuing self-interested behavior, potentially undermining otherwise mutually beneficial relationships. Additionally, their unique network position can generate suspicion and reduce trust among potential partners (Uzzi, 1997). As a result, occupying a brokerage position may, ceteris paribus, suppress entrepreneurial activity.

We further hypothesize that less developed countries may have stronger incentives to exploit their brokerage positions for at least two reasons. First, many of these countries rely heavily on the export of raw materials for economic growth. Because such resources are naturally occurring and location-specific, other countries may have limited options to bypass the brokerage country, allowing it to better capitalize on its position. Second, trade in less developed countries tends to be less diversified. Exploiting a brokerage position in one area is therefore less likely to create negative spillovers in other trade relationships. For these reasons, we expect the negative impact of brokerage on entrepreneurship to be particularly strong in less developed countries. Together, these arguments lead to the following two hypotheses:

Hypothesis 2a: Economic development weakens the positive relationship between centrality of BITs network and entrepreneurship.

Hypothesis 2b: Economic development weakens the negative relationship between brokerage of BITs network and entrepreneurship.

2.2.2 The impact of BITs network on entrepreneurship depends on trade integration

Alternative and overlapping international investment agreements can also influence the impact of BITs on entrepreneurial activity. Regional Trade Agreements (RTAs) and BITs are inherently interconnected, as both involve trade-investment relationships (Htwe et al., 2020). While the primary objective of BITs is to encourage foreign direct investment (FDI) by reducing investment risk, RTAs are intended to promote trade and broader economic cooperation.

The similarities between RTAs and BITs extend further. Many RTAs include clauses that resemble those found in BITs. In fact, several treaties with investment provisions (TIPs), as classified in the United Nations Conference on Trade and Development (UNCTAD) database, are RTAs that include investment-specific chapters. These TIPs often function similarly to BITs, allowing RTAs to serve as partial substitutes. Consequently, the presence of RTAs may reduce a country's incentive to enter into additional BITs. Moreover, overlapping agreements can lead to coordination challenges. Parallel treaties may duplicate provisions or contain conflicting commitments, thereby discouraging the negotiation of new BITs.

For both substitution and coordination reasons, greater trade integration may reduce the effectiveness of BITs. However, these effects are likely to vary depending on a country's position within the BIT network. Countries with high centrality are typically parties to numerous investment treaties and may therefore experience greater overlap and redundancy. As a result, the competition and coordination costs associated with multiple treaties can diminish the institutional benefits normally associated with BITs.

In contrast, countries in brokerage positions—often regarded as less trustworthy or stable—may benefit more from complementary trade integration. Trade agreements can help to legitimize these countries within the network, reduce coordination barriers, and strengthen their role as connectors between otherwise unlinked countries. Trade integration may thus enhance the strategic value of brokerage countries, enabling them to function as effective hubs. The findings of Stojčić et al. (2021), which highlight the role of trade in generating entrepreneurial opportunities, are particularly relevant in this context. Based on these considerations, we propose the following hypotheses:

Hypothesis 3a: Trade integration weakens the positive relationship between centrality of BITs network and entrepreneurship.

Hypothesis 3b: Trade integration weakens the negative relationship between brokerage of BITs network and entrepreneurship.

3. Research design

3.1 Description of the data

Data on country-level entrepreneurial activity are drawn from the World Bank Group's *Enterprise Surveys* and the *Doing Business* dataset. Together, these sources provide extensive firm-level information, covering approximately 171,000 firms across 148 countries. To measure entrepreneurship, we focus on the number of newly registered formal firms established each year from 2006 to 2018—an approach widely used in prior research (Acs et al., 2008; Dau and Cuervo-Cazurra, 2014; Kim and Li, 2014; Moore et al., 2020, 2021).

Data on investment integration are obtained from UNCTAD's *International Investment Agreements (IIAs)* database, which includes both bilateral and multilateral investment treaties. In practice, bilateral investment treaties (BITs) are far more prevalent than multilateral agreements, exhibiting significantly denser global coverage (Htwe et al., 2020). To differentiate between IIA diversity (total number of treaties) and partnership diversity (number of treaty partners), our analysis focuses exclusively on BITs. This focus aligns with our objective to examine reciprocal investment relationships at both the country and country-pair level.

Control variables are sourced from multiple databases: the *Design of Trade Agreements (DESTA)* database, the *World Bank Development Indicators (WBDI)*, the *Worldwide Governance Indicators (WGI)*, the *Investment Dispute Settlement Navigator (IDSN)*, and additional data from UNCTAD. After addressing missing values, the final sample comprises 102 countries over a 13-year period (2006–2018), yielding 972 country-year observations. To classify countries by level of development, we use the World Bank's standard classification. Additional details on data sources and variable construction are provided in Table A of the Supplementary Appendix.

3.2 Measures and variables

Table 1 provides a description of the variables, measures and data sources used in this study. It also contains variables used in the subsequent robustness and heterogeneity analyses. Descriptive statistics for all variables used in the empirical analysis can be found in Table B of the Supplementary Appendix. Correlations among variables in baseline regression are shown in Table C of the Supplementary Appendix.

3.2.1 Dependent variables

The dependent variable in our analysis is entrepreneurship, defined as the formation of new firms. Our primary measure is a count variable representing the total number of newly registered firms within a country in a given year. This measure is widely used in the literature, as business registration signals the formal establishment of a firm and its entry into the market—core elements of entrepreneurial activity (Kim and Li, 2014).

In many developing countries, however, business registration can be costly and complex. As a result, this measure may underestimate the actual extent of entrepreneurship by omitting informal business activity. To address this concern, we conducted robustness checks and heterogeneity analyses. Specifically, we examined differences between formal and informal entrepreneurship (Dau and Cuervo-Cazurra, 2014), domestic and international entrepreneurship (Coviello, 2006), and male and female entrepreneurship (Gunawan et al., 2021).

To capture informal entrepreneurship, we followed the approach of Dau and Cuervo-Cazurra (2014), using data from the World Bank Group's *Enterprise Surveys*. The relevant variable is derived from responses to two questions: "Year Establishment Began Operations" and "Was Establishment Formally Registered When It Began Operations?" While we examined informal entrepreneurship in our heterogeneity analysis, in this study "entrepreneurship" generally refers to formal entrepreneurship unless stated otherwise.

Table 1
Variables and measures

Variable name	Measure	Type	Source
Entrepreneurship	Number of total newly registered firms	Count	World Bank's Doing Business dataset
Registered directors	Measures the individuals who registered new limited liability firms in the calendar year	Count	World Bank Group's Enterprise Survey
Informal entrepreneurship	Calculates the number of total newly unregistered businesses	Count	World Bank Group's Enterprise Survey
Male entrepreneurship	Measures the individuals who registered new limited liability firms in the calendar year based on male	Count	World Bank's Doing Business dataset
Female entrepreneurship	Measures the individuals who registered new limited liability firms in the calendar year based on female	Count	World Bank's Doing Business dataset
International entrepreneurship	Calculates the number of total newly registered and exported firms	Count	World Bank Group's Enterprise Survey
In-force-IIA closeness	Calculates the closeness centrality index by forming the in-force bilateral network based on annual international investment agreements	Continuous	International Investment Agreements Navigator
In-force-IIA brokerage	Calculates the brokerage index by forming the in-force bilateral network based on annual international investment agreements	Continuous	International Investment Agreements Navigator
In-force-IIA degree	Calculates the closeness degree index by forming the in-force bilateral network based on annual international investment agreements	Continuous	International Investment Agreements Navigator
Sign-IIA closeness	Calculates the closeness centrality index by forming the signed bilateral network based on annual international investment agreements	Continuous	International Investment Agreements Navigator
Sign-IIA brokerage	Calculates the brokerage index by forming the signed bilateral network based on annual international investment agreements	Continuous	International Investment Agreements Navigator
Sign-IIA diversity	Calculates the total number of the signed international investment agreements by all economies in a given year	Count	International Investment Agreements Navigator
In-force-IIA diversity	Calculates the total number of the in-force international investment agreements by all economies in a given year	Count	International Investment Agreements Navigator
ISDS dummy	Refers to treaty-based investor-state dispute settlement (ISDS) case or not	0-1	Investment Dispute Settlement Navigator
Economic development	Calculates the GDP per capita (constant 2010 US$)	Continuous	World Bank Development Indicators
PTA depth index	Ranges from one to seven, depending on how many provisions are presented in each trade agreement	1-7	Design of Trade Agreements (DESTA)
Inward FDI	Captures the total foreign equity inflows coming into an economy in a given year	Continuous	UNCTAD database
Outward FDI	Captures the total foreign equity outflows coming from an economy in a given year	Continuous	UNCTAD database
Rule of law	Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence	Continuous	Worldwide Governance Indicators (WGI)
Labor participation	Calculates the labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate)	Continuous	World Bank Development Indicators
Interest payments	Calculates the interest payments (% of expense) in a given year	Continuous	World Bank Development Indicators
Intellectual property rights	Based on sum: binary calculation of general intellectual property rights provisions	Count	Design of Trade Agreements (DESTA)

International entrepreneurship is identified using responses to two survey questions in the World Bank Group's *Enterprise Surveys*: "In what year did this establishment first export directly or indirectly?" and "Year establishment began operations." If the responses to these questions are the same, the firm is classified as an *international entrepreneur* or *born-global venture*.

For male and female entrepreneurship, we utilize data from the *Entrepreneurship Database*, part of the *Women Entrepreneurs Finance Initiative (We-Fi)*. This source provides information on female entrepreneurial activity across 40 countries, covering the period from 2014 to 2018.

3.2.2 Main independent variables

The primary independent variables of interest in this study are the BIT network indicators. In our analysis, countries that are parties to the same BIT are treated symmetrically. To capture the evolving structure of BIT networks over time, we constructed annual network configurations, using the date each BIT entered into force as the starting point. As part of our robustness checks, we also tested an alternative specification that uses the date of signature as the starting date (see Table 1).

For the network indicators, we focus on closeness centrality and the brokerage index. Closeness centrality captures both direct and indirect ties, reflecting how centrally positioned a country is within the overall network. Conceptually, it measures the expected time for information or influence to travel through the network to other countries, assuming optimal (shortest-path) routes (Coviello, 2006). For simplicity and to distinguish it from other centrality metrics, we refer to closeness centrality as *closeness* throughout the analysis.

As robustness checks, we also examine two alternative centrality measures: degree centrality and betweenness centrality (Freeman, 1979). The brokerage index, by contrast, measures the extent to which a country serves as a bridge between otherwise disconnected

components of the network (Burt, 2002). Technical details and formulae used to compute these indices are provided in the Supplementary Appendix.

3.2.3 Moderating variables

To measure economic development, we use GDP per capita, sourced from the World Bank's *World Development Indicators*. Data on international trade agreements are drawn from the *Design of Trade Agreements (DESTA)* database, which includes information on over 700 agreements, covering all active preferential trade agreements (PTAs).

Following Kox and Rojas-Romagosa (2020), we use the PTA depth index as our measure of trade integration. This index captures "the extent to which an agreement restricts a country's autonomy to hamper the cross-border flow of goods and services" (Dür et al., 2014), thus reflecting the substantive commitments embedded in a country's trade agreements.

3.2.4 Control variables

To minimize omitted variable bias, we include a comprehensive set of control variables (see Table 1). First, we incorporate country and year fixed effects to account for unobserved heterogeneity and common time-specific shocks that may influence entrepreneurial activity (Moore et al., 2021).

Second, we control for a country's rule of law, as domestic legal and regulatory environments can significantly affect both the level and nature of entrepreneurship (Dau and Cuervo-Cazurra, 2014). Third, we include the labor force participation rate for individuals aged 15–64, recognizing that access to attractive wage employment may serve as a substitute for self-employment.

Fourth, we control for interest payments, which can influence access to credit. High interest payments may deter borrowing by prospective entrepreneurs; however, they may also signal a robust and active financial market that supports business formation (Misra et al., 2014). Fifth, we control for the strength of intellectual property rights (IPR). Effective IPR

frameworks can stimulate entrepreneurship by safeguarding technological innovations and intangible assets, though they may also raise the cost of adopting existing technologies (Laplume et al., 2014).

Finally, we include both inward and outward foreign direct investment (FDI). Inward FDI can stimulate entrepreneurship in host countries by creating business opportunities and enabling knowledge spillovers from foreign subsidiaries (Kim and Li, 2014). Outward FDI, on the other hand, may foster entrepreneurship through export-oriented strategies and the development of new opportunities in overseas markets (Albulescu and Tămăşilă, 2016).

3.3 Method of analysis

As noted above, the dependent variable in our analysis is a count variable and our data are structured as a panel. Accordingly, we used panel negative binomial regression (Lin et al., 2009). Using a Hausman test, we rejected a random effects model in favour of fixed effects. Hence, we estimated the following equations to test the hypotheses above:

$$\begin{aligned} entrepreneurship_{it} &= \beta_0 + \beta_1 In\_force\_IIA\ closeness_{it} + \beta_2\ In\_force\_IIA\ brokerage_{it} \\ &+ \beta_3 Economic\ development_{it} + \beta_4 PTA\ depth\ index_{it} \\ &+ \beta_m Control\ variable_{it} + \mu_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (1)$$

$$\begin{aligned} entrepreneurship_{it} &= \beta_0 + \beta_1 In\_force\_IIA\ closeness_{it} + \beta_2\ In\_force\_IIA\ brokerage_{it} \\ &+ \beta_3 Economic\ development_{it} + \beta_4 PTA\ depth\ index_{it} \\ &+ \beta_5 In\_force\_IIA\ closeness_{it}\ \text{x}\ Economic\ development_{it} + \beta_6\ In\_force\_IIA\ brokerage_{it}\ \text{x}\ Economic\ development_{it} \\ &+ \beta_7 In\_force\_IIA\ closeness_{it}\ \text{x}\ PTA\ depth\ index_{it} + \beta_8\ In\_force\_IIA\ brokerage_{it}\ \text{x}\ PTA\ depth\ index_{it} \\ &+ \beta_m Control\ variable_{it} + \mu_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (2)$$

where *i* and *t* refer to country and year (2006-2018), β_0 is a constant term, μ_i is country fixed effect, μ_t is year fixed effect, ε_{it} is the regression residual, and the meaning of other variables can be found in Table 1. Hypotheses 1a and 1b are tested using Equation (1). Equation (2) incorporates interaction terms to test the moderating effects in Hypotheses 2a and 2b, and Hypotheses 3a and 3b.

4. Exploratory analysis

4.1 Network statistics

To assess the overall development trends of the BIT network, we examined the evolution of several key network characteristics from 2006 to 2018, as reported in Table D of the Supplementary Appendix.

First, the total number of edge links—representing BIT connections between countries—increased by 19%, from 3,934 in 2006 to 4,682 in 2018. This growth suggests that BITs have become increasingly prevalent, consistent with the broader trend of accelerating investment internationalization. The network density also rose over this period, indicating that investment partnerships among countries have become more interconnected.

Second, centralization peaked in 2007 at 0.594 and has gradually declined since. This trend suggests that international investment activity has become less concentrated among a small group of dominant countries. It also reflects the impact of the 2008 global financial crisis on the trajectory of investment integration.

Third, the average path length of the network shows a slight decline over time, stabilizing around a value of 2, while the network diameter has remained constant at 4. These metrics indicate that any two countries in the network can typically be connected through no more than two intermediary links, and the maximum distance between any two nodes in the network does not exceed four steps.

Table E of the Supplementary Appendix provides further detail on how the structure of the BIT network evolved over time, underscoring its relative stability throughout the 2006–2018 period. Table F of the Supplementary Appendix focuses on centrality and brokerage metrics for the top five countries each year from 2006 to 2018. It reveals that, regardless of the specific centrality measure used, the same countries consistently rank at the top. This

consistency across degree, betweenness, and closeness centrality supports the validity of using degree and betweenness centrality as proxies for closeness centrality in the robustness checks.

4.2 Geographical pattern

To analyze geographical patterns within the BIT network, we mapped each participating country's centrality using ArcGIS. As illustrated in Figure 1 and detailed in Table F of the Supplementary Appendix, the BIT network expanded in size between 2006 and 2018, while its overall structure remained relatively stable. The network shows a clear concentration of central countries in Europe and Asia.

In particular, Germany (DEU) serves as the central hub in the European region, while China (CHN) occupies a comparable position in Asia. Outside of the United States (USA), most participating countries in the Americas and Africa tend to be more peripheral, with centrality concentrated in relatively developed coastal nations. This pattern suggests that active participation in global investment agreements tends to require strong economic fundamentals and a conducive investment environment.

The presence of strong network ties across continents, along with the absence of clearly defined intercontinental clusters, aligns with the broader trend of global trade and investment integration in the world economy.

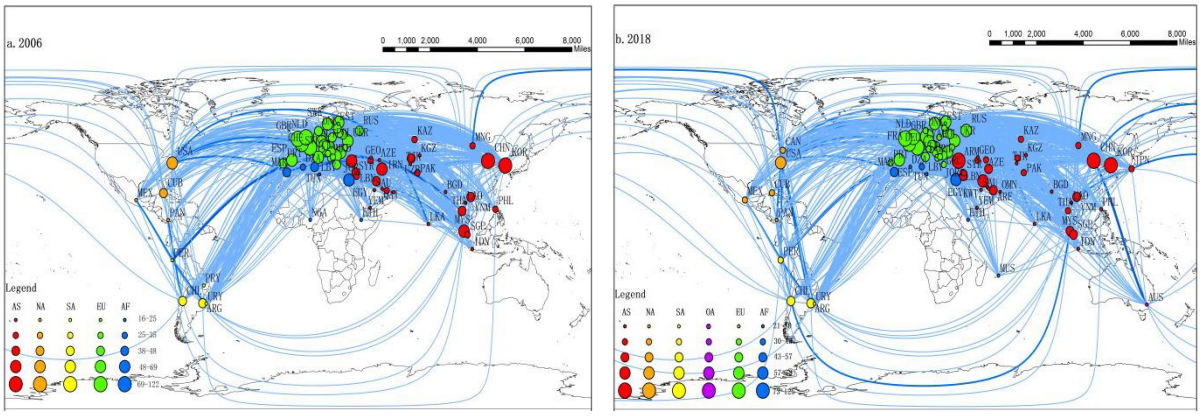

Fig. 1. The geographical pattern of BIT networks in 2006 and 2018.
Notes: The size of the nodes changes with the centrality; the thickness of the edge varies with the BITs frequency; and the color of the line is consistent with that of the node—that is, this economy sign BITs with other economies.

4.3 Core-periphery structure

Using Ucinet and Gephi, two software packages commonly used for social network analysis, we classified countries into four categories based on their coreness scores: core (coreness score ≥ 0.18), semi-core ($0.17 \leq$ coreness < 0.18), semi-periphery ($0.15 \leq$ coreness < 0.17), and periphery (coreness < 0.15). The core–periphery structure of the BIT network from 2006 to 2018 is visualized in Figure 2. In this figure, node size reflects node strength, while line thickness corresponds to the number of BITs signed between countries.

This core–periphery structure reveals the uneven growth of BITs globally. The core group includes countries with the highest number of BITs and the strongest attractiveness to international investors. In 2006, both China (CHN) and Germany (DEU) occupied core positions. However, by 2012 and continuing through 2018, China (CHN) remained the sole core country.

Semi-core countries maintain strong connections not only with core countries but also with one another and with semi-periphery countries. The increasing number of semi-core countries, the rise of multiple regional hubs, and the growing complexity of the network structure over time all indicate a declining trend in network centralization. The semi-periphery group is composed largely of European countries, while the remaining countries fall into the periphery category.

Overall, countries with large domestic investment markets serve as the key drivers of the BIT network, shaping the direction and flow of global investment resources.

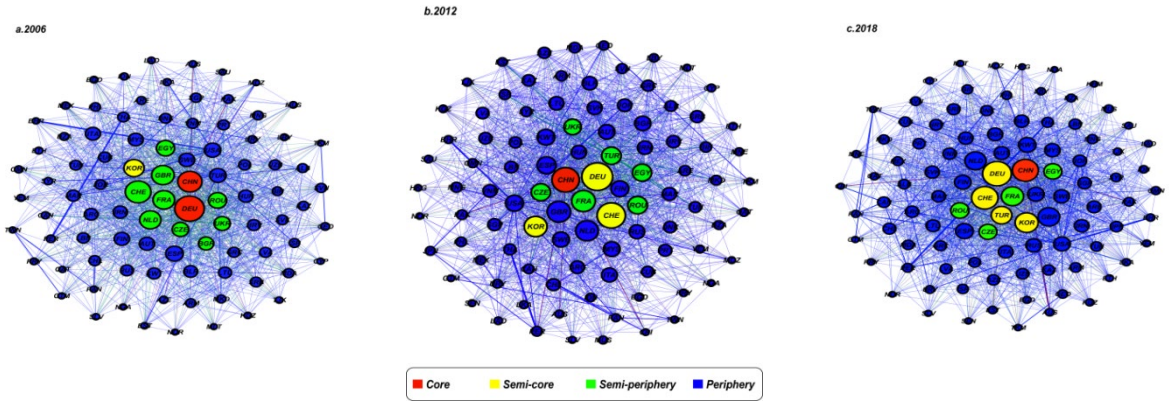

Fig. 2. The core-periphery structure of BITs network from 2006 to 2018.

5. Empirical Results

5.1 Main test results

Table 2 presents the results of the analysis examining the impact of the BIT network on entrepreneurship, providing a test of Hypotheses 1a and 1b. The results from Model 4 indicate that BIT network centrality has a positive effect on entrepreneurship, while brokerage has a negative effect. Both coefficients are statistically significant at the 1% or 5% level, and the magnitudes of the estimated effects are economically meaningful. These findings are fully consistent with the theoretical expectations outlined in Hypotheses 1a and 1b.

Table 2
Results of the impact of BITs network on entrepreneurship: based on negative binomial regression

	Model 1	Model 2	Model 3	Model 4
In-force-IIA closeness			1.89*	2.15*
			(0.82)	(0.88)
In-force-IIA brokerage				-0.57**
				(0.20)
Economic development		0.15*	0.13^{+}	0.15*
		(0.07)	(0.07)	(0.07)
PTA depth index		0.04**	0.04**	0.04**
		(0.01)	(0.01)	(0.01)
Rule of law	0.15**	0.09	0.12*	0.10^{+}
	(0.05)	(0.06)	(0.06)	(0.06)
Labor participation	0.01**	0.01*	0.01^{+}	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)
Interest payments	0.01	0.01^{+}	0.01^{+}	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)

	Model 1	Model 2	Model 3	Model 4
Intellectual property rights	-0.00	-0.02***	-0.02***	-0.02***
	(0.00)	(0.01)	(0.01)	(0.01)
Inward FDI	0.00	0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Outward FDI	0.05***	0.02	0.02	0.02
	(0.01)	(0.02)	(0.02)	(0.02)
Individual fixed effects	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included
Chi-squared	478.38	510.22	521.16	534.33
Log likelihood	-8156.29	-8149.04	-8145.76	-8142.64
Countries	101	101	101	101
Observations(n)	971	971	971	971

Notes: Indicators for the country and year are included in all the models, but their coefficients are not reported for the sake of parsimony. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}p<0.10$, *p<0.05, **p<0.01, ***p<0.001.

Regarding the control variables, the estimated coefficients in Models 1–4 align with our theoretical expectations. Both rule of law and labor force participation show positive and statistically significant effects on entrepreneurship, supporting the view that a stronger institutional environment and greater employment opportunities foster entrepreneurial activity (Dau and Cuervo-Cazurra, 2014).

Although not significant in Model 1, interest payments are positively associated with entrepreneurship in subsequent models, suggesting that a more robust financial environment may enhance entrepreneurial motivation (Misra et al., 2014). In contrast, intellectual property rights exhibit a negative relationship with entrepreneurship, implying that higher costs of technology adoption may deter new venture formation (Laplume et al., 2014).

Finally, neither inward nor outward FDI consistently shows a significant effect on entrepreneurship, with the exception of outward FDI in Model 1. This finding aligns with the results reported by Hong et al. (2021).

5.2 Robustness tests

5.2.1 Alternative dependent variable

Model 1 of Table 3 presents a robustness check using an alternative measure of entrepreneurship, derived from the World Bank Group's *Enterprise Survey*. The estimated coefficients for centrality and brokerage are 52.35 and –30.09, respectively—both consistent

with the theoretical expectations outlined in Hypotheses 1a and 1b**.**

Table 3
Results of the impact of BITs network on entrepreneurship: Robustness checks

	Model 1	Model 2	Model 3	Model 4	Model 5
	Alternative dependent variable	*Alternative independent variable: Degree Centrality*	*Alternative independent variable: Betweenness Centrality*	*The mean of independent variable for3 years*	*Endogeneity: Lewbel instrument*
In-force-IIA closeness	52.35***	2.69***	8.51***	2.30**	2.98**
	(8.65)	(0.39)	(1.46)	(0.77)	(1.16)
In-force-IIA brokerage	-30.09***	-0.66***	-0.46*	-0.78***	-0.53*
	(7.25)	(0.19)	(0.19)	(0.23)	(0.28)
Economic development	0.55^{+}	0.08	0.16*	0.16*	-0.04
	(0.30)	(0.07)	(0.06)	(0.07)	(0.11)
PTA depth index	0.09*	0.03*	0.03*	0.04**	0.03
	(0.04)	(0.01)	(0.01)	(0.01)	(0.02)
Control variables	Included	Included	Included	Included	Included
Individual fixed effects	Included	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included	Included
Chi-squared	137.81	633.65	575.50	544.01	189.13
Log likelihood	-731.55	-8124.00	-8135.68	-8141.22	-2863.31
Countries	24	101	101	101	98
Observations(n)	111	971	971	971	426

Notes: Indicators for the country, year, and control variables are included in all the models, but their coefficients are not reported for the sake of parsimony. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}$p<0.10, *p<0.05, **p<0.01, ***p<0.001.

5.2.2 Alternative independent variable

Models 2 and 3 of Table 3 further assess robustness by employing alternative measures of the centrality variable: degree centrality and betweenness centrality. Degree centrality captures the number of direct ties a country has relative to others (Inekwe, 2021), while betweenness centrality reflects a country's potential to control interactions between other countries in the network (Freeman, 1979). In both models, the estimated coefficients are statistically significant and remain consistent with the theoretical expectations of Hypotheses 1a and 1b.

5.2.3 Endogeneity

We do not expect endogeneity to pose a major concern in this study. Entrepreneurship is a domestic, micro-level behavior, whereas the BIT network reflects a macro-level, strategic investment framework negotiated between national governments. As such, individual

entrepreneurial actions are unlikely to exert meaningful influence on the investment treaty decisions of government agencies. Moreover, the BIT network encompasses not only agreements signed or in force within a given country, but also includes third-party effects, further reducing the potential for reverse causality.

To address any remaining concerns about endogeneity, we implement several strategies. First, we employ mean regression techniques using three-year moving averages of BIT network indicators (e.g., centrality and brokerage) to smooth short-term fluctuations and reduce contemporaneous feedback effects. These results, presented in Model 4 of Table 3, are consistent with the predictions of Hypotheses 1a and 1b.

We also conduct an instrumental variables (IV) analysis. Given the nature of our panel negative binomial regression, standard IV procedures are not directly applicable, and suitable instruments are challenging to identify. We select "cost to import"—the average cost in U.S. dollars to import goods into a country—as a plausible instrument. Prior research has shown that higher import costs are associated with lower participation in investment agreements, as they reflect more interventionist domestic policies and greater investment barriers (Moore et al., 2021). Using this instrument, we conduct a Hausman test for endogeneity, which yields a p-value of 0.171. Thus, we fail to reject the null hypothesis of exogeneity.

Even so, we proceed with IV estimation using the Lewbel (2012) two-stage estimator, which leverages heteroskedasticity for identification. This method constructs instruments based on the expression $(Z - \bar{Z})\hat{\varepsilon}$, where Z represents the exogeneous variable – here "cost of import" – and $\hat{\varepsilon}$ denotes the residuals from a regression of the endogenous variable on all control variables.

Accordingly, we regressed centrality and brokerage on all control variables and retrieved the corresponding residuals. Breusch-Pagan tests for residual terms rejected the hypothesis of homoscedasticity. This indicates that the heteroscedasticity necessary to create instruments in

the manner of Lewbel (2012) is present. Instruments for centrality and brokerage were constructed by interacting the residual terms ($\hat{\varepsilon}$) with the difference between the "cost to import" variable and its mean $(Z - \bar{Z})$.

The corresponding first stage regressions show that the instruments are statistically significant, and the corresponding F-statistics are greater than 10, indicating their relevancy. The second stage panel negative binomial regression demonstrates that the signs and significance of the estimated coefficients for centrality and brokerage are consistent with the baseline regressions. The results are reported in Model 5 of Table 3 and provide further confirmation of Hypotheses 1a and 1b.

5.2.4 Entrepreneurship density

One potential concern with the preceding results is the lack of adjustment for population differences across countries. We addressed this issue through several robustness checks. First, we included alternative population measures as control variables. Model 1 in Table 4 includes total population, while Model 2 uses adult population.

Second, we adjusted the dependent variable to account for population size. Specifically, Models 3 and 4 use the ratio of entrepreneurship to total population and the ratio of entrepreneurship to adult population, respectively. Across all specifications, the results remain consistent with the predictions of Hypotheses 1a and 1b.

We also conducted an additional robustness check in response to concerns over data irregularities in the World Bank's *Doing Business* reports. Given that 2018 data were at the center of this controversy, we re-estimated the model excluding that year. The corresponding estimates, reported in Model 5 of Table 4, continue to support the baseline findings, further reinforcing the robustness of our results.

Table 4
Results of the impact of BITs network on entrepreneurship: based on comparable entrepreneurship

	Model 1	Model 2	Model 3	Model 4	Model 5
	Add control variable: Population	*Add control variable: Adult Population*	*DV: The ratio of entrepreneurship to Population*	*DV: The ratio of entrepreneurship to Adult Population*	*Drop 2018 data*
In-force-IIA closeness	55.35***	55.23***	2.32*	2.44*	2.94***
	(9.62)	(9.65)	(1.01)	(1.03)	(0.87)
In-force-IIA brokerage	-36.87***	-36.86***	-1.17***	-1.05***	-0.54*
	(6.74)	(6.79)	(0.33)	(0.28)	(0.23)
Economic development	0.71*	0.71*	0.24^{+}	0.13	0.10
	(0.29)	(0.29)	(0.12)	(0.11)	(0.07)
PTA depth index	0.14***	0.14***	0.12***	0.11***	0.05***
	(0.04)	(0.04)	(0.02)	(0.02)	(0.01)
Control variables	Included	Included	Included	Included	Included
Individual fixed effects	Included	Included	Included	Included	Included
Chi-squared	90.44	90.71	177.10	200.76	298.69
Log likelihood	-737.30	-737.31	-2338.58	-2653.47	-7438.74
Countries	24	24	101	101	97
Observations(n)	111	111	971	971	889

Notes: Indicators for the country and control variables are included in all the models, but their coefficients are not reported for the sake of parsimony. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}$p<0.10, *p<0.05, **p<0.01, ***p<0.001.

5.3 Network robustness analysis

5.3.1 Signed BITs network

When constructing network configurations at a given point in time, two approaches can be used to determine the starting date of a BIT: the date the agreement was signed, and the date it entered into force. These dates can differ substantially, as considerable time may elapse between signing and ratification—and in some cases, agreements may never enter into force at all (Jean and Bureau, 2016). The primary analysis in this study relied on the in-force date to construct the BIT network. However, other studies have used the signature date as the reference point (Elkins et al., 2006; Saban et al., 2010).

Model 1 of Table 5 presents results using this alternative approach, in which agreements are dated by their signature date. The estimated coefficient for centrality is 3.21, and for

brokerage is –0.05. Both coefficients are consistent in sign with the predictions of Hypotheses 1a and 1b, although only the centrality coefficient is statistically significant.

Table 5
Results of the impact of BITs network on entrepreneurship: based on different types of BITs network

	Model 1 *Sign-IIA*	Model 2 *Sign-IIA diversity*	Model 3 *In-force-IIA diversity*	Model 4 *ISDS home dummy=Yes*	Model 5 *ISDS home dummy=No*
Sign-IIA closeness	3.21*** (0.89)				
Sign-IIA brokerage	-0.05 (0.58)				
Sign-IIA diversity		0.01*** (0.00)			
In-force-IIA diversity			0.01*** (0.00)		
In-force-IIA closeness				7.32*** (1.47)	-0.19 (0.50)
In-force-IIA brokerage				-0.45 (1.70)	-0.58*** (0.18)
Economic development	0.12^{+} (0.07)	0.07 (0.07)	0.06 (0.07)	0.33 (0.22)	0.20* (0.08)
PTA depth index	0.04** (0.01)	0.03* (0.01)	0.03* (0.01)	0.04^{+} (0.02)	0.05** (0.02)
Control variables	Included	Included	Included	Included	Included
Individual fixed effects	Included	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included	Included
Chi-squared	567.66	627.78	627.06	214.44	399.14
Log likelihood	-8139.98	-8128.90	-8127.62	-1762.72	-5875.55
Countries	101	101	101	44	92
Observations(n)	971	971	971	220	740

Notes: Indicators for the country, year, and control variables are included in all the models, but their coefficients are not reported for the sake of parsimony. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}$p<0.10, *p<0.05, **p<0.01, ***p<0.001. The sum of country sample in Models 4 and 5 is not equal to 101 just because some countries are ISDS home country in a specific year but not in other years. Likewise, the sum of observation in Models 4 and 5 is not equal to 971.

5.3.2 Diversity of BITs network

Other studies have measured the prevalence of BITs with the number of BITs rather than measures of network characteristics. As a result, we also adopted this measure in our analysis as a robustness check. Models 2 and 3 of Table 5 report the results of using this alternative measure, called “diversity”. Model 2 used the signed date of agreements in constructing BIT network while Model 3 used the date the agreements went into force. In both models, the

diversity coefficient is estimated to be positive and statistically significant. These two models illustrate how a simple measure of number of BITs can mask important network relationships.

5.3.3 Investor-State dispute settlement

One source of controversy surrounding BITs is the inclusion of provisions that allow private firms to sue governments if they believe the terms of a BIT have been violated, resulting in diminished investment value. These disputes, known as Investor-State Dispute Settlements (ISDS), are typically adjudicated under the auspices of the International Centre for Settlement of Investment Disputes (ICSID). The initiation of an ISDS case can signal to other members of the network that the host government may not be a reliable investment partner. This, in turn, can damage the reputation of a BIT and diminish its potential impact on entrepreneurship.

To explore this dynamic, we used newly released data on 1,104 treaty-based ISDS cases to determine whether a country has ever had an ISDS claim brought against it. To identify whether the country was acting as a home partner, we constructed a dummy variable, ISDS Home. We then divided the sample into two subsamples: countries that have experienced an ISDS dispute (ISDS Home = Yes) and those that have not (ISDS Home = No). We re-estimated our main model—including the centrality and brokerage indicators—for each subsample. The results are reported in Models 4 and 5 of Table 5.

In Model 4, for countries that have been the subject of an ISDS dispute, centrality has a positive and statistically significant effect on entrepreneurship, while brokerage is not significant. In contrast, Model 5, which focuses on countries without ISDS disputes, shows that centrality is insignificant, whereas brokerage has a negative and statistically significant effect.

These results are consistent with the findings of Allee and Peinhardt (2011), who argue that the effectiveness of BITs in attracting FDI depends on how the host country behaves after the agreement is signed. When a country allows investors to initiate ISDS cases under ICSID jurisdiction, it signals a strong commitment to protecting foreign investment, thereby creating

a more trustworthy and stable investment environment. This enhances investor confidence and facilitates entrepreneurship. In contrast, countries without any ISDS disputes may be perceived as less credible or less open to investment-related legal protections, which can weaken their attractiveness to foreign investors. As a result, prospective entrepreneurs may delay or even abandon plans to launch new ventures in such environments.

5.4 Entrepreneurship heterogeneity analysis

5.4.1 Formal and informal entrepreneurship

Entrepreneurship is often conceptualized as the sum of formal and informal business activity (Acs et al., 2008). However, different types of entrepreneurs may respond differently to institutional and network influences (Dau and Cuervo-Cazurra, 2014). Formal entrepreneurship refers to legally registered businesses, whereas informal entrepreneurship encompasses business activity that occurs without legal registration (Webb et al., 2009). Given these differences, it is reasonable to expect that formal and informal entrepreneurs may be differentially affected by the BIT network.

We present results for formal and informal entrepreneurship in Models 1 and 2 of Table 6. In both models, the estimated coefficients for centrality are statistically significant, indicating a positive relationship with entrepreneurship across both types. However, the coefficient for brokerage is significant only in the case of informal entrepreneurship. In all cases, the signs of the estimated coefficients are consistent with the predictions of Hypotheses 1a and 1b.

5.4.2 Male and female entrepreneurship

Previous research has consistently found that entrepreneurship is predominantly male-dominated, although the underlying factors contributing to this gender gap remain insufficiently understood (Gunawan et al., 2021; Barcena-Martin et al., 2021; Brieger and Gielnik, 2021). To explore whether this gap extends to differential responses to the BIT

network, we examined the effects of centrality and brokerage separately for male and female entrepreneurs.

The results, presented in Models 3 and 4 of Table 6, show that both centrality and brokerage retain their predicted signs and are statistically significant in both models. These findings suggest that the structural position of countries in the BIT network influences male and female entrepreneurial activity in similar ways.

Table 6
Results of the impact of BITs network on entrepreneurship: based on different types of entrepreneurship

	Model 1 *Formal*	Model 2 *Informal*	Model 3 *Male*	Model 4 *Female*	Model 5 *International*
In-force-IIA closeness	5.97***	9.09**	51.33***	45.38***	-4.67^{+}
	(1.70)	(3.33)	(8.65)	(10.92)	(2.44)
In-force-IIA brokerage	-0.49	-1.12*	-30.06***	-20.24*	0.47
	(0.35)	(0.55)	(7.04)	(9.21)	(0.36)
Economic development	-0.15^{+}	-0.40^{+}	0.54^{+}	0.24	-0.27
	(0.09)	(0.21)	(0.30)	(0.30)	(0.18)
PTA depth index	-0.12***	-0.22**	0.08^{+}	0.12**	-0.17***
	(0.02)	(0.08)	(0.04)	(0.04)	(0.05)
Control variables	Included	Included	Included	Included	Included
Individual fixed effects	Included	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included	Included
Chi-squared	1149.37	312.93	116.68	170.05	295.99
Log likelihood	-2919.22	-1018.26	-706.92	-604.99	-1526.14
Countries	84	75	24	24	82
Observations(n)	924	835	111	111	937

Notes: Indicators for the country, year, and control variables are included in all the models, but their coefficients are not reported for the sake of parsimony. Due to data limitations, Models 3 and 4 use *Male* and *Female* entrepreneurship data for 2014-2018, with 111 observations in the regressions. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}$p<0.10, *p<0.05, **p<0.01, ***p<0.001.

5.4.3 International entrepreneurship

In recent years, a particular subset of entrepreneurs known as born-globals has attracted growing scholarly attention (Prieto-Sanchez and Merino, 2021). These are small, entrepreneurial firms that defy traditional, incremental theories of internationalization. The born-global phenomenon challenges the long-held assumption that small firms are inherently constrained by limited resources. A growing body of literature has highlighted the critical role

of network ties in shaping the internationalization paths of born-globals (Sedziniauskiene et al., 2019; Su et al., 2020).

Building on this literature, we examined international entrepreneurship in Model 5 of Table 6. The results are unexpected. The estimated coefficients for centrality and brokerage run counter to the predictions of Hypotheses 1a and 1b, although only the centrality coefficient is statistically significant.

Our ex-post explanation draws from the literature on strong and weak ties. Countries with high centrality in the BIT network are typically characterized by strong, well-established ties, while countries in high brokerage positions tend to maintain weaker, more exploratory connections. For international entrepreneurship, weak ties may be more valuable, as they provide access to new information and non-redundant contacts across different parts of the network (Sepulveda and Gabrielsson, 2013). For example, Kontinen and Ojala (2011) find that family-owned SMEs are more likely to identify overseas opportunities through weak ties. Similarly, Freund et al. (2020) emphasize the importance of weak network ties in the internationalization of high-tech SMEs and in facilitating knowledge acquisition.

In this light, the brokerage position—with its emphasis on weak ties—may actually enhance international entrepreneurial activity, while centrality, associated with strong ties, may have a constraining effect. While this explanation is post hoc, we believe it offers a promising direction for future research on the interaction between network structure and international entrepreneurship.

5.4.4 Post-hoc Analysis: Entrepreneurship ratio

By disaggregating entrepreneurship into distinct types, we lose the ability to directly compare the effects of centrality and brokerage across these categories. Table 7 addresses this limitation by enabling such comparisons. Our primary objective is to examine the potential "push and pull" effects of the BIT network on different forms of entrepreneurship (Moore et al., 2021).

Accordingly, the dependent variables in Table 7 are expressed as ratios: the ratio of formal to informal entrepreneurship, the ratio of male to female entrepreneurship, and the ratio of international to total entrepreneurship.

Table 7
Results of the impact of BITs network on entrepreneurship ratio: based on different entrepreneurship types

	Model 1 *the ratio of formal to informal*	Model 2 *the ratio of male to female*	Model 3 *the ratio of international to total*
In-force-IIA closeness	64.19***	142.80^{+}	0.00
	(12.40)	(81.50)	(0.01)
In-force-IIA brokerage	-4.78	-318.09***	-0.02***
	(5.72)	(63.00)	(0.00)
Economic development	1.51*	10.80*	0.00
	(0.72)	(4.16)	(0.00)
PTA depth index	-0.29^{+}	0.83	-0.00
	(0.17)	(0.65)	(0.00)
Control variables	Included	Included	Included
Year fixed effects	Included	Included	Included
Log likelihood	-3795.74	-463.25	2303.48
Observations(n)	965	113	545

Notes: Indicators for the year and control variables are included in all the models, but their coefficients are not reported for the sake of parsimony. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}$p<0.10, *p<0.05, **p<0.01, ***p<0.001.

Table 7 provides additional insights into the impact of the BIT network on entrepreneurial activity. Overall, the BIT network is associated with a significant increase in the relative proportion of formal entrepreneurs and a corresponding decrease in informal entrepreneurship. At the same time, it is associated with a decrease in the relative proportion of male and international entrepreneurs, and a corresponding increase in female and domestic entrepreneurship.

6. Moderating effects

6.1 The moderating role of economic development

Table 8 presents our final set of results, focusing on the moderating effects outlined in Hypotheses 2a, 2b, 3a, and 3b. Models 1 and 2 examine how economic development influences the relationship between closeness, brokerage, and entrepreneurship.

The first row reports the interaction effects for centrality. In both models, the coefficients are negative and statistically significant, consistent with Hypothesis 2a, which posits that economic development weakens the positive relationship between BIT network centrality and entrepreneurship.

The second row shows the interaction effects for brokerage. The coefficient is positive and significant at the 5 percent level, supporting Hypothesis 2b, which predicts that economic development mitigates the negative relationship between BIT network brokerage and entrepreneurship. An illustrative summary of these moderating effects is provided in the Supplementary Appendix's Figure 1.

6.2 The moderating role of trade integration

Models 3 and 4 of Table 8 present the results of interacting trade integration with centrality and brokerage. In Model 3, the interaction term between trade integration and closeness is negative and statistically significant at the 5 percent level. In Model 4, after including an interaction term for brokerage, the interaction effect for closeness remains negative but loses statistical significance. These results offer weak support for Hypothesis 3a, which posits that trade integration dampens the positive relationship between BIT centrality and entrepreneurship.

In contrast, we find no support for Hypothesis 3b, which predicts a positive interaction between trade integration and brokerage. The corresponding interaction term in Model 4 is

negative and statistically insignificant, suggesting that trade integration does not moderate the relationship between brokerage and entrepreneurship in the expected direction.

Table 8
Results of the impact of BITs network on entrepreneurship: based on the moderating role of economic development and trade integration

	Model 1	Model 2	Model 3	Model 4
	Economic Development		*PTA Depth Index*	
In-force-IIA closeness x Economic development	-25.86***	-35.36***		
	(6.77)	(7.87)		
In-force-IIA brokerage x Economic development		5.71*		
		(2.82)		
In-force-IIA closeness x PTA depth index			-1.01*	-0.70
			(0.50)	(0.55)
In-force-IIA brokerage x PTA depth index				-0.33
				(0.24)
In-force-IIA closeness	2.71***	3.45***	1.96*	1.83*
	(0.66)	(0.73)	(0.78)	(0.78)
In-force-IIA brokerage	-1.19***	-1.83***	-0.61**	-0.48*
	(0.25)	(0.40)	(0.20)	(0.23)
Economic development	0.20**	0.20**	0.13^{+}	0.14*
	(0.07)	(0.07)	(0.07)	(0.07)
PTA depth index	0.04**	0.04**	0.04**	0.04**
	(0.01)	(0.01)	(0.01)	(0.01)
Control variables	Included	Included	Included	Included
Individual fixed effects	Included	Included	Included	Included
Year fixed effects	Included	Included	Included	Included
Chi-squared	565.38	575.41	533.62	538.92
Log likelihood	-8135.82	-8133.90	-8140.55	-8139.61
Countries	101	101	101	101
Observations(n)	971	971	971	971

Notes: Indicators for the country, year, and control variables are included in all the models, but their coefficients are not reported for the sake of parsimony. Standard errors are shown in parentheses. Significance levels (2-tailed): $^{+}$p<0.10, *p<0.05, **p<0.01, ***p<0.001.

7. Conclusion

This paper investigates the relationship between Bilateral Investment Treaty (BIT) networks and entrepreneurship. We began by hypothesizing that centrality within a BIT network positively influences entrepreneurship, while brokerage has a negative effect (Hypotheses 1a and 1b). We further hypothesized that these relationships are moderated by economic development and trade integration (Hypotheses 2a, 2b, 3a, and 3b). These hypotheses were

tested using a panel dataset of 102 countries spanning 2006 to 2018. We found broad support for our theoretical expectations.

In support of Hypotheses 1a and 1b, we estimated that centrality is positively associated with entrepreneurship, while brokerage is negatively associated. These findings are robust across multiple specifications, including alternative measures of entrepreneurship, different network centrality metrics, alternative dating methods for BIT entry into effect, and various subsamples—such as formal vs. informal entrepreneurship, male vs. female entrepreneurship, and countries with and without Investor-State Dispute Settlement (ISDS) cases. The only exception to this pattern was observed among born-global entrepreneurs, for whom the expected relationships did not hold.

Regarding the moderating hypotheses, we found strong evidence that economic development weakens the relationship between BIT network structure and entrepreneurship. However, there was only weak evidence that trade integration moderates this relationship.

This study makes several contributions to the literature on entrepreneurship, investment integration, and network theory. First, it offers an initial theoretical framework linking BIT network positions to country-level entrepreneurship through the lens of social network analysis (SNA). Second, it advances our understanding by examining how economic context—specifically, levels of development and trade integration—moderates these network effects. Third, it explores the "push and pull" dynamics of BIT networks across different forms of entrepreneurship, including formal/informal, male/female, and domestic/international entrepreneurship.

The findings have important policy and practical implications. For entrepreneurs, our results suggest that the investment network position of a country should be taken into account when considering international ventures. Network centrality can provide access to stable, well-connected markets, whereas brokerage may signal instability or mistrust. For policymakers,

the results indicate that BITs may be particularly valuable for less developed countries seeking to enhance entrepreneurial activity through greater integration into global investment networks.

We also acknowledge several limitations of the study. First, because our unit of analysis is the country, we are unable to capture the behaviors and decision-making processes of individual entrepreneurs. Second, our focus is on new venture creation, rather than the growth trajectories of entrepreneurial firms over time. Third, although our dataset includes 102 countries from 2006 to 2018, data constraints prevent us from extending the analysis to a broader set of countries or a longer time span.

These limitations point to several directions for future research. First, do multilateral investment agreements have a stronger or different impact on entrepreneurship compared to bilateral ones? Second, what is the time lag between investment integration and its entrepreneurial effects? Third, what are the mechanisms—beyond centrality and brokerage—through which BIT networks influence entrepreneurship? Fourth, how can we empirically differentiate direct and indirect effects of BITs?

In light of growing political resistance to investment integration in many parts of the world, it is increasingly important to understand who benefits from these networks. This study demonstrates that a network-based perspective offers valuable insights into the distributional consequences of investment treaties. Moreover, if entrepreneurship is to serve as a catalyst for economic development, we must identify the conditions that enable it to thrive. It is our hope that this study will stimulate further research into these pressing and timely questions.

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Appendix

Table A

Country list (n=972)

Highest income country	N	Missing	Middle income country	N	Missing	Lowest income country	N	Missing
Australia	13	0	Albania	8	5	Afghanistan	10	3
Austria	12	1	Argentina	5	8	Bangladesh	2	11
Belgium	11	2	Armenia	13	0	Burkina Faso	2	11
Canada	2	11	Azerbaijan	11	2	Cambodia	13	0
Chile	13	0	Belarus	13	0	Cape Verde	9	4
Croatia	13	0	Belize	11	2	Cote d'Ivoire	6	7
Cyprus	13	0	Bosnia and Herzegovina	3	10	El Salvador	8	5
Czech Republic	13	0	Botswana	11	2	Ghana	6	7
Denmark	11	2	Brazil	9	4	India	13	0
Estonia	13	0	Bulgaria	11	2	Kenya	2	11
Finland	10	3	Colombia	8	5	Kyrgyzstan	3	10
France	13	0	Costa Rica	13	0	Madagascar	5	8
Germany	12	1	Gabon	6	7	Malawi	1	12
Greece	7	6	Georgia	13	0	Mali	10	3
Hungary	11	2	Guatemala	13	0	Moldova, Republic of	5	8
Iceland	10	3	Indonesia	9	4	Mongolia	12	1
Ireland	10	3	Jamaica	13	0	Morocco	13	0
Israel	13	0	Jordan	13	0	Philippines	13	0
Italy	12	1	Kazakhstan	9	4	Rwanda	5	8
Korea, Republic of	11	2	Macedonia, the Former Yugoslav Republic of	13	0	Senegal	4	9
Latvia	12	1	Malaysia	13	0	Sri Lanka	12	1
Lithuania	11	2	Mexico	11	2	Togo	9	4
Luxembourg	8	5	Namibia	11	2	Tunisia	7	6
Malta	13	0	Peru	13	0	Uganda	4	9
Mauritius	13	0	Russian Federation	13	0	Ukraine	12	1
Netherlands	11	2	Saint Lucia	5	8	Uzbekistan	5	8
New Zealand	11	2	Saint Vincent and the Grenadines	4	9	Vanuatu	8	5
Norway	10	3	Samoa	2	11	Zambia	13	0
Panama	5	8	Serbia	11	2	Zimbabwe	8	5
Poland	13	0	South Africa	11	2			
Portugal	9	4	Thailand	13	0			
Saudi Arabia	9	4	Tonga	4	9			
Singapore	13	0	Turkey	6	7			
Slovakia	10	3						
Slovenia	11	2						
Spain	2	11						
Sweden	13	0						
Switzerland	12	1						
United Arab Emirates	8	5						
United Kingdom	13	0						

Table B

Descriptive statistics

Variable name	Number of observations	Mean	Standard deviation	Minimum	Maximum
Entrepreneurship	972	41634.79	84419.85	23	660000
Registered directors	113	14489.31	19747.75	2123	110000
Formal entrepreneurship	545	25.58	47.91	0	445
Informal entrepreneurship	545	1.20	2.31	0	16
Male entrepreneurship	113	10443.36	12439.24	1622	61374
Female entrepreneurship	113	4045.95	8022.22	11	46922
International entrepreneurship	545	2.80	3.50	0	35
In-force-IIA closeness	972	0.52	0.10	0	0.76
In-force-IIA brokerage	972	0.88	0.18	0	0.98
In-force-IIA degree	972	0.20	0.15	0	0.72
Sign-IIA closeness	972	0.54	0.09	0	0.76
Sign-IIA brokerage	972	0.91	0.14	0	0.98
Sign-IIA diversity	972	40.25	27.57	0	131
In-force-IIA diversity	972	34.96	26.43	0	125
ISDS home dummy	972	0.23	0.42	0	1
Economic development	972	9.12	1.29	6.02	11.61
PTA depth index	972	8.72	8.84	0	34.30
Inward FDI	972	7.97	1.92	0.95	12.46
Outward FDI	972	8.91	3.28	-0.64	14.74
Rule of law	972	0.37	0.95	-1.90	2.10
Labor participation	972	68.86	8.92	41.53	88.41
Interest payments	972	7.31	6.54	0	48.76
Intellectual property rights	972	17.19	16.91	0	60.60

Table C

Correlation matrix

	Entrepreneurship	In-force-IIA closeness	In-force-IIA brokerage	Economic development	PTA depth index	Rule of Law	Labor participation	Interest payments	Intellectual property rights	Inward FDI	Outward FDI
Entrepreneurship	1										
In-force-IIA closeness	0.192***	1									
In-force-IIA brokerage	0.165***	0.844***	1								
Economic development	0.263***	0.201***	0.230***	1							
PTA depth index	0.260***	0.202***	0.208***	0.527***	1						
Rule of Law	0.196***	0.073***	0.126***	0.782***	0.577***	1					
Labor participation	0.102***	0.0210	0.0250	0.117***	0.218***	0.259***	1				
Interest payments	-0.0150	-0.0150	0.0190	-0.195***	-0.177***	-0.165***	-0.216***	1			
Intellectual property rights	0.196***	0.229***	0.242***	0.569***	0.932***	0.611***	0.216***	-0.221***	1		
Inward FDI	0.459***	0.421***	0.493***	0.555***	0.453***	0.409***	0.103***	-0.0220	0.469***	1	
Outward FDI	0.449***	0.300***	0.329***	0.717***	0.568***	0.585***	0.215***	-0.110***	0.562***	0.815***	1

Notes: N=972. Statistically significant at $^{***}p<.01$. Year dummies are omitted for the sake of parsimony.

Table D

The whole characteristics of BITs network from 2006-2018

Year	Node	Edge	Density	Centralization	Average Path Length	Diameter
2006	174	3934	0.131	0.581	2.041	4.000
2007	174	4066	0.135	0.594	2.024	4.000
2008	174	4166	0.138	0.591	2.013	4.000
2009	175	4304	0.141	0.584	2.006	4.000
2010	176	4370	0.142	0.579	2.008	4.000
2011	177	4426	0.142	0.575	2.013	4.000
2012	177	4456	0.143	0.574	2.008	4.000
2013	177	4512	0.145	0.572	2.003	4.000
2014	177	4570	0.147	0.570	1.999	4.000
2015	178	4622	0.147	0.566	2.001	4.000
2016	178	4646	0.147	0.565	2.000	4.000
2017	178	4660	0.148	0.565	1.999	4.000
2018	178	4682	0.149	0.564	1.998	4.000

Table E

The tie evolution type of BITs network

Period	0-0	Proportion of 0-0	0-1	Proportion of 0-1	1-1	Proportion of 1-1	Distance	Total Change of Ties	Jaccard Similarity Coefficient
2006→2007	29342	93.52%	66	0.21%	1967	6.27%	132	198	0.968
2007→2008	29292	93.36%	50	0.17%	2033	6.48%	100	150	0.976
2008→2009	29223	93.14%	69	0.24%	2083	6.64%	138	207	0.968
2009→2010	29190	93.04%	33	0.11%	2152	6.86%	66	99	0.985
2010→2011	29162	92.95%	28	0.10%	2185	6.96%	56	84	0.987
2011→2012	29147	92.90%	15	0.05%	2213	7.05%	30	45	0.993
2012→2013	29119	92.81%	28	0.10%	2228	7.10%	56	84	0.988
2013→2014	29090	92.72%	29	0.10%	2256	7.19%	58	87	0.987
2014→2015	29064	92.63%	26	0.09%	2285	7.28%	52	78	0.989
2015→2016	29052	92.60%	12	0.04%	2311	7.37%	24	36	0.995
2016→2017	29045	92.57%	7	0.02%	2323	7.40%	14	21	0.997
2017→2018	29034	92.54%	11	0.04%	2330	7.43%	22	33	0.995

Notes: The Jaccard similarity coefficient is defined as the Hamming distance between continuous waves of observations of the network. It is an index used to measure the degree of network change or network stability between two continuous time points.

Relationships between members of BITs network can be categorized by a pair of 0-1 values. 0-0 indicates that no BITs relationship existed between two countries in the previous period, and that no BITs relationship was established in the current period. 0-1 indicates no BITs relationship existed in the previous period, but a BITs relationship was established between them in the current period. And 1-1 indicates the existence of a BITs relationship both before and during the current period. This table shows how the BITs network evolved from 2006 to 2018. The proportions of 0-0 and 1-1 are relatively high while the proportion of 0-1 is very low, which indicates a greater inertia in investment behavior of countries. It is clear that the existing state of investment relationships between countries is usually constant in the next period. The overall decreasing proportion of 0-1 indicates a growing resistance to the formation of new relations in BITs network. In addition, the Jaccard similarity index shows a clear upward trend.

Table F

The centrality and brokerage analysis of BITs network for the top 5 countries from 2006-2018

2006							
Closeness		Degree		Betweenness		Brokerage	
DEU	0.7457	DEU	0.7052	DEU	0.1905	DEU	0.9799
CHN	0.6920	CHE	0.6012	CHE	0.1011	CHE	0.9781
CHE	0.6578	CHN	0.5607	GBR	0.0816	GBR	0.9759
KOR	0.6407	GBR	0.5145	CHN	0.0792	NLD	0.9737
GBR	0.6314	FRA	0.4913	NLD	0.0552	FRA	0.9735
2009							
Closeness		Degree		Betweenness		Brokerage	
DEU	0.7565	DEU	0.7184	DEU	0.1698	DEU	0.9793
CHN	0.7160	CHE	0.6322	CHE	0.0937	CHE	0.9762
CHE	0.6850	CHN	0.6092	CHN	0.0739	GBR	0.9758
KOR	0.6641	FRA	0.5230	GBR	0.0729	NLD	0.9740
GBR	0.6350	GBR	0.5115	NLD	0.0555	FRA	0.9734
2012							
Closeness		Degree		Betweenness		Brokerage	
DEU	0.7489	DEU	0.7102	DEU	0.1624	DEU	0.9791
CHN	0.7184	CHE	0.6420	CHE	0.0936	GBR	0.9759
CHE	0.6957	CHN	0.6193	CHN	0.0725	CHE	0.9758
KOR	0.6642	FRA	0.5227	GBR	0.0721	NLD	0.9738
GBR	0.6331	GBR	0.5114	NLD	0.0534	FRA	0.9734
2015							
Closeness		Degree		Betweenness		Brokerage	
DEU	0.75	DEU	0.7062	DEU	0.1572	DEU	0.9789
CHN	0.7254	CHE	0.6441	CHE	0.0862	GBR	0.9756
CHE	0.6969	CHN	0.6271	GBR	0.0694	CHE	0.9751
KOR	0.686	KOR	0.5424	CHN	0.0683	NLD	0.9736
TUR	0.6507	FRA	0.5254	NLD	0.0502	FRA	0.9731
2018							
Closeness		Degree		Betweenness		Brokerage	
DEU	0.75	DEU	0.7062	DEU	0.1554	DEU	0.9788
CHN	0.7254	CHE	0.6441	CHE	0.0849	GBR	0.9756
CHE	0.6969	CHN	0.6271	GBR	0.069	CHE	0.9749
KOR	0.6887	KOR	0.548	CHN	0.0671	NLD	0.9736
TUR	0.658	FRA	0.5254	NLD	0.0496	FRA	0.9730

This table shows that the top-ranked countries are largely stable, represented by Germany (DEU), Switzerland (CHE) and China (CHN), and mainly include European and some economically advanced countries in Asia since the more sophisticated investment market attracts most countries in BITs network. Meanwhile, the top-ranked degree centrality countries have not significantly continued to increase the number of BITs signed, and new agreements have been signed more among the sub-center countries, reflecting a declining network centralization. The top countries ranked by brokerage are mainly European countries, represented by Germany (DEU), Switzerland (CHE), United Kingdom (GBR), and France (FRA).

Figure 1

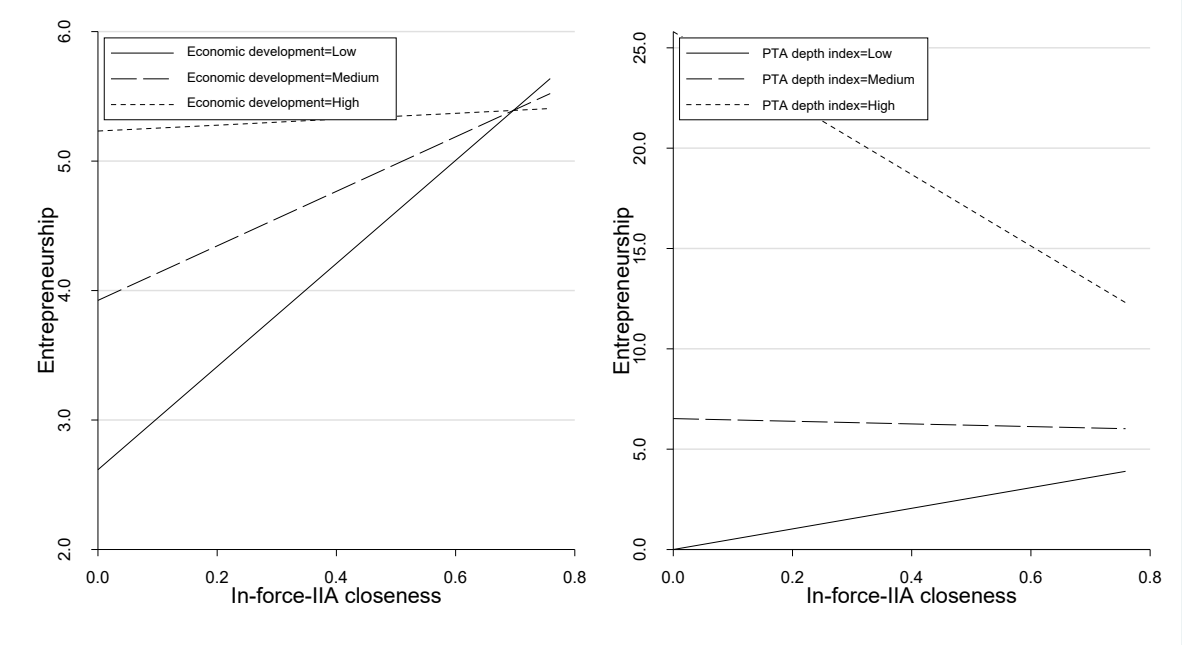

Fig. A. The moderating role of economic development and trade integration

The left panel of Figure 3 illustrates how the relationship between closeness and entrepreneurship is moderated by economic development. We defined low, medium and high levels of economic development by the following categories, respectively: (i) *Economic development* = $\bar{X}_{ED} - \hat{\sigma}_{ED}$, (ii) *Economic development*= $\bar{X}_{ED}$, and (iii) *Economic development*= $\bar{X}_{ED} + \hat{\sigma}_{ED}$, where $\bar{X}_{ED}$ is the sample mean of the economic development variable and $\hat{\sigma}_{ED}$ the sample standard deviation. When economic development is low (the solid curve), the slope of entrepreneurship is steepest. When economic development is medium (the long-dash curve), the slope of entrepreneurship is flatter than the slope for low economic development. Finally, when economic development is high (the short-dash curve), the slope of entrepreneurship is flattest. Even so, except for the very highest levels of closeness, entrepreneurial activities in high-level economic development countries is greater than that of low-level economic development countries in our sample.

The right panel in Figure 3 illustrates the moderating effect of trade integration on closeness. As before, we categorized countries into low, medium and high levels of trade integration ones, where the categories are defined respectively by (i) *Trade integration* = $\bar{X}_{TI} - \hat{\sigma}_{TI}$, (ii) *Trade integration*= $\bar{X}_{TI}$ and (iii) *Trade integration*= $\bar{X}_{TI} + \hat{\sigma}_{TI}$, where $\bar{X}_{TI}$ is the sample mean of the *PTA depth* variable and $\hat{\sigma}_{TI}$ the sample standard deviation. When trade integration is low (the solid curve), the slope of closeness centrality is positive and steepest. When trade integration is medium (the long-dash curve), the slope of entrepreneurship is flatter and nearly equal to zero. When trade integration is high (the short-dash curve), the slope of entrepreneurship becomes negative. Although trade integration negatively moderates the positive relationship between closeness centrality and entrepreneurship, entrepreneurial activities in high-level trade integration countries are still higher than those in low-level trade integration countries in our sample.

Formula

We can think of a network as a collection of points and edges, with edges connecting pairs of points. Given a point p_k in a network consisting of n points, it can at most be adjacent to n-1 other points. For any unordered pair of points (p_k, p_i), there may be many paths linking them together. The distance between two points connected along a given path is measured by the associated number of edges. The smallest distance between two points is called a geodesic.

According to Freeman (1979), closeness centrality of a specific country p_k in a BIT network can be measured by

$$C_C^{'}(p_k) = \left[\frac{\sum_{i=1}^{n} d(p_i, p_k)}{n-1} \right]^{-1} = \frac{n-1}{\sum_{i=1}^{n} d(p_i, p_k)} \tag{1}$$

where $C_C^{'}(p_k)$ is closeness centrality of country p_k, $d(p_i, p_k)$ is the number of edges in the geodesic linking country p_i and p_k, and n is the number of countries in the BIT network.

One alternative measure by Freeman (1979) is given by

$$C_D^{'}(p_k) = \frac{D_k}{n-1} = \frac{\sum_{i=1}^{n} a(p_i, p_k)}{n-1} \tag{2}$$

Here, $C_D^{'}(p_k)$ is the degree centrality of country p_k since it measures centrality based on the degree or number of adjacencies for country p_k. $a(p_i, p_k)$ equals 1 if and only if country p_k and p_i are connected by a line. Otherwise, it equals 0. D_k is the sum of the degree of country p_k and n is the number of countries in the BIT network.

In addition, Freeman (1979) measures betweenness centrality as follows:

$$C_B^{'}(p_k) = \frac{C_B(p_k)}{\left(\frac{n^2-3n+2}{2}\right)} = \frac{2C_B(p_k)}{n^2-3n+2} \tag{3}$$

$$C_B(p_k) = \sum_i^n \sum_j^n \frac{g_{ij}(p_k)}{g_{ij}} \tag{4}$$

where g_{ij} is the number of geodesics linking country p_i and p_j, $g_{ij}(p_k)$ is the number of geodesics linking country p_i and p_j that contain country p_k, $C_B(p_k)$ is an index of the overall partial betweenness of country p_k, and $C_B^{'}(p_k)$ is the normalized betweenness of country p_k.

Brokerage calculates the extent to which a node links sub-components of a network that are not otherwise connected (Burt, 2002). According to Burt (2004), brokerage of a specific country p_k in a BIT network can be measured by

$$B(p_k) = 1 - \sum_{j \in V_k \setminus \{k\}} \left(p_{kj} + \sum_{i \in V_k \setminus \{k,j\}} p_{ki} p_{ij} \right)^2 \tag{5}$$

$$p_{kj} = \frac{a_{kj}}{\sum i \in V_k \{k\} a_{ki}} \tag{6}$$

where $B(p_k)$ is structural hole of country p_k in BIT network V_k, and p_{kj} is the proportion of p_k's network time and energy invested directly in all connections with any other country p_j in V_k. It ranges from 0 to 1. $\sum_{i \in V_k \setminus \{k,j\}} p_{ki} p_{ij}$ is the proportion of p_k's network time and energy invested indirectly in all connections with any other country p_j through country p_i in V_k. It also ranges from 0 to 1. a_{kj} and a_{ki} are elements of graph adjacency matrix.