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TRANSNATIONAL CORPORATIONS

INVESTMENT AND DEVELOPMENT

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EDITORIAL STATEMENT

Transnational Corporations[1] is a longstanding, policy-oriented, refereed research journal on issues related to investment, multinational enterprises and development. It is an official journal of the United Nations, managed by the United Nations Conference on Trade and Development (UNCTAD). As such it has global reach, a strong development policy imprint and high potential for impact beyond the scholarly community. There are no fees or article processing charges associated with submitting to or publishing in *Transnational Corporations*. All articles of the online version of the journal are open access and free to read and download for everyone.

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The journal aims to advance academically rigorous research to inform policy dialogue among and across the business, civil society and policymaking communities. Its central research question – feeding into policymaking at subnational, national and international levels – is how cross-border investment, international production, multinational enterprises and other international investment actors affect sustainable development. The journal invites contributions that provide state-of-the-art knowledge and understanding of the activities conducted by and the impact of multinational enterprises and other international investors, considering economic, legal, institutional, social, environmental or cultural aspects.

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In addition, *UNCTAD Insights* articles feature original research by UNCTAD staff, frequently conducted in collaboration with researchers from other organizations, universities and research institutions. The aim of the *UNCTAD Insights* articles is to

[1] Previously: *The CTC Reporter*. In the past, the Programme on Transnational Corporations was carried out by the United Nations Centre on Transnational Corporations (1975–1992) and by the Transnational Corporations and Management Division of the United Nations Department of Economic and Social Development (1992–1993).

advance and support research on investment and development, in line with UNCTAD's work programme, catalysing further work and helping to set a policy-relevant research agenda.

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For further information on the journal, including ethics statement and review policy, visit https://unctad.org/Topic/Investment/Transnational-Corporations-Journal.

CONTENTS

ARTICLES

UNCTAD INSIGHTS

Deep trade integration and North-South participation in global value chains*

Zarlasht M. Razeq[a]

Abstract

Do comprehensive trade agreements increase the participation of States in global value chains (GVCs) and contribute to their development? Although there is extensive evidence in the trade literature that deep preferential trade agreements (PTAs) can increase States' bilateral export of final goods and, by implication, contribute to local development, much less is known about the characteristics of this effect on GVC relations. This paper answers the question in the framework of a gravity model and uses a comprehensive dyadic data set on trade in GVCs, PTAs, export and other characteristics for 188 countries and economies between 1990 and 2018. Results provide robust evidence that deep PTAs increase members' bilateral trade in GVCs over the long term, especially when these agreements involve at least one developing country or economy and include provisions that support investment. These results underscore that GVC-facilitating deep PTAs are a powerful policy tool that can mobilize the potential of production and trade in GVCs for development.

Keywords: development, global value chains (GVCs), integration, investment, trade agreements

JEL classification codes: F14, F15, F55, F63

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1. Introduction and background

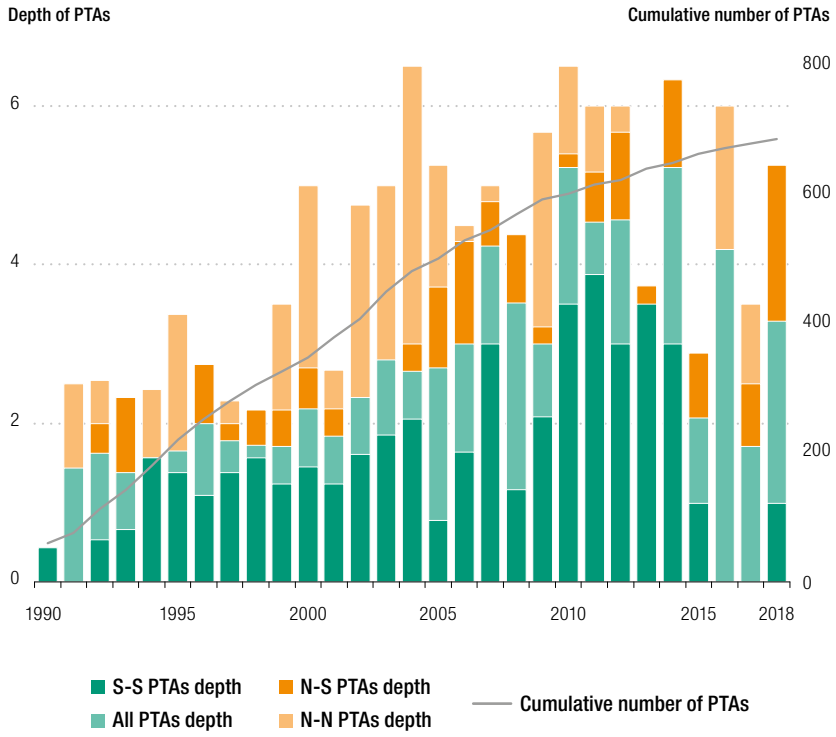
Over the past three decades, there have been two important changes in the organization and institutions of international trade and production: the proliferation and deepening of preferential trade agreements (PTAs) and the globalization of production and the consequent rise of global value chains (GVCs). In terms of PTAs, the gridlock in progress towards multilateral trade liberalization after the Doha Round has made preferential trade liberalization a de facto (and often more preferable) instrument for States to organize their bilateral trade relations (Hartman, 2013). Just between the end of the 1990s and 2018, the cumulative number of PTAs signed globally – especially with and among developing economies – tripled, reaching over 600 (Dür et al., 2014). Over the same period, the share of more comprehensive (deep) PTAs, which cover tariffs but also beyond-tariff areas such as investment, market access, services, competition, procurement policies and others, also increased (figure 1).

In terms of production, globalization has made the fragmentation and outsourcing of production processes less costly, giving rise to GVCs, which are product-specific sets of interconnected production stages such as design, making of parts, assembly and sales, "with each stage adding value, and with at least two stages being produced in different countries" (Antras, 2020, p. 553). In the first decade of the 2000s alone, nearly half of global trade was already in inputs exported for further processing or assembly (World Bank et al., 2017; World Bank, 2020), and between 1990 and 2019, the value added production of foreign affiliates of large firms increased fivefold (UNCTAD, 2020). An increase in participation by developing and emerging economies is notable if we compare States' participation in GVC trade across the globe between 1990 and 2018, using the data set built for this paper (figure 2).

The interplay of these two changes has already been subject to extensive discussions and reassessments of trade and development strategies, especially for the developing world (UNCTAD, 2013 and 2020; Van Assche and Brandl, 2021; World Bank et al., 2017; World Bank, 2020). Despite the surge in policy interest, in the literature a systematic analysis of the causal relation of these global dynamics has been limited, and although there is extensive evidence that deeper PTAs increase trade in final goods (Baccini et al., 2015; Baier and Bergstrand, 2007; Rose, 2004; Spilker et al., 2018), there is still much less known about whether PTAs that are designed primarily to address trade in final goods (Antras and Staiger, 2012) have similar policy and theoretical implications for the growing trade in GVCs.

One reason for this gap has been the limitation of statistics for rigorous cross-country analysis, which emerges from both empirical and conceptual complexities associated with GVC relations. In the context of trade in GVCs, the organization

Figure 1. Annual cumulative number and the average depth of PTAs, 1990–2018

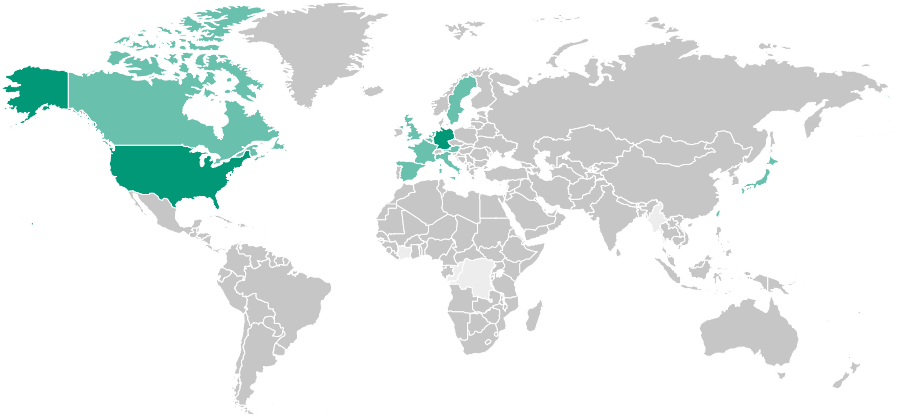


Source: Author's calculation, based on the Design of Trade Agreements (DESTA).
Note: N-N = North-North dyads, N-S = North-South dyads, S-S = South-South dyads.

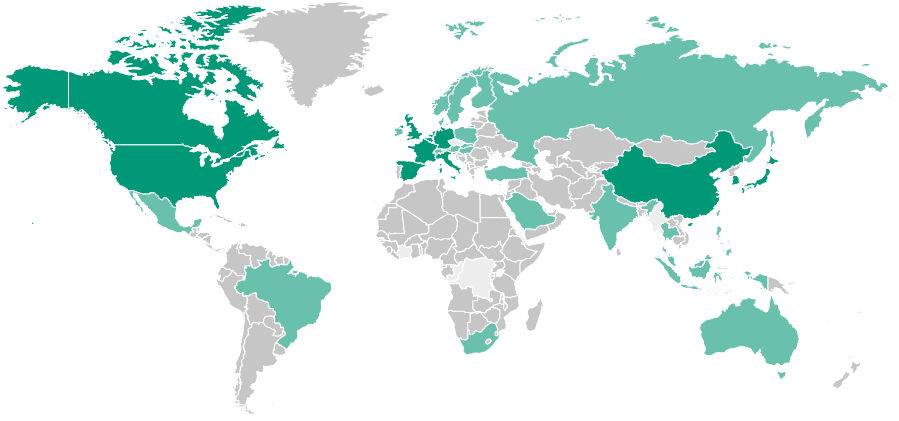
of production and trade is "structurally different from its predecessors" wherein "trade was largely in finished goods" (Gereffi, 2018, p. 431). Within GVCs, the value of items that move from a source to a destination country for further processing or assembly increases only by the value of the modification and changes that the destination country can add domestically to the imported items. The gain from bilateral trade in GVCs is not simply the total value of export but the value of domestic value added (DVA), which is the difference between the total value of export and foreign value added (FVA) to export (UNCTAD, 2013; appendix table A.1). Countries involved in simple and low value added stages, such as assembly of ready-to-use parts, contribute little domestically towards their exported items, whereas those involved in more complex stages of production, such as the design of prototypes, produce most of the value of their exported items (Gereffi, 2018).

Figure 2. GVC trade in 1990 and 2018

GVC trade, 1990
(Thousands of dollars, 2010 = 100)



GVC trade, 2018
(Thousands of dollars, 2010 = 100)



Source: Author's calculations, based on Eora-UNCTAD data set.
Note: GVC trade is the sum of foreign value added (FVA) and indirect value added (DVX) to exports.

Electronics are an oft-given example: Although the iPhone X label shows *Made in China*, only 10 per cent of its pre-sale commercial value is produced and added by firms in China. The rest is added by 10 upstream and downstream countries and economies[1] involved in various bilateral agreements.[2] Therefore, in bilateral terms, economies that trade more in final goods with one another, e.g. China and the United States or Japan and Taiwan Province of China, may not be those that trade more in GVCs with one another.

For these reasons, trade in GVCs and conventional trade qualitatively and quantitively draw different pictures of bilateral trade (Casella et al., 2019; Johnson and Noguera, 2012; Koopman et al., 2014; European Commission et al., 2008; United Nations, 2013), and hence, analysing trade in terms of GVCs offers more direct policy implications for development. In this context, conducting a detailed cross-country analysis of the effect of trade integration on GVCs will improve our understanding of whether and how deep integration can help countries upgrade and expand their production capacity and, by implication, contribute to their development.

The goal and empirical contribution of this paper are in this area. By contributing to the literature on bilateral trade integration (Baccini et al., 2015; Dür et al., 2014) and GVCs (Antras et al., 2012; Koopman et al., 2008; Lenzen et al., 2013) and building a comprehensive dyadic data set with data on PTAs (from DESTA),[3] trade in GVCs (from the Eora-UNCTAD data set)[4] and other country-level dyadic variables, the paper empirically examines the effect of deep integration on bilateral trade in GVCs. Of particular interest are the variations across time, PTAs' design features and countries' income levels. To further qualify that trade in GVCs and conventional trade are indeed qualitatively and quantitively different, I also estimate the effect of deep PTAs on bilateral export flows. Methodologically, the paper follows best practices in the gravity model of trade analysis and applies panel-data techniques with a full set of fixed effects (FE), accounting for the endogeneity of trade policy to the extent possible (Yotov et al., 2016).

In doing so, it improves upon and adds to the coverage and mechanisms of a scant and recent number of empirical works on the subject (Boffa et al., 2019; Laget et al., 2020). Using both Eora and DESTA covers the entire universe of PTAs and bilateral GVC relations from 1990 to 2018 for 188 countries or economies,

[1] The data set used in this paper includes Hong Kong, China and Taiwan Province of China. In line with the approach in the Eora-UNCTAD data set, the term "countries" in this paper covers both countries and economies.

[2] See appendix table A.2 for a tear-down of the iPhone X's major parts, as well as firms, economies and PTAs involved.

[3] The Design of Trade Agreements (DESTA) data set can be accessed at www.designoftradeagreements.org.

[4] The Eora-UNCTAD data set is periodically updated and can be accessed at https://worldmrio.com. This paper uses the 2019 version. For a simplified view of relations between GVC indicators, see appendix table A.1.

including many developing ones. Laget et al. (2020), in contrast, use a selected sample of 260 PTAs compiled by the World Bank and the estimations of Wang et al. (2013) of GVC trade for 40 major economies, which covers the period 1995–2011, leaving the 2010s trade recover and many PTAs and developing countries out of the analysis. Boffa et al. (2019) use Eora-UNCTAD but the same data for PTAs and compare their effect on GVC trade with the effect of bilateral investment treaties (BITs).

Key findings in this paper show that deep trade integration increases States' participation in GVCs. Furthermore, the size of this effect varies significantly across time, the content of PTAs and States' level of development. More specifically, the study shows that the effect of deep PTAs on bilateral trade in GVCs is more pronounced over the long term, showing that deep PTAs are conducive to an effective institutional framework needed for bilateral trade in GVCs to develop. In addition, GVC-facilitating deep PTAs also support investment-related activities, especially when they include developing economies. Finally, the reformative long-term effect of deep PTAs on GVC relations persists when we compare it with those of (BITs and the World Trade Organization (WTO). These results emphasize that deep trade integration is a powerful and long-lasting policy tool that can be effective in facilitating trade in GVCs and contribute to development.

The rest of the paper is organized as follows. In the next section, I derive from the literature several hypotheses related to the expected effect of PTAs on trade in GVCs. The following three sections explain the data set, the empirical strategy and the results. Concluding remarks highlight the policy implications of this paper.

2. The expected effect of deep trade integration on GVCs

What is the expected effect of PTAs on trade in value added? As argued by others, trade in GVCs is more responsive to preferential than to multilateral trade agreements. This is because PTAs are "more individualized" by design and, therefore, "can better reflect member-specific idiosyncratic needs" (Antras and Staiger, 2012, p. 3144). Furthermore, in comparison with shallow PTAs, i.e. PTAs with few provisions, deep PTAs are more effective in facilitating GVC trade because they go beyond "broadly applied" tariff cuts and foster deeper market integration (Antras and Staiger, 2012, p. 3144).

Stylized facts arising from the empirical assessments of the effect of deep PTAs on final exports suggest that their effect is stronger than the effect of shallow PTAs for several reasons. First, deep PTAs help to reduce the uncertainty associated not only with tariffs but also with non-tariff barriers (Antras and Staiger, 2012; Limao, 2016).

This encourages buyers and suppliers to source or sell their products in those markets where the risk is predicted to be low because of higher commitments of local governments bound by a comprehensive PTA. In addition, because entering deeper agreements goes beyond tariffs, their ratification and then implementation by members entail extensive reforms and harmonization in all member States. For example, if under a deep PTA the tax or customs codes have to be revised or new national agencies need to be created, it will take more time for these changes to be implemented and take effect.

In contrast to shallow PTAs, the effect of deep PTAs is, therefore, expected to materialize over the long rather than short term and lead to deeper, here-to-stay institutional and structural changes in member states, propelling more certainty in bilateral relations. Second, because deep PTAs go beyond tariff and customs issues, they have a more extensive spillover effect on the economy overall, fostering stronger production linkages among firms in member States. When compared with shallow agreements, for example, deep PTAs have been more effective in increasing the flows of foreign direct investment (FDI) as well as stimulating firms' specialization upstream or downstream along the GVC, especially over the long run (Büthe and Milner, 2014; Hofmann et al., 2017; Johnson and Noguera, 2012; Orefice and Rocha, 2014; World Bank et al., 2017).

Finally, previous research comparing the effects of deep and shallow PTAs also shows that there are more variations in the effect of deep PTAs on trade across the design features of agreements, e.g. the number and the characteristics of provisions that they cover, as well as countries' characteristics. When stratified by countries' income levels, for example, deep North-South PTAs indicate a stronger effect on trade and investment flows between members than North-North and South-South PTAs (Baccini et al., 2015; Egger and Nigai, 2015). Compared with other dyads, deep North-South PTAs exhibit a stronger effect because the North-South comparative advantages in terms of factors of production and resources are complementary rather than substituting for one another. This complementarity encourages resource-seeking producers from developed countries to establish more backward linkages with suppliers from developing countries after deeper integration and to buy more inputs from them (Harding and Javorcik, 2011; Markusen and Maskus, 2001). Suppliers in the South, similarly, get better access to producers from the North, and through customizing their production and improving their technology improve their competitiveness against firms in other developing countries that are not in a deep PTA with the North (Amendolagine et al., 2013; Baldwin et al., 2014; Fernandez and Portes, 1998). Therefore, deep PTAs are also expected to increase the flow of trade in GVCs, especially over the long term or when the trade is between a developed (North) and a developing (South) economy. This discussion suggests these hypotheses:

H1a: Deep PTAs increase bilateral value added trade more than shallow PTAs.

H1b: Deep PTAs increase bilateral value added trade over the long term more than shallow PTAs.

H1c: Deep PTAs increase bilateral value added trade more between North-South dyads than between other dyads.

The effect of deep PTAs may also depend on another design feature of PTAs: the number and characteristics of provisions that make the depth of an agreement. According to DESTA's classification, these provisions include standards and certification rules, government procurement rules, competition policies, intellectual property rights (IPRs), services (e.g. liberalization and national treatment) and investment (e.g. commitments to no restriction on transfers and payments, compensation in case of expropriation, investor–state dispute settlement mechanisms and national treatment (Dür et al., 2014, p. 360).

While relying on the quantity (number) of these provisions included in a PTA is important to understanding and comparing the depth and coverage of agreements, all seven provisions constituting the depth of PTAs may not have an equal qualitative effect on production and the flow of bilateral value added trade, and as stated by others, only "the role of specific provisions in shaping GVCs may be relevant" (World Bank et al., 2017, p. 179). For example, while the flow of trade in final goods and services may be more directly influenced by the elimination of tariffs and market access rules, the flow of cross-border production may respond more directly to factors such as the promotion of investment, regulation and liberalization of services, and ease of technology transfers, i.e. factors that have a direct impact on the productive capacities of domestic firms and their abilities to add more value to the national exports.

Based on this characterization, I further identify and examine the effect of PTAs that contain specific provisions: PTAs containing investment-related (i.e. either investment, services or IPR) provisions, PTAs containing competition-related (i.e. either procurement or competition) provisions and PTAs with other (i.e. either scope or standards) provisions. As previous research indicates, the primary mechanisms through which agreement may facilitate greater participation in GVCs are investment-related provisions because they have a more direct effect on domestic production capacity through FDI and production specialization. More specifically, the inclusion of investment-related provisions in PTAs augments the effect of preferential liberalization on trade indirectly through multinationals' investment and resource-seeking strategies (Allee and Peinhardt, 2014; Boffa et al., 2019; Büthe and Milner, 2014; Dixon and Haslam, 2016). Likewise, service liberalization and service-related provisions have a greater impact on domestic production than liberalization of trade in goods because the services sector (e.g. finance or communications) is normally an upstream (closer

to suppliers) sector that supports the development and operation of production relations. Service liberalization can further accelerate technological development and help in upgrading the overall productivity of the economy (Carmody, 2020; Konan and Maskus, 2006). IPR provisions also facilitate technology diffusion and knowledge transfer and support efforts to increase production and advance development through FDI and licensing (Maskus and Fink, 2005; Maskus and Penubarti, 1995).

Competition-related provisions aim to liberalize national procurement markets and remove discrimination against foreign suppliers, changing the way firms sell their products in local markets. Although including these provisions directly affects the demand for more downstream imports into the economy, their impact on the production linkages of local firms and their value added activities is effectuated indirectly over time and through FDI because preliminary reforms may be required in the first place to establish an open procurement market (Anderson et al., 2012; Anderson and Muller, 2008). Similarly, although other provisions on standards and tariffs can potentially enable local suppliers to meet the regulatory requirements in foreign markets, their impact materializes only in the long run and after implementing extensive reforms (Brusick et al., 2005; Piermartini and Budetta, 2009; Vijil, 2014). This discussion leads to the following hypothesis:

> *H2: The inclusion of investment-related provisions in PTAs increases trade in GVCs more than PTAs that do not include these provisions.*

To further qualify deep PTAs as an effective institutional framework, I compare their effect with the effect of BITs and joint membership in the WTO for each dyad.[5] Standing alone, BITs improve the terms and environment of trade in goods between the two member States because they offer investment protection mechanisms, most-favoured nation treatment, national treatment and fair compensation mechanisms – among others (Bergstrand and Egger, 2013). When compared with deep PTAs, however, the effect of stand-alone BITs on bilateral exports is often much smaller. Recent research shows that this is, indeed, the case with trade in GVCs as well (Boffa et al., 2019).

There are several reasons for this difference. First, the mitigating effect of PTAs on the uncertainty associated with trade relations is higher than that of BITs. Whereas BITs are always bilateral and time-limited, PTAs can be multilateral, and once in force, they remain in force until members (old and new) decide to ratify or revise them. Second, the effect of PTAs is much greater than that of BITs. Whereas BITs focus more on protection than liberalization of investment, a feature already weakening in recent years (Kerner and Pelc, 2022), PTAs with investment provisions focus on both.

[5] Although there has been little change in the WTO membership in the 2000s and afterward, there were still variations among developed and developing countries in the 1990s. The coefficient of the WTO is not absorbed by FE, which means there are still variations in this variable that can be exploited.

For example, PTAs with investment provisions may also stipulate national treatment rules for pre-establishment or entry phases of investment, specify performance requirements (e.g. local content, export, technology transfer), touch upon corporate governance rules (e.g., the nationality of senior management) or extend the most-favoured-nation clause to investors outside the PTA area (World Bank, 2020). PTAs with a certain level of depth, therefore, are considered more comprehensive in their effect than stand-alone BITs.

Compared with both PTAs and BITs, the WTO is viewed as a low-impact institution in the context of trade in GVCs for two reasons. First, with the growing fragmentation of production, States find it increasingly difficult "to utilize traditional GATT/WTO concepts and rules" to discipline their trade relations under GVCs (Antras and Staiger, 2012, pp. 3144–3177). This is because tariff cuts and trade liberalization through the WTO are small in those sectors that use highly customized inputs, i.e. sectors that rely on few but highly specialized suppliers across the world. Therefore, rules negotiated through the WTO may not interest those countries that seek more specific and customized integration and liberalization. In contrast, under preferential agreements, tariff cuts and trade liberalization can be not only more customized but also implemented faster, especially "for intermediate goods than for finished products" as shown in recent studies on the effect of tariff cuts on intermediate trade (Baccini et al., 2018, p. 1).

Second, liberalization of policies that have a direct impact on production at the plant- and factory-level activities, i.e. investment, services and technology transfer, are outside of the WTO mandate. As the evidence indicates, the WTO has made little progress in areas other than the liberalization of trade in goods (Francois and Hoekman, 2010). Therefore, the effect of PTAs on trade in value added may be more salient than the effect of WTO membership too. In other words:

> *H3: The long-term effect of deep PTAs is higher on value added trade than the stand-alone effect of BITs or joint WTO membership.*

3. Data and variables

For this paper I put together and use a dyadic data set.[6] Each observation is a unique ij pair of economies ($country1$ and $country2$) producing and receiving value added to export at year t. The measure of GVC trade is the estimation of bilateral value added trade flows from Eora-UNCTAD. The measure of the deepness of trade agreements also differs from the mentioned studies on the subject and is an absolute index of PTAs' depth from DESTA. The depth index is based on direct coding and

[6] The data set created and used in this paper is available from the author through Harvard Dataverse.

aggregation of over 100 issue areas mentioned directly in the texts of PTAs into seven major provisions: scope of coverage, investment, services, procurement, intellectual property, competition and standards. It ranges, therefore, between zero (when a PTA is shallow and does not include any issue area) and seven (when a PTA is deep and includes all seven issue areas). The World Bank's measure of PTA depth is relative and defined in relation to the WTO's legal texts: A PTA is deep if it includes provisions that complement or go beyond the WTO mandate, i.e. provisions that are WTO-plus or WTO-extra. Preference in this paper is given to the absolute measure of deep to avoid any misspecification of deepness that may arise from reference to external (other than PTA) texts.

Outcome and predictor variables: The key outcome variable is the log-transformed dyadic value added trade (in thousand constant United States dollars, 2010 = 100) from country i to country j at year t ($ln(VAtrade_{ijt})$) and is derived from the Eora-UNCTAD data set (Casella et al., 2019; Lenzen et al., 2013). The Eora-UNCTAD data set estimates GVC statistics from multi-region input-output tables (MRIO) and the System of National Accounts (Aslam et al., 2017; Koopman et al., 2014). Compared with other data sets, the Eora-UNCTAD data set covers a greater number of developing countries or economies and years.[7]

The main predictor is a dummy variable (PTA_{ijt}) that takes the value of one if the dyad is in a PTA and zero otherwise. As noted, this and other characteristics of PTAs are based on DESTA. It also provides a straightforward additive index of depth (*Depth Index*) that ranges between 0 (very shallow) and 7 (very deep) and covers, as noted before, provisions on such issues as standards, investment, services, procurement policy, competition policy, IPRs and whether a PTA is a partial or full agreement. The depth of a PTA in this paper is captured by a *Depth* dummy that equals one if a PTA's *Depth Index* is above the sample's median, i.e., it includes two or more provisions, and zero otherwise. For a robustness check, I also use the Rasch Index of depth (*DRI*) from DESTA, which is a continuous measure of depth, based on item response theory, and gives more weight to provisions that are more difficult to negotiate and agree upon, e.g. IPRs (Dür et al., 2014, p. 360).

The presence of *investment-related provisions* is measured by a dummy if a PTA covers either investment, services or IPRs areas. The presence of *market-access provisions* is measured by a dummy if a PTA covers either procurement or

[7] In appendix table B.2 and figure B.1, I conduct further robustness checks and compare the Eora-UNCTAD bilateral value added trade variable with the bilateral value added trade variable from the Trade in Value Added database of the Organisation for Economic Co-operation and Development for 35 member countries. The two variables produce comparable results, and the correlation between the two variables is 0.95.

competition policies. *Other provisions* are captured by a dummy if a PTA either includes a provision on standards or has a full rather than partial PTA. To benchmark the effect of PTAs on value added trade with final export, I use the log-transformed value of dyadic export in constant 2010 United States dollars $ln(export_{ijt})$.[8] Finally, I use BIT_{ijt}, WTO_{ijt} dummies and their lags to capture the effect of signing a *BIT* and *WTO membership*. Descriptive statistics are presented in appendix table A.3.

Time variable: Similar to Dür et al. (2014), the variable *year* in this paper shows the year of signature of a PTA and not the year when a PTA enters into force, because "the large majority of agreements enter into force after a relatively short period [i.e. within one or two years] where states seek domestic ratification" (p. 364). Although this dyadic data set records observations consecutively by year (from 1990 to 2018), I use four-year interval data for estimations, i.e. 1990, 1994, 1998, 2002, 2006, 2010, 2014 and 2018. Using interval data in gravity estimation is proven to be important because trade volumes adjust to changes in trade policy after a few years (Baier and Bergstrand, 2007; Yotov et al., 2016). The choice of the length of intervals in gravity estimations is not justified and can range from three to five years (Anderson and Yotov, 2016; Baier and Bergstrand, 2007; Olivero and Yotov, 2012; Trefler, 2004). It is, however, "recommended experimenting with alternative intervals while keeping estimation efficiency in mind" (Yotov et al., 2016, p. 24). This paper uses four-year intervals because the effect of PTAs on value added trade stabilizes three years after signing a PTA as our experiments with two-, three-, and five-year intervals confirm.[9]

Other key variables: Measure of income is a three-level categorical variable (*NS*) that encodes the income group of dyads, based on World Bank Atlas data, as *S-S* if both partners are middle- or low-income countries, *N-S* if one is high-income and the second is middle- or low-income, and *N-N* if both partners are high-income countries. The key challenge in using the *NS* variable is that it is time-invariant: developing economies rarely become developed over a few years and the within-group variation for developed ones is even more invariant. To estimate the effect of PTAs, given income variations among dyads, I use *NS* to split the observations into *N-N*, *N-S* and *S-S* sub-samples and estimate the effect of PTAs in separate models.[10]

[8] Bilateral export data are from the IMF Direction of Trade Statistics (DOTS) online database (https://data.imf.org/?sk=9D6028D4-F14A-464C-A2F2-59B2CD424B85, accessed 1 September 2021).

[9] See appendix tables B.3 and B.4.

[10] Other macroeconomic indicators, such as United States consumer price index, gross domestic product and gross domestic product per capita are from the World Development Indicators (https://databank.worldbank.org/source/world-development-indicators, accessed 1 September 2021).

4. Empirical strategy

This paper implements a structural gravity model and estimates the effect of PTAs on value added trade between dyads. One issue that may seriously affect the reliability of estimations and lead to attenuation bias is that trade policy is endogenous to trade flows. As argued by others, endogeneity bias has become the "gold medal mistake" (Baldwin and Taglioni, 2006, p. 793) in gravity estimations because the gravitational effects of unobserved characteristics at the level of the economy or dyad too often are not considered. No empirical strategy other than a lab-controlled experiment can, of course, fully account for the endogeneity issue; however, to minimize the issue, the accumulated best practices in gravity literature recommend the following three steps: using directional dyadic panel data, using intervals instead of consecutive periods and including the full set of the dyad (ij), year (t) and country-year (it and jt) FE (Baier and Bergstrand, 2007; Yotov et al., 2016).

This paper implements all the recommended steps.[11] Applying the full set of FE is justified in our context as follows. FE controls for time-invariant (observable and unobservable) country-specific, dyad-specific, and time-specific characteristics, including various national policies, institutions, and exchange rates (Yotov et al., 2016, p. 19). The directed dyad FE controls for bilateral characteristics (e.g. distance, contiguity, and language) and the general level of trade costs between i and j. Country-specific time FEs are necessary to control for multilateral trade resistance terms, which are unobserved trade barriers between a dyad and the rest of the world (Feenstra and Hanson, 1996; Hummels et al., 2001; Olivero and Yotov, 2012). Controlling for multilateral trade resistance terms with country-year FE for both partners is expected to produce more reliable results when the sample covers nearly the entire population, which is the case in this paper as it covers the entire universe of PTAs and a large number of economies.[12] Based on these details, I estimate the effect of PTAs given their depth and phased-in effect over the long term, with full samples and samples split by income groups, in the following log-linear form:

$$ln(VAtrade_{ijt}) = \beta_1(PTA_{ijt}) + \beta_2(X_{ijt}) + \gamma_{ij} + \delta_{it} + \tau_{jt} + \epsilon_{ijt},$$

[11] One more recommendation is the implementation of Poisson Pseudo Maximum Likelihood (PPML) estimation when trade data take a lot of zero values. I do not implement a PPML model because the response variable does not take zero values after I remove 14 exporting countries with poor data reporting practices, which are flagged as problematic in Eora's documentation.

[12] Scaling the left-hand side variables by the product of gross domestic products, which is equivalent to imposing restriction of unitary income elasticities, could be an alternative solution; however, as Baier and Bergstrand (2007) indicate, imposing unitary income elasticities has no impact on the PTA coefficient if we use the full set of FE.

where $ln(VAtrade_{ijt})$ is the volume of value added trade between country i and j at period t, i.e., four-year intervals; PTA_{ijt} is a dummy showing the year when a dyad signs a PTA; X_{ijt} represents other specifications such as the depth of PTAs $Depth_{ijt}$, income groups of country-dyad (NS), provisions included in a PTA, and one- and two-period lagged effects of PTAs ((PTA_{ijt-1}), (PTA_{ijt-2})) and PTAs' depth ($(Depth_{ijt-1})$, $(Depth_{ijt-2})$). The full set of FE is represented by γ_{ij}, δ_{it}, τ_{jt}, where γ_{ij} is the directed dyad FE, δ_{it} is country1-year and τ_{jt} is country2-year FE.

As noted, for comparison, I also estimate the effect of PTAs on log-transformed dyadic export $ln(export_{ijt})$ as well as the effect of BITs (BIT_{ijt}) and WTO (WTO_{ijt}) membership on both log-transformed value added trade and dyadic export.

5. Results and discussion

Table 1 presents the main and phased-in effects of shallow and deep PTAs.[13] Results of model 1 show that countries or economies that are in a PTA trade more in GVCs than those that are not in a PTA: for every 1 per cent increase in shallow or deep PTAs, bilateral value added trade increases by more than 3 per cent.[14] These results only partially confirm $H1a$. In other words, in the short term, there is no difference between dyads that are in a deep PTA and dyads that are in a shallow PTA; bilateral GVC relations of both groups benefit from preferential liberalization in the same way. This observation is confirmed when I use the two other measures of depth provided in DESTA for a robustness check: categorical $Depth\ index$ and depth Rasch $Index$, DRI (appendix table B.1). Coefficients for both alternative predictors are nearly zero (and even turning negative for $DRI\ (e^{0.003})$, suggesting that entering a deep PTA may even disrupt the flow of bilateral value added trade in the short term. The short-term (one to three years) non-significant effect of deep PTAs is explained by the fact that in anticipation of a deep PTA and its associated reforms, firms may adjust the organization of their supply chains and switch to new suppliers from the PTA market to gain from the phased-in effect of deep PTAs later.

[13] Because the 2019 version of Eora-GVC data set that I used in 2018 is nowcasted, I re-estimated all models in this paper after dropping the observations for 2018. The re-estimated results (not reported) were not different from those shown here with the 2018 data included, which shows that nowcasted data do not affect our results.

[14] Unless otherwise stated, all coefficients that are expressed in percentage in this paper reflect the average percentage change in the exponentiated coefficients of the response variable per 1 per cent change in the predictor variable, i.e. $(e^{\beta}-1)*100$.

Table 1. The main and long-term effects of PTAs

	ln(VA trade)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Split samples		
				N-N	N-S	S-S
Shallow	0.034*** (0.004)	0.031*** (0.003)	0.035*** (0.004)	0.020** (0.008)	-0.008* (0.005)	0.102*** (0.008)
Shallow (medium term)		0.005** (0.002)				
Shallow (long term)		-0.000 (0.002)				
Depth	0.033*** (0.003)	0.033*** (0.003)	0.022*** (0.003)	-0.002 (0.006)	0.022*** (0.005)	0.140*** (0.012)
Depth (medium term)			0.016*** (0.002)			
Depth (long term)			0.013*** (0.003)			
Constant	6.252*** (0.001)	6.252*** (0.001)	6.251*** (0.001)	9.027*** (0.002)	6.697*** (0.001)	5.012*** (0.001)
Observations	232 242	232 242	232 242	27 360	105 667	99 215
R-squared	0.998	0.998	0.998	0.999	0.998	0.995
Dyad FE	Yes	Yes	Yes	Yes	Yes	Yes
country1-year FE	Yes	Yes	Yes	Yes	Yes	Yes
country2-year FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The devil, however, appears when we explore the details of PTAs across time and national income. Models 2 and 3 indicate the main and phased-in effect of shallow and deep PTAs over four (*t-1*) and then eight (*t-2*) years. These results confirm *H1b*: deep PTAs outperform shallow PTAs over the long term. If we follow Baier and Bergstrand's (2007) suggestion and add up significant coefficients of the main and lagged effects of deep PTAs, for example in model 3, for every 1 per cent increase in deep PTAs, trade in GVCs increases by 3.8 per cent after four years and by 5.2 per cent after eight years. Under shallow PTAs, there is no difference in GVC

trade after four and eight years although in the short term the effect remains significant and above 3 per cent.[15] These findings are consistent with previous research on final exports that shows that trade policy and "terms-of-trade changes tend to have lagged effects on trade volumes" (Baier and Bergstrand, 2007, p. 90).

Models 4–6 stratify the data set by income levels (by *NS* variable) and estimate the effect of deep and shallow PTAs with split samples. The results suggest that deep PTAs have a strong and positive effect on value added trade only if at least one partner is a developing economy: signing deep PTAs accounts for a 2.2 per cent and a 15 per cent increase in bilateral value added trade between North-South and South-South dyads, respectively. These results confirm *H1c* and add that the effect on South-South GVC relations is even higher than on North-South GVC relations. The effect of shallow PTAs is also positive and significant for South-South dyads, but for North-South dyads, the effect is nearly zero.

Given that the South often has a comparative advantage in terms of the cost of labour and raw inputs and hosts offshored tasks and operations along the supply chains, it is not unusual to see that trade liberalization is stronger if at least one partner in the dyad is a developing economy. What is novel, however, is that, unlike trade in final exports, the effect of PTAs and their depth is stronger on South-South value added trade than on North-South value added trade. One explanation is that when we look at bilateral trade relations from a value added angle, South-South dyads trade more in GVCs because they perform most of the processing activities, exchanging more partially processed rather than fully finished items. Their bilateral trade, thus, carries more value added than North-South bilateral trade and, therefore, is more responsive to changes in the scope and coverage of trade liberalization.

For this reason, the development and strengthening of South-South trade integration and production relations may not only increase the participation of developing economies in GVCs but also can strengthen the development of specialized production hubs in the South. The presence of variations in the effect of deep PTAs across dyads and over time suggests that policy areas that constitute the depth of PTAs determine the effect of PTAs and their depth on bilateral value added trade, depending on the institutional and economic contexts of partners.

Table 2 estimates the effect of provisions *H2*, using full and split samples stratified by income groups. While the effect of provisions varies across dyads stratified by income groups, PTAs that include investment-related provisions (investment,

[15] In appendix table B.4, I also estimate the effect of PTAs and their 1- to 10-year lags. This re-estimation confirms model 3's result that the full effect of trade liberalization on value added trade materializes over the long term (after four to nine years).

services or IPRs) have an economically large positive and significant effect on bilateral value added trade across all dyads. Model 1 with the full sample confirms *H2* – that investment-related provisions have a greater effect on bilateral value added trade than market-access provisions (procurement or competition) or other provisions (standards or full free trade area). When I split the sample by income group in models 2–4, the effect of investment-related provisions stays positive for all dyads but more strongly for North-North and South-South bilateral value added trade (more than 3 per cent each) than for North-South. The effect of market-access provisions is also notable but only for South-South dyads (over 4 per cent). Finally, the other two provisions have a strong positive effect on both North-North and South-South dyads (approximately 8 per cent and 3 per cent, respectively), while the same effect is negative for North-South dyads.

Table 2. The effect of provisions

	ln(VA trade)			
	(1)	(2)	(3)	(4)
	Full sample	Split samples		
		N-N	N-S	S-S
PTA	0.028*** (0.006)	-0.064*** (0.015)	0.020*** (0.007)	0.084*** (0.012)
Investment-related provisions	0.015** (0.007)	0.035** (0.016)	0.020* (0.011)	0.032** (0.014)
Market-access provisions	-0.018*** (0.007)	-0.051*** (0.016)	-0.004 (0.01)	0.046** (0.019)
Other provisions	0.009* (0.005)	0.083*** (0.014)	-0.021*** (0.006)	0.038*** (0.012)
Constant	6.250*** (0.001)	9.027*** (0.002)	6.695*** (0.001)	4.999*** (0.002)
Observations	232 242	27 360	105 667	99 215
R-squared	0.998	0.999	0.998	0.995
Dyad FE	Yes	Yes	Yes	Yes
country1-year FE	Yes	Yes	Yes	Yes
country2-year FE	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

To check that these results are not driven by collinearity among provisions (although data diagnostics point to a variance inflation factor less than 5), I also test the effects of these provisions in separate models with split samples.[16] These robustness checks confirm again our observations in models 2–4 in table 2. It must be noted, however, that this paper looks only at bilateral relations and compares dyads that have a PTA with dyads that do not. Therefore, a positive and significant effect from all provisions on South-South value added trade does not suggest that South-South PTAs have a greater effect on GVC trade than North-North and North-South PTAs, or that South-South integration is better than North-South integration. I do not have evidence for such a suggestion. It is, however, clear from these results that signing PTAs with investment-related provisions helps South-South dyads more than others to trade bilaterally in value added, establish production linkages and participate in GVCs.

Previous models show that the depth of integration matters for trade in GVCs when PTAs cover investment-related provisions. Given that attracting foreign investment plays an important role in upgrading and in the competitiveness of production processes, the effect of PTAs on trade in GVCs may depend on the presence of other institutions such as BITs and the WTO membership of both partners.

Table 3, therefore, compares the effect of PTAs, BITs and joint WTO membership on bilateral value added trade over time. Overall, the results of models 1–3 suggest that economies with a joint PTA, BIT and WTO membership trade more in value added than others. More precisely, model 1 shows that the effect of a joint BIT (5 per cent) on bilateral value added trade is greater than the effect of a joint PTA (3 per cent) and joint WTO membership (1 per cent) across all dyads. This means that when compared with one another, a joint BIT explains more of the variations in bilateral value added trade than joint PTAs or WTO memberships. The coefficient of PTAs in model 1 does not differ significantly from the coefficient of PTAs in models 1–3 in table 1. This means that, for all economies, signing BITs does not divert the impact of PTAs on GVCs. In contrast, BITs seem to only strengthen bilateral GVC integration because BITs can facilitate investment in production processes, causing an increase in the quality and value added content of exports.[17]

Models 4–6 in table 3 show the disaggregated effect of joint institutional memberships on GVC trade for different dyads. Joint memberships in PTAs, BITs and WTO increases GVC integration of developing economies more than of

[16] See appendix table C.1.

[17] Although the causal question in this paper differs from previous seminal studies on the relationship between PTAs and BITs (Tobin and Busch, 2010), findings in table 3 also show that for developing countries stand-alone BITs may not be "better than a lot" in the context of bilateral trade in GVCs. For all dyads (models 1–3), there are no substitution or supplementary effects from BITs and PTAs on GVC trade. The effect of each of these institutions remains significant and nearly unchanged in the presence of others.

developed ones. This effect is particularly strong for South-South dyads (model 6): they engage more in GVCs with one another when they share a PTA as well as a BIT. This means that signing BITs further supports preferential trade liberalization and strengthens GVC integration, providing developing economies with further opportunities for development. Since most processing facilities and plants producing parts and components are located in developing economies, a strong and complementary effect from BITs or PTAs with investment-related provisions on GVC trade (table 2, models 2–4) is expected. The implication is that for developing economies, signing PTAs with investment-related provisions is more important to trade more in GVCs than signing a shallow PTA or a stand-alone BIT.

The effect of joint membership in the WTO is also more important for bilateral GVCs relations between South-South dyads than between North-North and North-South dyads, but this effect is not as significant as the other two institutions. The low impact of joint WTO membership on bilateral trade in GVC is also expected because tariff cuts and trade liberalization through the WTO are small in those sectors that use highly customized inputs and are important for the durability of GVC relations.

Models 2 and 3 in table 3 and model 1 in table 1 confirm *H3*: the long-term effect of stand-alone BITs or joint WTO membership on value added trade are smaller than the phased-in-effect of deep PTAs. Although the effect of BITs on GVCs declines gradually over time, it remains positive over the medium and long terms. The effect of WTO, however, is positive and significant only over the short term, pointing again to the fact that shallow liberalization, through the removal of tariffs and customs-related barriers, does not have a long-term reformative effect on the development and expansion of bilateral GVC trade among economies. Comparing the significance of the dynamic effects of BITs and WTO with the effects of shallow and deep PTAs (models 2 and 3, table 1), we see that, indeed, the cumulative effect of WTO over time is similar to the effect of shallow PTAs, whereas the cumulative effect of deep PTAs is more important than BITs. To check that institutional complementarity does not drive these results, I estimate separately the individual effect of the three institutions with split samples.[18] The results are similar to the results presented in table 3.

Tables 1–3 show that although the overall effect of PTAs and their depth on GVCs is similar to their effect on final export, significant variation in the magnitude of this effect on the two outcome variables appears when we zoom in on specific design features of PTAs, such as the time effect, the content of depth and the income levels of members. To ensure that the estimation approach taken in this paper is as

[18] See appendix table C.2.

Table 3. The main and long-term effect of BITs and joint WTO membership

	ln(VA trade)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Split samples		
				N-N	N-S	S-S
PTA	0.030*** (0.003)			-0.001 (0.006)	0.010** (0.004)	0.113*** (0.008)
BIT	0.049*** (0.004)	0.043*** (0.004)		0.039*** (0.007)	0.026*** (0.005)	0.058*** (0.011)
WTO	0.011** (0.005)		0.012*** (0.004)	0.039 (0.024)	-0.010 (0.008)	0.029*** (0.006)
BIT (medium term)		0.011*** (0.003)				
BIT (long term)		0.005* (0.003)				
WTO (medium term)			0.001 (0.003)			
WTO (long term)			-0.008* (0.004)			
Constant	6.241*** (0.002)	6.254*** (0.001)	6.256*** (0.003)	8.998*** (0.015)	6.697*** (0.004)	4.983*** (0.004)
Observations	232 242	232 242	232 242	27 360	105 667	99 215
R-squared	0.998	0.998	0.998	0.999	0.998	0.995
Dyad FE	Yes	Yes	Yes	Yes	Yes	Yes
country1-year FE	Yes	Yes	Yes	Yes	Yes	Yes
country2-year FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

robust as the state-of-the-art gravity models implemented with bilateral final export data, I re-estimate models in tables 1–3 with bilateral export in final goods as an outcome variable.[19] Results with bilateral final export data confirm previous findings (Baier and Bergstrand, 2007) that deep trade integration between two economies

[19] For bilateral export as an outcome variable, see appendix tables C.3 and C.4.

significantly increases their bilateral trade in final export (by 28 per cent), especially if the trade involves a North-South dyad, which is not the case in the context of GVCs, as table 1 shows.

In addition, BITs have a much smaller effect on trade in final export than WTO membership, which is also consistent with results in table 2, showing that GVC trade depends more on preferential investment facilitation than on multilateral trade liberalization. Benchmarking the results of tables 1–3 with bilateral exports as an outcome variable confirms that trade in value added and trade in final goods and services respond to separate sets of mechanisms. Whereas trade in final exports responds well to deep integration, mostly through the removal of tariffs and non-tariff barriers, trade in GVCs depends on deep integration when investment and time effects are considered.

6. Conclusions and policy implications

The deepening and proliferation of PTAs and the rise of GVCs have become the defining features of global trade and the policy headlines of international organizations in the past few years. Despite the significant implications that the interplay of these two trends holds for trade and development policy, we know surprisingly little about whether and how the change in the design features of trade agreements affects the way economies, especially developing ones, can trade more in and benefit from GVCs. To address this gap, this paper used a comprehensive bilateral data set on PTAs and trade in GVCs and assessed the effect of the deepening of trade agreements on bilateral trade in GVCs, accounting for heterogeneous characteristics of PTAs and economies. In doing so, it improved upon, and added to, the coverage and mechanisms of the scant and recent number of empirical works on the subject.

The main finding in this paper suggests that comprehensive (deep) trade agreements increase bilateral trade in GVCs, but the devil of this effect is in its details: the significance and magnitude of deep PTAs on GVC integration vary with the design features of PTAs. Compared with shallow and multilateral trade agreements, deep PTAs that facilitate GVC trade have a strong cumulative long-term effect; they involve at least one developing economy, and they specifically include provisions that support investment and investment-related activities.

Several important policy implications follow from these findings. First, GVC-facilitating deep PTAs are an effective development policy instrument at the micro level because an increase in the value added to export means improvement in the production processes and capabilities of domestic firms. By supporting economies in the process of designing, negotiating and acceding to GVC-facilitating PTAs,

intergovernmental development organizations and advanced economies can play leading roles in using the proliferation of deep PTAs and the fragmentation of international production for development.

Second, the significance of deep PTAs over the long rather than short term also indicates that deep PTAs are more conducive to institutional changes and to creating an enabling environment for firms to produce and add more value to their export. This outcome is not surprising because deep trade integration involves more extensive industrial and institutional changes in the member States that can increase the short-term costs of trade liberalization. Therefore, reference to a small (or even negative) short-term effect on the economy from deep trade integration may further strengthen economic-nationalistic and protectionist sentiments of the incumbent governments, as was the case with the withdrawals of India from the Regional Comprehensive Economic Partnership in 2020 and the United States from the Trans-Pacific Partnership in 2017. In these situations, it is important to remember and weigh the long-term economic gains from deep integration against its short-term costs before outright rejecting a comprehensive deal that may benefit the economy a few years after the accession. In this context, to withstand the short-term costs of joining and implementing deep agreements developing economies may be more in need of assistance than developed ones.

Third, the significance of investment and investment-related provisions, especially for developing economies, underlines that the effect of trade policy on development depends on the effectiveness of investment policy and vice versa. Whereas shallow trade liberalization, for example, may boost the export of upstream inputs from a resource-rich developing economy, the prospects for its long-term growth and development will improve when it can upgrade to higher value added tasks and processes along the GVCs. The primary sources of an increase in value added production are technology and knowledge transfer, which can be induced by the liberalization of services and (or) investment in new and better products or production processes, which can be facilitated through investment liberalization. As the results of the analysis for developing economies in this paper show, BITs in conjunction with deep PTAs with investment-related provisions can achieve these goals more effectively than shallow preferential and multilateral agreements.

Finally, the significant effect of deep PTAs on GVC trade of dyads that include a developing economy, i.e. North-South and South-South dyads, point to developing economies' unparalleled comparative advantages in terms of low costs of production and resource endowment. At the same time, it also underlines the importance of an open international trade system – first and foremost for developing economies, most of which are upstream exporters, to access downstream buyers. Therefore, it is important to acknowledge that any intentional (e.g. global trade wars)

or unintentional (e.g. global pandemics) disruptions of supply chains, especially in the context of the current fragile economic and geopolitical environment, will be more costly for developing economies than for developed ones.

It must be emphasized that the findings in this paper are based on a macro country-level analysis. For a more fine-grained micro-level analysis of the effect of comprehensive trade agreements on GVCs, future research should focus more on the variation across sectors and firms' responses to trade and development policy in the context of GVCs. After all, the evolving production patterns depend directly on firms' decisions and performances, as they are the ones that import, process, produce, add value and trade internationally.

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Appendix A: Descriptive statistics

In table A.1, I simplify and demonstrate the relations between different components of GVC trade, bilateral value added trade, and monadic GVC variables, i.e. foreign value added to export (FVA), domestic value added to export (DVA), indirect value added to export (DVX) and their compositions: (a) total monadic GVC trade, which is the sum of FVA and DVX, and visualized in this table as the sum of green column and row; and (b) total monadic VA to export (VAX), which is the sum of FVA and DVA, and visualized here as the sum of green column and diagonal cells.

Appendix table A.1. A simplified and transposed demonstration of MRIO tables and the relations between commonly used value added variable

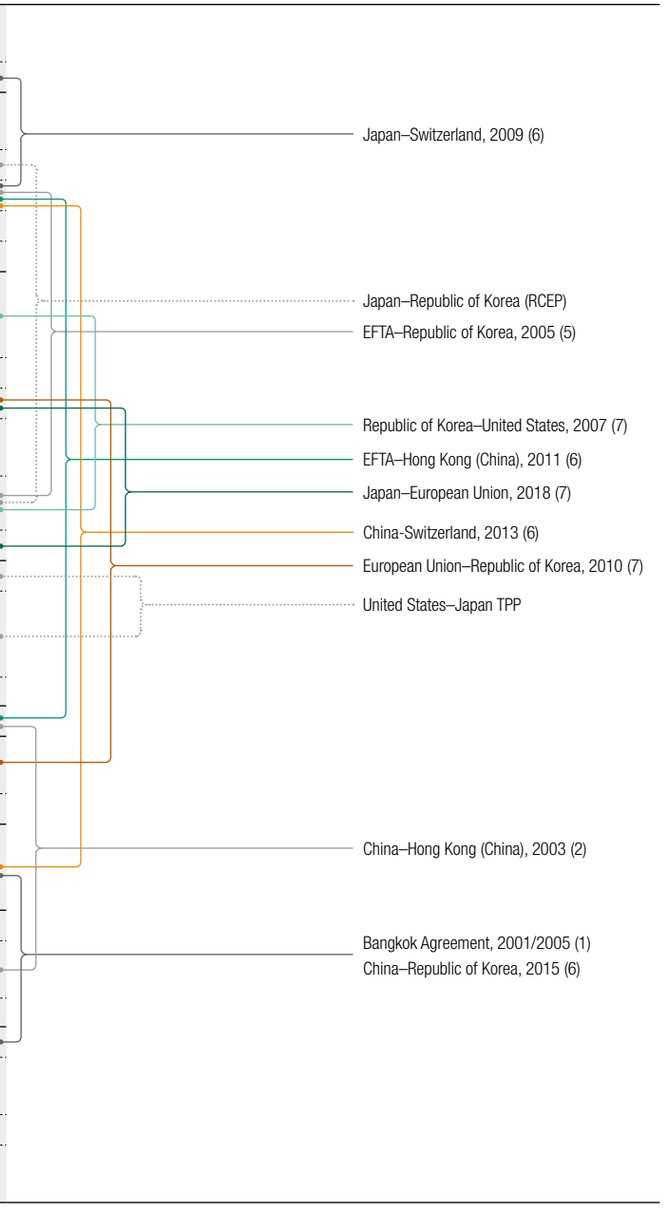
		Downstream countries (j)						
		country1	**country2**	**country3**	**countryk**	**…**	**countryN**	
Upstream countries (i)	**country1**	DVA country1	Bilateral VA trade country1, country2	Bilateral VA trade country1, country3	Bilateral VA trade country1, countryk	…	Bilateral VA trade country1, countryN	FVA for country1 = sum of row – DVA country1
	country2	Bilateral VA trade country2, country1	DVA country2	Bilateral VA trade country2, country3	Bilateral VA trade country2, countryk	…	Bilateral VA trade country2, countryN	FVA for country2 = sum of row – DVA country2
	country3	Bilateral VA trade country3, country1	Bilateral VA trade country3, country2	DVA country3	Bilateral VA trade country3, countryk	…	Bilateral VA trade country3, countryN	FVA for country3 = sum of row – DVA country3
	country k	Bilateral VA trade countryk, country1	Bilateral VA trade countryk, country2	Bilateral VA trade countryk, country3	DVA countryk	…	Bilateral VA trade countryk, countryN	FVA for countryk = sum of row – DVA countryk
	…	…	…	…	…	…	…	…
	country N	Bilateral VA trade countryN, country1	Bilateral VA trade countryN, country2	Bilateral VA trade countryN, country3	Bilateral VA trade countryN, countryk	…	DVA countryN	FVA for countryN = sum of row – DVA countryN
		DVX for country1 = sum of column – DVA country1	DVX for country2 = sum of column – DVA country2	DVX for country3 = sum of column – DVA country3	DVX for countryk = sum of column – DVA countryk	…	DVX for countryN = sum of column – DVA countryN	

Source: Author's elaborations, based on Koopman et al. (2014).

Note: DVA = domestic value added, DVX = domestic value added embodied in exports of other countries, FVA = foreign value added, VA = value added. For more on the derivation of these GVC indicators from MRIO tables, see Aslam et al. (2017), Casella et al. (2019) and Wang et al. (2013).

Appendix table A.2. Companies, economies and PTAs involved in iPhone X GVC

Major parts	Minor parts	Company	Economies
Dual camera	Lens	Largan Precision	Taiwan Province of China
		Genius Electronic Optical	
	CMOS image sensors	Sony	Japan
True depth 3D-sensing camera	Receiver	Largan Precision	Taiwan Province of China
		Genius Electronic Optical	
		Kantatsu	Japan
	Sensor	STMicroelectronics	Switzerland
	Infrared filter	Viavi	United States
	Sensor assembly	Tong Hsing	Taiwan Province of China
Projector	Vertical-cavity surface-emitted laser	Lumentum	United State
		Finisar	
		II-VI	
	Wafer-level lens	Himax	Taiwan Province of China
		Ams	Austria
	Laser manufacturer	Win Semi	Taiwan Province of China
	Laser tester	Chorma	
	3D camera module assembly	LG innotek Sharp (Japan-based unit of Taiwan's Foxconn)	Republic of Korea
	Ceramic substrate	Kyocera	Japan
NAND flash memory chips		Toshiba	Japan
		Western Digital/SanDisk	United States
Modem chips		Qualcomm	
		Intel	
Bionic core processors (A11)		TSMC	Taiwan Province of China
Casing	Glass back, cover glass	Biel Crystal	Hong Kong, China
DRAM chips		Samsung Electronics	Republic of Korea
		SK Hynix	
		Micron	United States
Batteries		Desay Battery	China
		Sunwoda	
		Simplo Technology	
Audio	Microphones, speakers	Knowles	United States
		AAC Technologies	China
		GoerTek	
		Merry Electronics	Taiwan Province of China
Display	OLED panels	Samsung Electronics	Republic of Korea
	3D force touch module	TPK Holding	Taiwan Province of China
		General Interface Solution (Foxconn)	
		Lens Technology	China
	Stainless steel frames, casing assembly	Foxconn Technology	Taiwan Province of China
Assembly	Final product	Foxconn	



Source: Author's elaborations, based on Nikkei Asian Review, "How the iPhone reshaped Asian tech", 20 December 2017 (for information about parts, companies and economies); and DESTA (for information on PTAs).

Appendix table A.3. Descriptive statistics (N = 232,242)

	Mean	Standard deviation	Minimum	Maximum
ln(VA trade)	6.26	2.91	-2.11	18.42
ln(dyadic export)	14.90	4.08	-0.14	26.76
PTA	0.28	0.45	0	1
Depth	0.09	0.28	0	1
Depth index	0.56	1.34	0	7
BIT	0.11	0.31	0	1
Depth Rasch Index	-0.03	0.61	-1.43	2.27
WTO	0.48	0.50	0	1
NS	2.31	0.67	1	3
Investment-related provisions	0.08	0.28	0	1
Market-access provisions	0.07	0.26	0	1
General provisions	0.20	0.40	0	1

Source: Author's estimation.
Note: All financial values are in constant United States dollar prices (2010 = 100).

Appendix B: Additional tests

Exogeneity test

To test the strict exogeneity assumption, i.e. that there is no feedback effect from the changes in trade flows to the changes in trade policy, I add one-period lead dummies for PTA and depth variables in models 1 and 2 in table B.1 (Baier and Bergstrand, 2007; Wooldridge, 2010). A negative and statistically significant coefficient of the PTA lead confirms previous findings that PTAs are endogenous to trade policy. In the context of GVC trade too, firms "delay trade temporarily in anticipation of an impending agreement" (Baier and Bergstrand, 2007, p. 90). With the full set of FE and interval data, the total effect of PTAs on value added trade remains positive and significant (5.4 per cent) as model 1 shows.

Appendix table B.1. Strict exogeneity test

	ln(VA trade)		
	(1)	(2)	(3)
PTAs	0.019*** (0.002)	0.036*** (0.003)	0.061*** (0.005)
PTAs (medium term)	0.024*** (0.002)		
PTAs (long term)	0.018*** (0.002)		
PTAs (anticipatory)	-0.008*** (0.002)		
Depth		-0.014*** (0.003)	
Depth (medium term)		0.017*** (0.002)	
Depth (long term)		0.016*** (0.003)	
Depth (anticipatory)		0.005** (0.002)	
DRI			-0.015*** (0.002)
Constant	6.246*** (0.001)	6.249*** (0.001)	6.248*** (0.001)
Observations	232 242	232 242	232 242
R-squared	0.998	0.998	0.998
Dyad FE, country1-year FE, country2-year FE	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

A comparison of bilateral value added trade variables in the Eora-UNCTAD data set and the OECD's TiVA data set

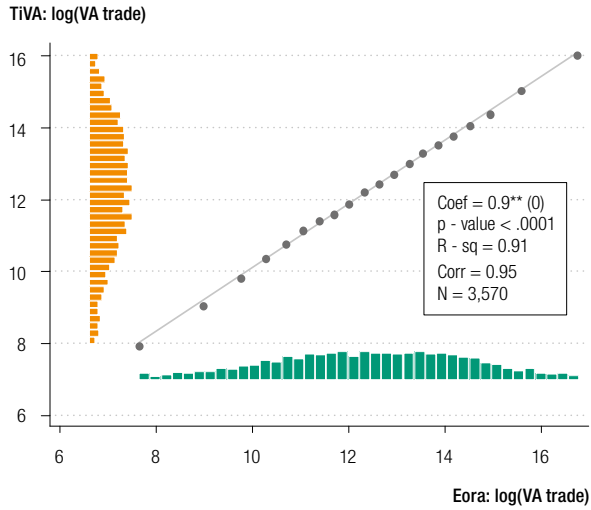
To make sure that this paper's main results are not driven by the underlying characteristics of the Eora-UNCTAD data set, I run a comparison between it and the bilateral value added trade variables for a sample of 35 member countries in the Organisation for Economic Co-operation and Development's Trade in Value-Added data set. Bilateral value added trade in the TiVA (2016 version) data set is captured by the *origin of value added in gross exports, USD million (EXGR_BSCI)* variable. After making TiVA data comparable with Eora data, i.e. after controlling for inflation and converting TiVA data in constant (2010 = 100) thousand United States dollars, I estimate the effect of PTAs on bilateral value added trade with both TiVA and Eora data. Since we cannot implement multi-way FE with a smaller sample size, I implement a simple FE OLS with interval data and clustered standard errors at the dyad level. As table B.2 shows, results between models 1 and 2 (with Eora data) and models 3 and 4 (with TiVA data) do not differ significantly. These results are consistent with those presented in the main models (table 1) in terms of signs and long- versus short-term differences. Figure B.1 presents the correlations between the two variables.

Appendix table B.2. The main and long-term effect of PTAs (Eora and TiVA data sets)

	ln(VA trade)			
	(1)	(2)	(3)	(4)
	Eora-UNCTAD		TiVA	
PTA	0.856*** (0.025)	0.754*** (0.023)	0.923*** (0.052)	0.805*** (0.05)
PTA (medium term)		0.441*** (0.02)		0.509*** (0.038)
PTA (long term)		0.638*** (0.023)		0.615*** (0.039)
Constant	11.804*** (0.017)	11.229*** (0.021)	11.477*** (0.036)	10.881*** (0.04)
Observations	3 570	3 570	3 570	3 570
R-squared	0.091	0.24	0.081	0.201
Number of dyads	1 190	1 190	1 190	1 190
FE	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix figure B.1. Binned scatterplot of Eora and TiVA bilateral value added trade variables



Source: Author's calculations, based on the data set created for this paper.
Note: ** p<0.05.

Appendix table B.3. Comparing the main effect of PTAs with three-, four-, five- and six-year interval data

	ln(VA trade)				
	(1)	(2)	(3)	(4)	(5)
	Consecutive years	Three-year interval	Four-year interval	Five-year interval	Six-year interval
PTA	0.017*** (0.001)	0.007*** (0.002)	0.035*** (0.002)	0.006*** (0.002)	-0.005* (0.002)
Constant	6.240*** (0.001)	6.231*** (0.001)	6.250*** (0.001)	6.312*** (0.001)	6.337*** (0.001)
Observations	841 037	289 640	232 242	174 236	145 083
R-squared	0.998	0.998	0.998	0.998	0.998
Dyad FE, country1-year FE, country2-year FE	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10.

The phased-in and anticipatory effect

The results in the following table point to the differences (and some similarities) between the long-term and anticipatory effects of PTAs and BITs: (1) both PTAs and BITs are endogenous to value added trade flows; (2) while in the anticipation of PTAs, firms indeed withhold their decisions (consistent with previous research on the anticipatory effect of PTAs (Baier and Bergstrand, 2007; Dür et al., 2014)), in the anticipation of a BIT, firms fast-track their activities in the BIT-covered market, which can eventually lead to an increase in trade; and (3) the total effect of PTAs diminishes after nine years, while the total and main effects of BITs only solidify over time.

Appendix table B.4. The phased-in and anticipatory effect of PTAs and BITs on VA trade with consecutive years

	PTAs				BITs			
	Models	Lag/lead effect	Agreement's effect	Total effect	Models	Lag/lead effect	Agreement's effect	Total effect
t-1	(1)	0.026***	-0.006**	0.02	(16)	0.016***	0.025***	0.041
t-2	(2)	0.026***	-0.002*	0.024	(17)	0.015***	0.028***	0.043
t-3	(3)	0.028***	-0.001	0.028	(18)	0.013***	0.031***	0.044
t-4	(4)	0.029***	0.001	0.029	(19)	0.012***	0.033***	0.045
t-5	(5)	0.031***	0.003***	0.034	(20)	0.011***	0.034***	0.045
t-6	(6)	0.028***	0.007***	0.035	(21)	0.010***	0.035***	0.045
t-7	(7)	0.028***	0.009***	0.037	(22)	0.009***	0.036***	0.045
t-8	(8)	0.027***	0.011***	0.038	(23)	0.008***	0.037***	0.045
t-9	(9)	0.025***	0.014***	0.039	(24)	0.008***	0.038***	0.046
t-10	(10)	0.023***	0.015***	0.038	(25)	0.008***	0.038***	0.046
t+1	(11)	-0.013***	0.028***	0.015	(26)	0.010***	0.032***	0.042
t+2	(12)	-0.009***	0.023***	0.014	(27)	0.009***	0.035***	0.044
t+3	(13)	-0.010***	0.022***	0.012	(28)	0.008***	0.037***	0.045
t+4	(14)	-0.013***	0.022***	0.009	(29)	0.007***	0.038***	0.045
t+5	(15)	-0.011***	0.020***	0.009	(30)	0.008***	0.040***	0.048
Constant		6.230***	6.230***	6.230***		6.240***	6.240***	6.240***
Observations		841 037	841 037	841 037		841 037	841 037	841 037
R-squared		0.998	0.998	0.998		0.998	0.998	0.998
Dyad FE, country1-year FE, country2-year FE		Yes	Yes	Yes		Yes	Yes	Yes

Source: Author's estimation.

Note: All clustered standard errors are =< 0.002 (not shown here). *** p < 0.01, ** p < 0.05, * p < 0.10.

Appendix C: Split samples

Appendix table C.1. Group of provisions by dyad

	ln(VA trade)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Split samples								
	Full sample	N-N	N-S	S-S	N-N	N-S	S-S	N-N	N-S	S-S
PTA	0.028*** (0.006)	0.006 (0.007)	0.001 (0.005)	0.114*** (0.008)	0.014* (0.007)	0.003 (0.005)	0.116*** (0.008)	-0.076*** (0.014)	0.033*** (0.006)	0.080*** (0.012)
Investment-related provisions	0.015** (0.007)	-0.009 (0.007)	0.023*** (0.005)	0.058*** (0.012)						
Market-access provisions	-0.018*** (0.007)				-0.021*** (0.007)	0.020*** (0.005)	0.082*** (0.017)			
Other provisions	0.009* (0.005)							0.085*** (0.014)	-0.027*** (0.006)	0.052*** (0.011)
Constant	6.250*** (0.001)	9.028*** (0.002)	6.695*** (0.001)	4.997*** (0.002)	9.028*** (0.002)	6.695*** (0.001)	4.997*** (0.002)	9.027*** (0.002)	6.694*** (0.001)	4.999*** (0.002)
Observations	232 242	27 360	105 667	99 215	27 360	105 667	99 215	27 360	105 667	99 215
R-squared	0.998	0.999	0.998	0.995	0.999	0.998	0.995	0.999	0.998	0.995
Dyad FE, country1-year FE, country2-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix table C.2. The effect of PTAs and BITs on dyadic VA trade by income group

	ln(VA trade)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Split samples					
	N-N	N-S	S-S	N-N	N-S	S-S	N-N	N-S	S-S
PTA	0.001 (0.006)	0.012*** (0.004)	0.121*** (0.008)						
BIT				0.039*** (0.007)	0.027*** (0.005)	0.076*** (0.011)			
WTO							0.04 (0.025)	-0.01 (0.008)	0.035*** (0.006)
Constant	9.027*** (0.002)	6.695*** (0.001)	4.996*** (0.002)	9.021*** (0.001)	6.694*** (0.001)	5.026*** (0.001)	9.004*** (0.014)	6.703*** (0.004)	5.015*** (0.003)
Observations	27 360	105 667	99 215	27 360	105 667	99 215	27 360	105 667	99 215
R-squared	0.999	0.998	0.995	0.999	0.998	0.995	0.999	0.998	0.995
Dyad FE, country1-year FE, country2-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix table C.3. The effect of provisions on dyadic export

	ln(dyadic export)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Split samples								
	Full sample	N-N	N-S	S-S	N-N	N-S	S-S	N-N	N-S	S-S
PTA	0.046 (0.041)	0.027 (0.063)	-0.04 (0.045)	0.202*** (0.073)	0.037 (0.065)	-0.055 (0.046)	0.184** (0.073)	0.263** (0.118)	0.138*** (0.053)	0.112 (0.085)
Investment-related provisions	0.090* (0.049)	0.019 (0.058)	0.141*** (0.042)	-0.131 (0.083)						
Market-access provisions	0.168*** (0.051)				0.003 (0.062)	0.170*** (0.044)	-0.001 (0.09)			
Other provisions	-0.141*** (0.033)							-0.251** (0.118)	-0.148*** (0.051)	0.101 (0.073)
Constant	15.031*** (0.01)	17.398*** (0.022)	15.116*** (0.014)	13.729*** (0.03)	17.399*** (0.022)	15.118*** (0.014)	13.730*** (0.03)	17.403*** (0.022)	15.110*** (0.013)	13.735*** (0.03)
Observations	142 379	21 892	73 749	46 731	21 892	73 749	46 731	21 892	73 749	46 731
R-squared	0.892	0.942	0.888	0.858	0.942	0.888	0.858	0.942	0.888	0.858
Dyad FE, country1-year FE, country2-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.
Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix table C.4. The effect of deep PTAs on dyadic export

	ln(dyadic export)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Split samples		
				N-N	N-S	S-S
PTA	0.052** (0.025)	0.055** (0.025)	-0.074** (0.031)	0.017 (0.066)	-0.067 (0.046)	0.205*** (0.073)
Depth			0.252*** (0.028)	0.033 (0.062)	0.181*** (0.041)	-0.127 (0.079)
BIT	0.028 (0.025)					
WTO	0.146** (0.074)					
Constant	14.930*** (0.045)	15.021*** (0.01)	15.036*** (0.01)	17.398*** (0.022)	15.119*** (0.014)	13.727*** (0.03)
Observations	142 379	142 379	142 379	21 892	73 749	46 731
R-squared	0.892	0.892	0.892	0.942	0.888	0.858
Dyad FE, country1-year FE, country2-year FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimation.

Note: Clustered standard errors at the dyad level are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

How does policy create an opportunity window for China's digital economy?*

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Abstract

From the initial stage of "bringing in" foreign firms to the stage of "going out" (going global), the four-decade development process of China is not just about its participation in globalization, but also about Chinese firms' innovation based on global knowledge sourcing. This study provides a new interpretation of the technology catching-up of Chinese firms, incorporating the theory of windows of opportunity, considering policies as windows for international knowledge sourcing and technology catch-up. It assesses the impact on innovation performance of inward and outward foreign direct investment policies as institutional windows for knowledge sourcing, aims to identify the effective width of windows of opportunity and establishes how these policies lead to outstanding innovation performance by latecomers over time by leveraging external knowledge. Threshold models were adopted using data from multiple sources on 187 Chinese listed firms in the digital industry, including 2,807 firm-year observations. The results show that nonlinear relationships exist between institutional windows and innovation performance. The roles and mechanisms of institutional windows of opportunities in Chinese firms' knowledge-sourcing process demonstrate the decisive effects of the Government's internationalization policies and their role in promoting the development of Chinese digital technologies. Implications are elaborated for both policymakers and Chinese multinational firms in the digital industry.

Keywords: institutional windows of opportunity, knowledge sourcing; internationalization policy, technology catch-up, innovation performance

JEL classification codes: F21, F23, L96, O3, O33

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1. Introduction

In 1978, with China's reform and open-door policy, the country began its catching-up process in the manufacturing sector under the Government's guidance and supportive policies. Soon, a wave of multinational enterprises (MNEs) flooded into China and brought a large amount of foreign direct investment (FDI) (UNCTAD, 2015), which created new developmental momentum for the country. Starting with China's 10th Five-Year Plan in 2001, policies began to target the acceleration of technology transfer through FDI under the "trading market for technology" plan and the indigenous innovation initiative (Luo et al., 2010). After engaging in a gradually accumulative process of technological catch-up, Chinese enterprises improved their innovation capability (Dutrénit, 2000; Cantwell, 2017). Policies that incentivized further sourcing of external knowledge emerged, promoting outward FDI (OFDI) by Chinese firms as a means to access and acquire more advanced technology by rapidly expanding to diverse host countries (Clegg et al., 2016). According to UNCTAD (2017), China's OFDI soared in 2016, up 44 per cent to $183 billion, making the country the world's second largest FDI home for the first time and a net outward investor; its FDI inflows were $134 billion, making it the third largest recipient of foreign capital in the world.

From the initial stage of "bringing in" to the final stage of "going out", this development trajectory demonstrates the roles of these policies in not only the internationalization performance but also the technology sourcing and innovation strategies of Chinese firms. Institutional demands drive the process of sourcing knowledge for advanced technology using public tools. Hence, a set of policy incentives can be considered important institutional windows of opportunity for development of science and technology, which is based on the introduction, digestion and absorption of external knowledge and the progress of indigenous innovation. The appearance of an opportunity window does not necessarily lead to a successful innovation, a result that greatly depends on knowledge sourcing and learning during the opportunity window, during which timely strategic responses must be made and actions taken (Lee and Malerba, 2017). The complex process is triggered by and conducted through a series of institutional measures and policy arrangements. The outcome of the process is that the innovation capacity of Chinese enterprises has improved significantly, providing a classic case of technological catch-up, allowing us to understand the process of knowledge sourcing by Chinese digital enterprises during their pursuit of innovativeness.

Drawing on the international literature on knowledge sourcing and windows of opportunity in technological innovation and based on multiple, large-scale databases containing 2,807 firm-year observations, this study first identifies the institutional windows of opportunity. It then delineates the roles of the institutional opportunity window in the knowledge-sourcing process and innovation, and finally

it explains how emerging MNEs (EMNEs), from a technology-deficient background, develop and maintain their competitive advantages in the global market in response to homeland institutional influences. In addition, heterogeneity analysis furthers understanding of the knowledge-sourcing behaviour of enterprises in the country's unique institutional context. The research is embedded in the context of the rapid development of the digital industry in China. In sum, we endeavour to explore two research questions: (1) How do the bringing-in and going-out policies create opportunity windows for digital firms to source knowledge externally? (2) What are the roles of opportunity windows in digital innovation?

The paper delivers insights on how governments create windows of opportunity to enhance innovation performance through international knowledge sourcing – insights that could have implications for industry, EMNEs and governments in their strategic decision-making with regard to internationalization and innovation. This study provides an analysis of the evolutionary process of institutional windows during an extended period of time, allowing more accurate capture of their roles and the evolution of their roles in the knowledge-sourcing process. The results show that knowledge sourcing in China was increasingly proactive during 2006–2020, a period that witnessed several major policies and initiatives that the Government formalized to support the development of technology capabilities in the country and in firms. Among these, the National Middle- and Long-term Plan for Science and Technology Development (2006–2020) (MLP) was one of the most influential.

2. Research context

At a critical time for knowledge sourcing through international business, China pursued technology development policies that combined the purposes of global market entry and technology catch-up. From 2003 to 2020, the Government formulated a number of major policies and measures to cultivate the technological capabilities of the country's main innovators, among which the Outline of the MLP is one of the most influential and provides the appropriate context for this study. During this period, the values of both inward and outward FDI (IFDI and OFDI) increased significantly as developed countries increasingly assigned core research and development (R&D) to China (Grosse, 2019). Consequently, knowledge seeking became a prominent motivation in international business activities (Dachs and Zahradnik, 2022).

A key challenge for policymakers in today's global economy is digital development. The digital economy is having a major impact on global patterns of investment (UNCTAD, 2017), and with the growing influence of the digital industry on the Chinese economy, it is instructive to study the institutional window of opportunity for the industry in the context of the country's digital upgrading. According to the White Paper on the Development of China's Digital Economy (CAICT, 2020),

the digital industry accounted for 38.6 per cent of gross domestic product by 2020, as the digital economy was becoming increasingly important to the country's economic development. Innovation in the digital industry is key to developing a high-quality digital economy. With the support and guidance of several national policies and the combined effect of the boom in cloud computing, artificial intelligence, big data, 5G and other next-generation information technologies, the digital industry has made outstanding achievements in innovation (Zhang et al., 2021). Some digital enterprises have become pillars of the country's new economy and high-tech industries, and are among the most active players in the global innovation ecosystem (Dachs and Zahradnik, 2022). These enterprises rely not only on internal R&D but also on external knowledge sources through international partnerships. Digital firms enjoy the convenience of knowledge flows through an open virtual network and the advantages of being borderless.

Thus, digital firms are the most active players in global innovation activities, with strong innovation capability, operating in a technologically dynamic environment where advanced knowledge is created constantly and quickly (Dachs and Zahradnik, 2022). According to the definition of digitalization in the G20 digital economy report, the digital industry includes software and information and communication technology (ICT), Internet and electronic information manufacturing (UNCTAD, 2021). We therefore define the Chinese firms that operate within this broad theme as digital enterprises.

3. Literature review

3.1 Knowledge sourcing for technological innovation through internationalization

Numerous studies identify the sources of innovation, with a focus on internationalization activities, such as FDI, trade and overseas R&D (Li et al., 2012; Sabir et al., 2019). Knowledge-based technological capabilities have long been recognized as an important source of competitiveness for firms. Seeking technological knowledge is particularly important for firms in emerging markets because of the increasingly fierce battle for innovation capabilities (Mudambi, 2008; Child and Rodrigues, 2005; Luo and Tung, 2007; Rui and Yip, 2008).

A widely held belief is that many EMNEs obtain technological knowledge by using IFDI and OFDI as key learning and catch-up mechanisms (Dunning, 1998; Luo and Tung, 2007; Mudambi, 2008) – China in particular (Buckley et al., 2007). As the globalization of production reshapes the international economic landscape, developing countries are emerging as outward investors (UNCTAD, 2005). Technology transfer and knowledge spillovers through the IFDI of MNEs from

developed countries have been recognized as a crucial reason for the latecomers' technology development and catching-up, at early stages (Fu et al., 2011). These latecomers develop and accumulate basic technological capability (Cui et al., 2017; Fu et al., 2018), based on which, together with their institutional advantages, they can gradually compete with advanced MNEs in their home markets and expand in other developing host markets (e.g. Guo et al., 2019; Sabir et al., 2019). In recent decades, latecomer firms have actively acquired technological assets through OFDI (Deng, 2009), especially from developed countries that have industry-specific comparative technological advantages (Li et al., 2012). Mathews' LLL (linkage-leverage-learning) model argues that EMNEs engage in OFDI to develop competitive advantages from external relationships (Mathews, 2006). EMNEs turn to OFDI to acquire more advanced technological capability. International expansion thus becomes a springboard to acquire strategic resources globally (Luo and Tung, 2007).

3.2 Institutional-based view of knowledge sourcing by EMNEs

A growing interest of the institution-based view on EMNEs is how institutional factors are unique to emerging markets, affecting innovation development (Chen et al., 2012; Lee et al., 2015; Pearce and Zhang, 2010). Governments are among the most salient institutions in emerging economies, with a critical influence through regulatory policies and control over scarce resources, which shape firms' country-specific advantages (Rugman and Li, 2007; Tang and Pearce, 2017). Most studies focus on how government regulations and internationalization policies stimulate innovation (Lazzarini, 2015; Zhou et al., 2017) and how various forms of State ownership foster firm performance (Peng et al., 2008). The technological capability of emerging firms is influenced top down, i.e. from government interventions (e.g. Guennif and Ramani, 2012) to innovation systems (e.g. Malerba and Nelson, 2011), and down to the firm level.

Scholars maintain different views on the impact of government policies on firm innovation. Some researchers stress that EMNEs have country-specific advantages to exploit initially; these are often only temporary and as such are just an avenue by which to access the knowledge-based capabilities that will help create and sustain competitive advantage in the long term (Kedia et al., 2018; Lei et al., 2019; Miao et al., 2018). Some hold that government policies, particularly regulations on market entry or technology transfer (Branstetter, 2018), facilitate the inward knowledge-observing process. For example, the Chinese Government applied the "technology for market" strategy, under which it allows foreign companies to enter the Chinese market in exchange for technology transfer to domestic companies or establishment of R&D centres in the country (Zhou and Liu, 2016). Other scholars focus on the process of outward knowledge sourcing. Because of insufficient

firm-level competitive resources, most emerging firms internationalize with the support of institutional conditions and policies (Mathews, 2006; Rugman et al., 2016). The institutional theorists point out that the supportive policies and industrial structure of the home country play crucial roles in Chinese firms' global expansion (Grosse, 2019) and that some good results have been achieved in some key industries, such as high-speed rail and telecommunication (Liu et al., 2017; Yap and Truffer, 2019).

Emerging firms, therefore, have strong incentives to accumulate global technology and build cross-border knowledge to acquire knowledge resources and advanced technological capabilities that enable them to catch up with industry leaders in the global market (Awate et al., 2015; Cantwell, 2017; Li et al., 2012; Mudambi, 2008). Alon (2010) emphasized the differences in mechanisms of knowledge-sourcing activities among enterprises with different ownership in emerging economies under incentive policies. This institutional difference creates a comparative advantage in terms of ownership structures, leading to heterogeneity in international business strategy. In practice, Chinese State-owned enterprises (SOEs) are believed to be better able to obtain more direct policy support, whereas private enterprises have the responsiveness to apply policies more flexibly.

3.3 Institutional windows of opportunity for knowledge sourcing

The concept of windows of opportunity has been applied to explain the catching-up phenomenon in global settings (Lee and Malerba, 2017; Shin, 2017). Government institutions exert a major influence in emerging markets. Changes in government intervention in industry that enable emerging enterprises to catch opportunities to leapfrog development are considered as institutional windows of opportunity for latecomers (Perez and Soete, 1988; Guennif and Ramani, 2012; Lee and Malerba, 2017). Thus, the institutional window is created through government intervention in an industry or through systemic changes in institutional conditions (Lee and Malerba, 2017; Vértesy, 2017), usually used as a specific country advantage for emerging firms (Rugman et al., 2016).

Liu (2017) states that the inverted U shape of institutional factors affects innovation performance, which indicate that institutional opportunities for knowledge sourcing may close if not accompanied by changes in institutions and innovation systems. Moreover, the costs of acquisition and imitation have increased as the overall technology gap between China and the West has narrowed (Liu, 2017). Some knowledge-seeking strategy is applied by the enterprises being "locked out" from critical technologies in industry and ineffective policy (Sauter and Watson, 2008).

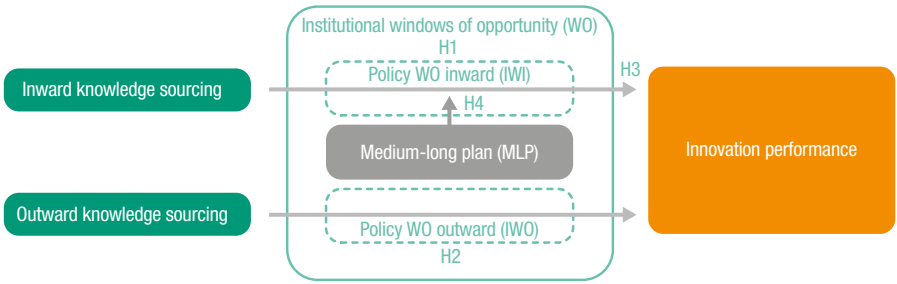
This paper contributes to the theory and policy by using the threshold effect mode and extending the measurement of institutional windows of opportunity.

By measuring the open period of a window, we can derive a rough estimation of the time lag between policy introduction and eventual effect, and try to explain what level of policy incentives might trigger the opening of opportunity windows. From the perspective of existing research, there is still no framework to study the mechanism of impact of IFDI and OFDI as indicators for institutional variables on the innovation performance of enterprises and to measure the institutional window of opportunity. This study focuses on the role of IFDI and OFDI policies in the knowledge-sourcing process of digital enterprises in China and how they affect, respectively, the threshold and the mechanism to enter the window of opportunity for technological innovation of enterprises. This paper also explores the degree to which Chinese enterprises of different ownership types differ in their abilities to sense and seek opportunity windows, in their responses to windows and in their innovation performance. We try to explain the differences in performance and mechanism. Is the threshold effect brought about by policy incentives consistent for enterprises of different ownership?

4. Hypotheses development

Because of the unique institutional settings of government, it plays a significant role in enabling latecomer firms to develop competence at home and abroad (Cuervo-Cazurra and Ramamurti, 2014). To keep up with the competition and develop the capability to confront a fast-changing technical world, external knowledge sourcing is an important path for firms – a way to tap into new ideas and technologies from beyond their boundaries (Monteiro and Birkinshaw, 2017) and fundamentally transform their core competence to enhance their long-term competitiveness (Li et al., 2012). Hence, knowledge sourcing has become a strategic purpose motivating IFDI and OFDI (Dunning and Lundan, 2008) (figure 1).

Figure 1. Structure of the knowledge-sourcing process of China's digital MNEs



Source: Authors' elaboration.

Bringing-in opportunity window

Institutional reforms appear to be an important determinant of FDI attraction in developing countries, as they can provide space, resources and opportunities for catching up (Mu and Lee, 2005; Pack and Saggi, 2006). Governments can effectively align market-driven incentives with knowledge-sourcing purposes to influence the behaviour of firms in their pursuit of technological catch-up and innovation performance. At the beginning of the economic reform period in the late 1970s, the Chinese Government opened the domestic market to foreign investors and provided favourable tax, regulatory and infrastructure conditions. The policy was inspired by the Government's goal to catch up economically and in basic technology rather than to achieve original innovation. As latecomers, Chinese firms started from a resource-meagre position as they did not possess strong technological resources, advanced management skills and marketing techniques (Wang et al., 2012) and could not offer firms sustainable competitive advantages in operating in an increasingly globalized and ever-changing context. A wave of multinational enterprises (MNEs) entered China and provided a large amount of FDI (World Bank, 2015). At this early stage, Chinese firms required strategic knowledge from successful firms. Given the policy orientation and supported by investment regulations, many were encouraged to pursue collaboration with foreign investors, primarily to gain access to technologies and know-how, rather than to exploit existing resources and capabilities (Liu and Woywode, 2013; Luo and Tung, 2007; Rui and Yip, 2008). In other words, they used FDI as a channel to overcome their disadvantages (Child and Rodrigues, 2005; Mathews, 2002). Rapid responses to policy incentives enabled the process of learning from inward spillovers of foreign knowledge. In 2008, the Government began to withdraw favourable policies for foreign companies, although the overall growth trend continued (Liu et al., 2017). We surmise that the bringing-in policy opened a window of opportunity for operationalizing Chinese firms' knowledge-seeking strategies and firms recognized the time slot. The "trading market for technology" policy produced the expected effect of expanded knowledge sources.

Hypothesis 1:

Bringing-in opportunity windows and exits have positive effects on knowledge acquisition within a certain window period.

Going-out opportunity window

In the gradual and cumulative process of technological catch-up, enterprises enhance their knowledge base (Dutrénit, 2000; Cantwell, 2017). When an enterprise has acquired the basic technical knowledge suitable for a low-end market or mastered certain core technologies through indigenous innovation, it gradually cultivates the ability to carry out OFDI. Especially in the technology field,

with its short cycle times and large initial-knowledge stock, the latecomers from China tend to reach a higher level within a shorter cycle time, have easier access to knowledge and show greater adaptability.

China has established clear direction about the types of OFDI it would like to encourage, in particular technology-related OFDI, and has created a supportive environment that helps strong firms to invest abroad for the purpose of becoming globally competitive MNEs. Among internationalization paths, cross-border mergers and acquisitions (M&As) are a major mechanism of overseas expansion that facilitates the integration of advanced technology. Greenfield investment is adopted to directly obtain more advanced technical knowledge and intellectual resources, in order to enhance innovation ability. By providing a stable and supportive institutional environment, government policy and incentives in relation to the promotion of OFDI also enabled strong Chinese firms to choose longer-term M&As as a means to acquire technology from global giants (Hitt et al., 2004). The initial firms capable of seeking patented technology may be large SOEs, as they can use government sponsorship and financial underwriting to secure strategic assets through purchases and associated learning opportunities (Child and Rodrigues, 2005; Sabir et al., 2019). Their international expansion aims to increase market share and to acquire and adapt technology from diverse sources to match firms' existing knowledge base. Consequently, the Government formulated a series of policies as institutional support for the acquisition of foreign knowledge in the form of tax measures and favourable financing (UNCTAD, 2005). However, as domestic industries upgrade, financial markets develop and policies are further updated, more private companies (such as Huawei, Tencent and Byte Dance) were able to invest overseas. The empirical analysis shows that after 2003, Chinese enterprises' technology-oriented OFDI gradually increased (Luo et al., 2010). The Government's policy support for technology-oriented outbound investment may have played an important role in Chinese companies' overseas investment decisions. The effort to drive Chinese firms to invest abroad gained momentum after the implementation of the "go global" strategy (announced in 2001), which played a crucial role in Chinese firms' internationalization. Therefore, we surmise that in the technological catch-up process, the existence of a "going-out" institutional window will increase knowledge sourcing at a faster speed within a certain time slot (Li et al., 2016). We propose:

Hypothesis 2:

Going-out opportunity windows and exits have positive effects on knowledge acquisition within a certain window period.

Variations of two windows in knowledge-sourcing process

In the research framework of this paper, we also focus on the impact of knowledge sourcing on latecomer firms' innovation performance. According to the literature, institutional demand and pressures are the key elements affecting

internationalization strategy and activities, and provide growth points for innovation (Lazzarini, 2015; Zhou et al., 2017; Awate et al., 2015; Mudambi, 2008; Rugman and Li, 2007).

Research on the nature of the digital industry shows that the effectiveness of policy stimulus for knowledge sourcing is not linear. Both incumbents and latecomers are equal in the face of institutional arrangements. Latecomers can use this opportunity to offset the disadvantage of being latecomers. However, by reacting to institutional arrangements, the first movers' capability enhancement in terms of technology and market demand led the narrowing of the window for the latecomers (Kim and Park, 2019). The costs of learning and imitation have increased as the overall technology gap between latecomers and advanced countries has narrowed (Liu, 2017). The sharp increase in technological standards by incumbents weakens the latecomers' advantages derived from institutional arrangements. The knowledge-sourcing process moves towards increasing internal investment in innovation and internal R&D, adopting a cost-out strategy and thereby increasing efficiency (Choquette et al., 2021). Based on these assumptions, it is reasonable to believe that in the empirical test, there may be a threshold that divides the different impacts of knowledge sourcing on enterprise innovation performance. When knowledge sourcing exceeds the threshold value, the impact of the institution window on enterprises' innovation performance will begin to decline. Owing to the weak absorptive capacities of latecomers in the early stage of the knowledge process and the imitation lag for innovation, the technological gap between latecomers and advanced foreign investors lags knowledge transfer for innovation performance.

Hypothesis 3:

Knowledge sourcing has a curvilinear relationship (inverted-U) with latecomers' innovation performance.

Internal Commitment: MLP for R&D investment

Research has pointed out that as more FDI flows into emerging economies, the catching-up EMNEs progress (Alon et al., 2018; Li et al., 2017; Luo and Tung, 2007). Some insights into the IFDI-OFDI linkage have been explored (Xia et al., 2014). Latecomers in emerging markets are learning from the foreign MNEs' inward knowledge-sourcing process, which could foster their subsequent OFDI.

Yet, the ultimate purpose of knowledge sourcing is to build a firm's core technology and innovation capacity. Whether latecomer firms can transform the technological advantages of FDI into technological progress depends on their absorptive capacity (Zhang et al., 2010). Spillovers of advanced technology from foreign investors improve domestic production and technical capacity for innovation. However, the competition and crowding-out effects of the industry intensify the pressure

of blocked-in technology transfer in EMNEs' home markets (Acemoglu, 2006), which may push them to seek internal development of technology. This compels supplementary policies to encourage internal technology investment.

The MLP, a government commitment to technology development, was created to stimulate domestic enterprises' R&D investment so as to promote technological capacity, in order to strengthen knowledge bases for acquiring frontier technology through outward knowledge sourcing. First, the Government subsidized focal sectors for R&D activities, which may encourage more R&D expenditure by enterprises. Subsequently, the Government promulgated policies, laws and legislation to sustain capability-building in domestic firms so that they can better utilize foreign technology so to develop their own core technology. This formed overlying effects for innovation, leading to more technology spillovers. This, in turn, provides opportunities for technological learning of firms (Fan, 2006; Dunning and Lundan, 2008) and increases the probability of catch-up on frontier technology. For example, in government-initiated programmes such as science parks, the Government provides financial resources and tax incentives to attract firms to locate in the park. These policies create new industrial clusters and market segments and attract more competitive foreign investment, leading to firm-specific advantages in building up knowledge sourcing through OFDI.

Hypothesis 4:

R&D investment positively moderates the relationship between institutional windows and knowledge sourcing.

5. Methodology

5.1 Data

The data was collected from multiple, large-scale databases by first obtaining data on 187 Chinese listed telecommunication companies from 2006 to 2020 from the China Stock Market Accounting Research database. We matched using R and Python from IncoPat, zephyr and UNCTADstat, and then combined them as panel data. The sample consists of data on 1,801 patents matched by stock codes for each of the 187 listed digital companies with their annual report data and contains 2,807 firm-year observations for the period from 2006 to 2020.

Here, we start with static linear models, to verify the results. To explore the effectiveness of the policy window on knowledge sourcing through internationalization, we then establish difference GMM (generalized method of moments) and system GMM models (Wooldridge, 2010). Then we apply threshold models to investigate potential nonlinear relationships between the effective range of policy windows and different directions of knowledge sourcing.

5.2 Model specification

Static model

$$lnpatent_{it} = \beta_0 + \beta_1 lnIKS_{it} + \beta_2 lnOKS_{it} + \beta_3 lnIWI_{it} + \beta_4 lnIWO_{it} + \sigma X_{it} + \vartheta_{it} + \varepsilon_{it} \quad (1)$$

The benchmark linear regression aims to investigate the impacts of knowledge sourcing through IFDI and OFDI and their associated opportunity windows on firm innovation performance. This study looks for the length of institution windows by examining for how many consecutive years the policies have impacts on knowledge sourcing and innovation. We use IFDI and OFDI as the threshold variables to estimate the length of windows for innovation, and we adopt R&D input as a moderating variable, to test the moderating effect of the MLP on the relationship of institutional window and innovation.

The model in this paper is based on the panel data threshold model of Hansen (1999). The basic equation given is

$$\gamma_{it} = \mu_i + \beta_1 x_{it} I(q_{it} \le \gamma) + \beta_2 x_{it} I(q_{it} > \gamma) + \varepsilon_{it} \quad (2)$$

Equation (2) is equivalent to

$$y_{it} = \begin{cases} \mu_i + \beta_1 x_{it} + \varepsilon_{it}, q_{it} \le \gamma \\ \mu_i + \beta_2 x_{it} + \varepsilon_{it}, q_{it} > \gamma \end{cases} \quad (3)$$

Where i represents the region, t represents the year, I is the indicator function, q_{it} is the threshold variable, γ is the threshold value to be estimated and ε_{it} is the random disturbance term. Referring to Hansen's threshold model, the threshold regression model of this study is set as follows:

Threshold model

$$lnpatent_{it} = \alpha_0 + \alpha^* lnpatent_{i,t\text{-}1} + \alpha_1 lnIKS_{it} \cdot I(lnIWI_{it} \le \gamma) + \alpha_2 lnIKS_{it} \cdot I(lnIWI_{it} > \gamma) + \sigma X_{it} + \vartheta_i + \varepsilon_{it} \quad (4)$$

$$lnpatent_{it} = \alpha_0 + \alpha^* lnpatent_{i,t\text{-}1} + \alpha_1 lnOKS_{it} \cdot I(lnIWO_{it} \le \gamma) + \alpha_2 lnOKS_{it} \cdot I(lnIWO_{it} > \gamma) + \sigma X_{it} + \vartheta_i + \varepsilon_{it} \quad (5)$$

Where γ is the threshold value.

In order to prove the existence of U-shaped relationship, researchers usually use the following mathematical model for regression:

$$Y = \beta_0 + \beta_1 X + \beta_2 X^2 \quad (6)$$

Accordingly, we construct the following model:

$$lnpatent_{it} = \beta_0 + \beta_1 lnIWI_{it} + \beta_2 lnIWI_{it}^2 \quad (7)$$

$$lnpatent_{it} = \beta_0 + \beta_1 lnIWO_{it} + \beta_2 lnIWO_{it}^2 \quad (8)$$

5.3 Variable specification

Dependent variable

Growth of innovation is the outcome of technology spillover. The literature mainly uses the number of patents (*patent*) to measure firms' innovation outputs and reflect outcomes of technology spillovers. Considering the validity of innovation, we use patents granted as the dependent variable.

Independent variables

Inward knowledge sourcing (*IKS*) – knowledge sourcing through IFDI – and outward knowledge sourcing (*OKS*) – knowledge sourcing through OFDI – are the classifications of learning styles in the field of innovation in international business. Learning activities can be divided into inward and outward according to whether they occur inside or outside a country's boundary (Dahlander and Gann, 2010; Mazzola et al., 2012). Inward knowledge sourcing is the means to integrate innovation and technology resources that spill over from the activities of MNEs in domestic markets. We use the percentage of foreign enterprises in total enterprises for *IKS*. Outward knowledge sourcing enables latecomers to catch up with frontier technology and knowledge through embeddedness of advanced countries. We use M&As of the digital industry to describe *OKS*.

Indigenous innovation (*linno*) reflects the ability to innovate. R&D capital expenditure reflects the investment intensity of firms in equipment for improving innovation and plays an irreplaceable role. In general, a high level of firm expenditure on R&D indicates a willingness to engage in technological innovation for catch-up. In this paper, the investment intensity of R&D is adopted to describe indigenous innovation, i.e. R&D expenditure as a share of total expenditure.

Threshold variable

Firms hitchhiking on the ride of opportunity reflects the effective range of policy support for internationalization action. Scholars in international business contend that latecomers build up initial technological capabilities by imitating technologies gained from IFDI and related technology transfer or spillovers (Lee et al., 2005; Wu and Zhang, 2010). FDI, often dictated by MNEs' knowledge-seeking motives,

is one of the most efficient channels to access and acquire strategic assets (Mathews, 2006). IFDI is the product and direct outcome of the open door policy. Thus, the value of IFDI is used to indicate the policy window of opportunity for inward technology spillovers. As firms' technological capabilities develop, they locate their OFDI in host countries with more advanced technologies and other strategic assets, where they catch up to technology frontiers, which is the result of the going-out policy. Therefore, both IFDI and OFDI reflect policy support for the technology catch-up of EMNEs. Thus, in this paper, IFDI flows and OFDI flows are adopted in the model as policy windows.

Control variables

We accounted for several attributes that may be expected to contribute to explaining the dependent variables. First, we controlled for absorptive capacity by R&D personnel investment (*rdp*), using the number of employees involved in R&D divided by the total number of employees. Investment in R&D personnel can increase the knowledge reserve of society and provide the human capital basis for technological innovation.

We also controlled for the age of the firm (*age*), on the basis that older firms have more experience and potentially more extensive resources, which may allow them to learn from international technology spillovers. We also distinguished firm ownership as a dual variable (0 = private, 1 = SOE), as additional knowledge-sourcing performance due to governmental support. Size of firms (*size*), reflects scale differences in tolerances of R&D risks, which directly affects firms' innovation enthusiasm. Tables 1 shows the definition of variables, and the descriptive statistics of variables are provided in table 2.

Table 1. Definition of variables

Variable	Abbreviation	Data description	Data source
Dependent variable			
Innovation performance	*patent*	Patent granted (patent1 = all patents granted, patent2 = patent for invention)	Incopat
Independent variable			
Policy WO inward	*IWI*	FDI flows	China, Ministry of Commerce; UNCTADstat
Inward knowledge sourcing	*IKS*	Number of enterprises with foreign capital in an industry as a share of the total number of enterprises	China, National Bureau of Statistics

/…

Table 1. Definition of variables (Concluded)

Variable	Abbreviation	Data description	Data source
Policy WO outward	*IWO*	OFDI flows	*Statistical Bulletin of China's Outward Foreign Direct Investment*
Outward knowledge sourcing	*OKS*	M&As	CSMAR database
Moderator variable			
Indigenous innovation	*linno*	Firms' R&D expenditure as a share of total expenditure	CSMAR database
Control variable			
Size	*size*	Total assets	CSMAR database
Age	*age*	Year of establishment	CSMAR database
Ownership	*dual*	Private = 0, SOE = 1	CSMAR database
Absorptive capacity	*rdp*	Number of R&D personnel	CSMAR database
Efficiency of R&D	*CapRD*	R&D expenseas a share of total revenue	CSMAR database

Source: Authors' compilation.
Note: CSMAR = China Stock Market & Accounting Research, M&As = mergers and acquisitions, OFDI = outward foreign direct investment, R&D = research and development, SOE = State-owned enterprise, WO = window of opportunity..

Table 2. Descriptive statistics of variables

Variable	N	p25	p50	p75	Minimum	Maximum	Mean	Standard deviation
patent1	1 801	28.0	73.0	234.0	0.4	25 000.0	346.3	1060.0
patent2	1 571	7.0	18.0	60.0	0.0	2780.0	89.9	249.8
IWI	2 793	183.4	281.4	367.5	14.9	512.3	270.4	108.6
IKS	2 200	41.3	64.9	90.6	0.0	464.3	74.8	59.3
IWO	2 681	158.1	276.8	394.6	1.6	634.3	275.5	140.6
OKS	1 943	69.1	258.8	923.1	0.0	71 000.0	1619.0	5 010.0
linno	1 795	91.6	302.5	960.4	0.1	17 000.0	979.3	1 778.0
size	2 428	163.1	349.5	934.9	1.1	150 000.0	1423.0	6 613.0
CapRD	2 485	18.8	36.0	55.0	0.0	985.1	51.6	66.8

Source: Authors' estimations.

6. Results and analyses

6.1 Correlation analysis

In order to deal with the problem of multicollinearity, we conducted correlation analysis, using the Pearson correlation coefficient to represent the strength of correlation and artificially eliminate collinear variables without losing important information. Table 3 shows the correlation coefficients.

Table 3. Correlation coefficients of the main variables

	patent1	IWI	IKS	IWO	OKS	linno	size	age	rdp
IWI	0.109***								
IKS	-0.018	0.006							
IWO	0.114***	0.989***	0.016						
OKS	-0.013	0.110***	0.057	0.081**					
linno	0.100***	0.030	-0.047	0.021	0.103***				
size	0.478***	0.023	-0.032	0.034	0.071**	0.068*			
age	-0.033	0.441***	0.150***	0.438***	0.052	-0.001	0.072**		
rdp	0.102***	0.933***	0.023	0.928***	0.024	0.040	-0.006	0.396***	
CapRD	0.021	0.117***	-0.028	0.125***	-0.019	0.027	-0.148***	-0.259***	0.119***

Source: Authors' estimations.
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Benchmark linear regression

We conducted basic linear regression, which indicated that inward and outward knowledge sourcing have significant roles in promoting innovation performance (table 4). In terms of policy incentives, the effect of inward policy incentives is not significant, but the regression coefficient of outward policy incentives passes the significance test at the level of 1 per cent. This indicates that they have a strong promotion effect in improving the innovation performance of enterprises (rather than inward policy incentives).

Table 4. Benchmark linear regression

Variable	Lnpatent1
LnIKS	0.211*** (0.055)
LnOKS	0.030** (0.014)

/…

Table 4. Benchmark linear regression (Concluded)

Variable	Lnpatent1
LnIWI	0.327 (0.272)
LnIWO	0.519*** (0.182)
Constant	-1.171* (0.652)
Number of observations	931
R^2	0.075
R-squared within	0.196

Source: Authors' estimations.
Note: *** p < 0.01, ** p < 0.05, * p < 0.10.

6.2 Threshold model test

6.2.1 Bootstrap

It can be seen from table 5 that in the case of 300 Bootstrap self-sampling there are two threshold values, for the policy window of opportunity – inward (*IWI*) and outward (*IWO*). The impact of the two variables on enterprise innovation performance has stage characteristics, indicating nonlinear relationships between innovation performance and inward and outward knowledge sourcing within the range of the policy window of opportunity.

Table 5. Threshold effect test

Threshold variable	Threshold	F-statistic	Probability	Crit10	Crit5	Crit1
LnIWI	Single	46.910	0.000	7.977	9.527	13.792
	Double	17.680	0.000	7.492	9.014	12.263
	Triple	3.150	0.800	10.759	12.801	18.787
LnIWO	Single	26.160	0.000	8.117	9.182	11.759
	Double	12.810	0.003	6.556	8.424	11.074
	Triple	4.770	0.763	13.857	15.500	20.445

Source: Authors' estimations.

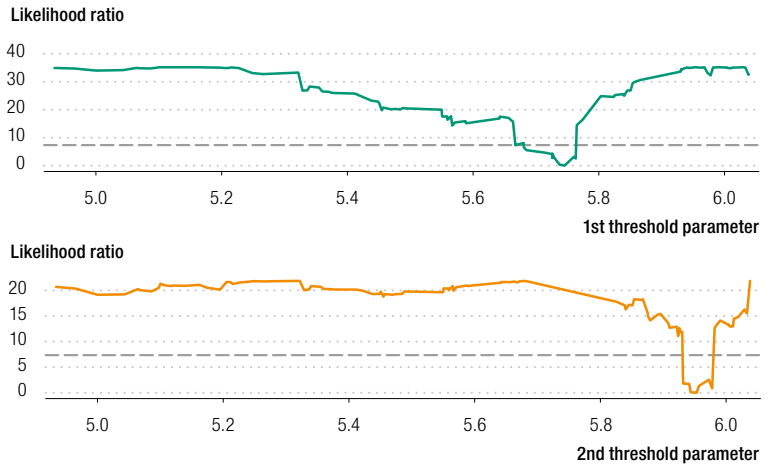
6.2.2 Determination of threshold value of two institutional windows of opportunity

Phased test of IWI

According to the estimated results of the threshold effect of *IWI* in figure 2, the corresponding likelihood ratio value of *IWI*'s threshold estimate is significantly smaller than the critical value of 7.35. Therefore, we believe that the obtained threshold estimate is true and valid. The results show that the impact of *IWI* on innovation performance has two stages, which can be regarded as the window opening in the first stage and further opening in the second stage.

The bringing-in policies have encouraged firms to pursue FDI to acquire advanced technology, which underpins innovation performance. Such policy direction enhanced inward knowledge spillovers, expanding the expected effect of knowledge sources for innovation. The institutional preference opens the window for domestic digital firms to catch up technologically. The second stage indicates that with the increase in inward knowledge sourcing, the institutional window shows a trend of strengthening for further opening, rather than closing. In formulating various institutional measures and incentives (e.g. gradually reducing the negative list of investment), China constantly encourages FDI, to keep the positive effect of technological knowledge spillover for innovation. Therefore, H1 is accepted for the existence of an inward institutional window of opportunity because of the positive effect on knowledge sourcing for innovation.

Figure 2. Likelihood ratio for institutional window for inward FDI (IWI)

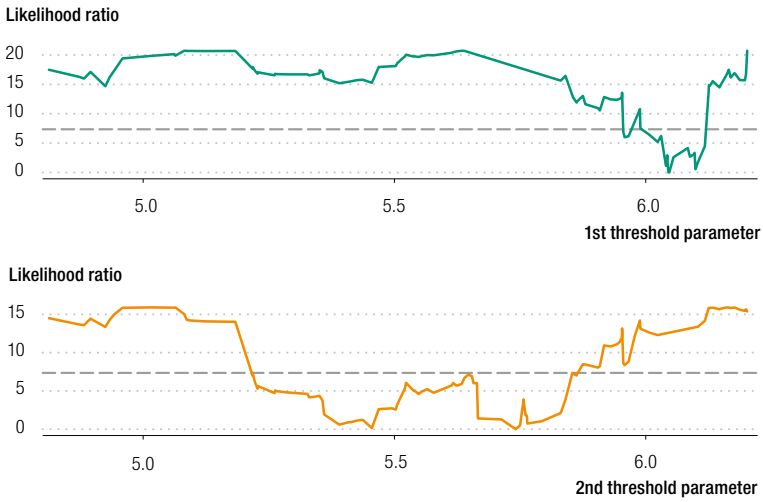


Source: Authors' estimations.

Phased test of IWO

According to the estimated results of the threshold effect of *IWO* in figure 3, the corresponding likelihood ratio value of *IWO*'s threshold estimate is significantly smaller than the critical value of 7.35. Therefore, we believe that the obtained threshold estimate is true and valid. The results in table 6 show that the impact of *IWO* on innovation performance shows two obvious stages, which can be regarded as the window opening and then further expanding. Outward knowledge sourcing is promoted by the Chinese Government's "go global" strategy, which opened the window for learning advanced technology through outbound investment. This policy orientation enhanced outward knowledge seeking, stimulating further innovation. Innovation activities gaining momentum with continued implementation of OFDI incentives explains the second stage of further opening-up of the institutional window for outward knowledge sourcing, which is the same as *IWI*. This indicates that with the increase in outward knowledge sourcing, the trend is for the institutional window to open further rather than closing. China promotes OFDI in formulating various institutional incentives (e.g. reformations of the foreign exchange management system and the administrative approval system, the launch of the Belt and Road Initiative), to maintain the positive effect on advanced technological knowledge-seeking for innovation. Therefore, H2 is accepted for the existence of the outward institutional window because of the positive effect on outward knowledge sourcing for innovation.

Figure 3. Likelihood ratio for institutional window for outward FDI (IWO)



Source: Authors' estimation.

Table 6. Threshold model estimates of two phrases of IWO

Policy WO inward		Policy WO outward	
LnIWI ($\gamma \leq 5.745$)	0.050 (0.042)	LnIWO ($\gamma \leq 5.741$)	-0.008 (0.018)
LnIWI ($5.745 < \gamma \leq 5.853$)	0.142*** (0.043)	LnIWO ($5.741 < \gamma \leq 6.047$)	0.039** (0.018)
LnIWI ($5.853 < \gamma$)	0.226*** (0.044)	LnIWO ($6.047 < \gamma$)	0.094*** (0.019)
lnsize	0.051 (0.050)	lnsize	0.333*** (0.060)
lnCapRD	0.051 (0.058)	lnCapRD	-0.071 (0.067)
lnlinno	0.043 (0.033)	lnlinno	-0.039 (0.035)
Constant	3.140*** (0.415)	Constant	2.498*** (0.463)
Number of observations	927	Number of observations	912
R-squared	0.128	R-squared	0.161

Source: Authors' estimations.
Note: *** $p < 0.01$, ** $p < 0.05$.

6.2.3 Measure of window of opportunity

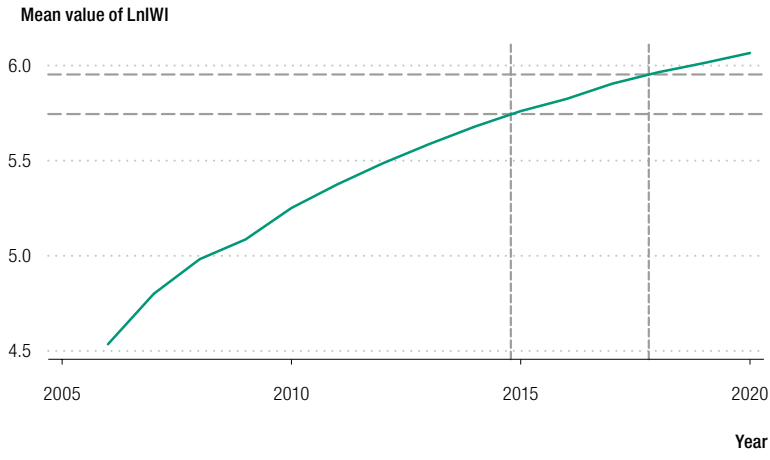
In order to identify the window periods, we obtain the mean value of *lnIWI* and *lnIWO* in each year (table 7). By comparing them with the threshold value of the threshold regression model, we can determine the years of the corresponding windows. For *IWI*, the window opened for the first time in 2014 and was further opened in 2016 (figure 4). For *IWO*, the window period also opened for the first time in 2014 and was opened further after 2018 (figure 5). This explains that not all policies can form institutional windows of opportunity for purposes of innovation. The window creates a promotional effect on knowledge sourcing for innovation in a specific time period. The possible reason for the further opening-up stage of *IWO* being later than that of *IWI* is that in the early stage of international expansion, Chinese MNEs mainly sought niche markets rather than more advanced technology. Therefore, H1 and H2 are also accepted for the existence of effective timing of windows of opportunity.

Table 7. Mean values of LnIWI and LnIWO

Year	LnIWI	LnIWO
2006	4.535	4.196
2007	4.801	4.342
2008	4.982	4.616
2009	5.086	4.727
2010	5.251	5.026
2011	5.375	5.227
2012	5.487	5.364
2013	5.587	5.52
2014	**5.679**	**5.66**
2015	5.761	5.77
2016	**5.825**	5.872
2017	5.905	5.989
2018	5.965	**6.073**
2019	6.013	6.144
2020	6.066	6.217

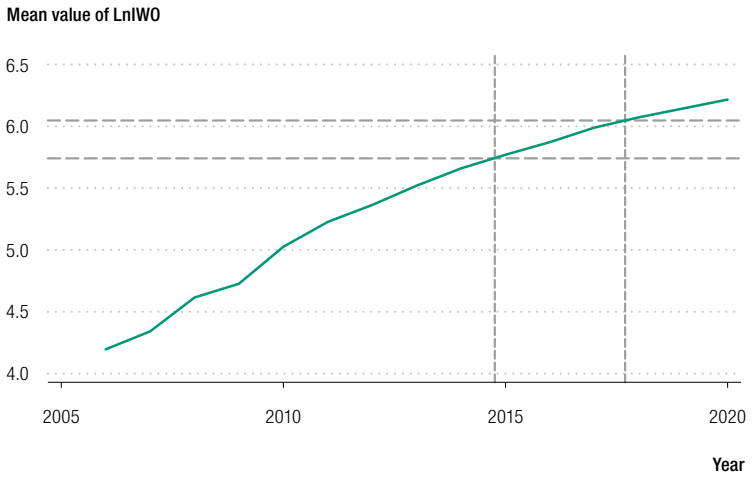
Source: Authors' estimations.

Figure 4. Policy window of opportunity for inward FDI



Source: Authors' estimations.

Figure 5. Policy window of opportunity for outward FDI



Source: Authors' estimations.

6.2.4 Heterogeneity analysis of firm's ownership structure

We further analyse the heterogeneity of enterprise ownership, trying to explore the different performances and characteristics of the threshold effect of the innovation performance of SOEs and private enterprises under institutional incentives.

Heterogeneity of firm ownership on IWI

The threshold effect test shows opposite results (table 8): SOEs failed to pass the double threshold test, and private enterprises passed it.

Table 8. Threshold effect test

Threshold variable	Threshold	F-statistic	Probability	Crit10	Crit5	Crit1
LnIWI (SOE)	Single	11.470	0.000	5.273	6.006	7.218
	Double	2.960	0.317	4.699	5.673	6.558
LnIWI (Private)	Single	23.570	0.000	7.702	9.942	13.351
	Double	10.530	0.027	7.086	8.513	12.559

Source: Authors' estimations.

According to the regression results in table 9, we can infer that for enterprises with different ownership, the threshold effect brought by policy incentives is similar and obvious. For SOEs, there is mainly one threshold in the inward policy window, and the threshold coefficient shows a significant impact on the promotion of inward knowledge sourcing on innovation performance. Private enterprises have experienced two policy thresholds, and the increase in the coefficient of the influence variable is relatively stable and phased. In general, after crossing the threshold, the threshold coefficient of SOEs is slightly higher than that of private enterprises.

Table 9. Heterogeneity of ownership in IWI

Variable	State-owned enterprise	Private enterprise
lnsize	0.199* (0.118)	-0.015 (0.056)
lnCapRD	0.082 (0.083)	-0.127 (0.089)
lninno	-0.070 (0.055)	0.121*** (0.041)
lnIKS ($\gamma \leq 5.76$)	0.170 (0.115)	0.006 (0.044)
lnIKS ($5.76 < \gamma \leq 6.047$)	0.295*** (0.112)	0.136*** (0.047)
lnIKS ($6.047 < \gamma$)	-	0.257*** (0.049)
Constant	1.867** (0.821)	3.938*** (0.514)
Number of observations	406	508
R-squared	0.123	0.200

Source: Authors' estimations.
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Heterogeneity of firm ownership on IWO

SOEs and private enterprises failed to pass the significance test of 5 per cent in the double threshold test, so we chose to return to a single threshold for these two models (table 10).

Table 10. Threshold effect test

Threshold variable	Threshold	F-statistic	Probability	Crit10	Crit5	Crit1
lnIWO (SOE)	Single	7.540	0.027	5.030	5.904	8.512
	Double	5.410	0.063	5.029	5.712	7.262
lnIWO (Private)	Single	22.130	0.000	5.654	7.089	8.736
	Double	4.970	0.073	4.592	5.260	7.154

Source: Authors' estimations.

As shown in the results in table 11, outward knowledge sourcing has no significant effect on innovation performance before OFDI, reaching the threshold value as it fails. After passing the threshold value, outward knowledge sourcing improves significantly in the promotion of innovation performance, in SOEs and private enterprises.

Table 11. Heterogeneity of ownership on IWO

Variable	State-owned enterprise	Private enterprise
lnsize	0.274** (0.112)	0.370*** (0.072)
lnCapRD	0.142 (0.096)	-0.029 (0.082)
lninno	-0.148** (0.066)	0.041 (0.054)
lnOKS ($\gamma \leq 5.634$)	0.0278 (0.023)	-0.019 (0.024)
lnOKS ($5.634 < \gamma$)	0.095*** (0.027)	0.107*** (0.025)
Constant	2.663*** (0.821)	2.034*** (0.564)
Number of observations	368	351
R-squared	0.135	0.299

Source: Authors' estimations.
Note: *** $p < 0.01$, ** $p < 0.05$.

6.3 Estimation of variations of two windows in knowledge sourcing process

6.3.1 Inward knowledge sourcing

As can be seen in table 12, *IKS* is significant in one-term regression and passes the significance test at the 1 per cent level. The coefficient of the quadratic term of *IKS* is significantly negative and different from the first-order term, which meets part of the conditions of the inverted U-shaped relationship.

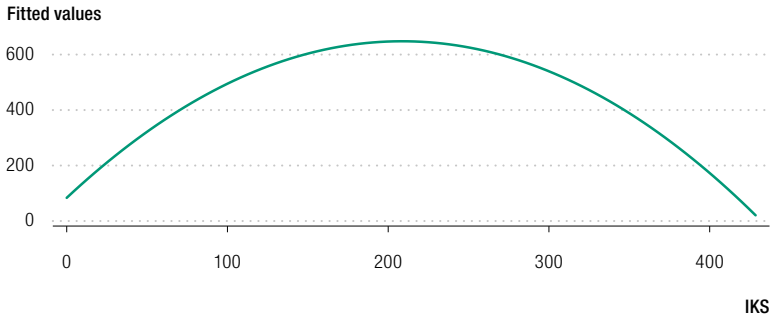
The three-step method proposed by Lind and Mehlum (2010) is used to test the data range, whether the slope at both ends of the data is steep enough and the relationship between its upper and lower bounds through a U-test (table 12). Figure 6 shows the regression curve, from which it can be preliminarily judged that the inverted U-shaped relationship is established. The result well explains the spillover effects and crowding-out effect of inward knowledge sourcing for innovation.

Table 12. Estimation of change of IKS

Variable	(1)	(2)
IKS	4.167*** (0.698)	9.370*** (1.375)
IKS2		-0.017*** (0.004)
Constant	45.460 (81.690)	-198.800** (98.670)
Number of observations	1 469	1 469

Source: Authors' estimations.
Note: *** p < 0.01, ** p < 0.05.

Figure 6. Regression of change of inward knowledge sourcing (IKS)



Source: Authors' estimations.

6.3.2 Outward knowledge sourcing

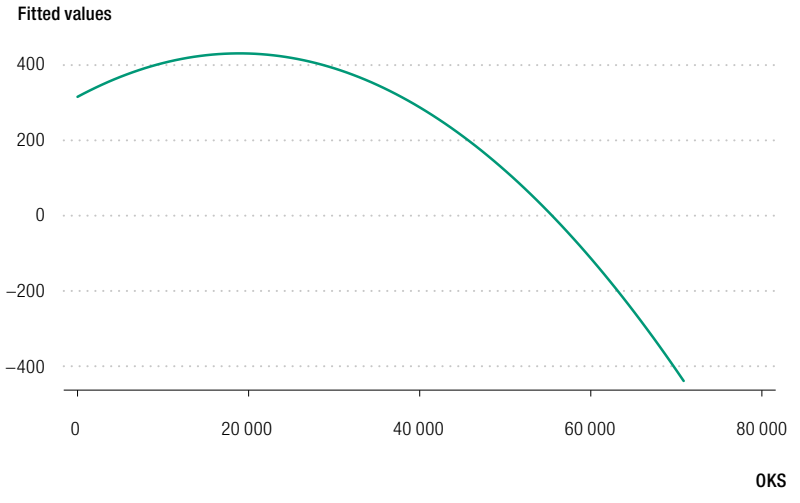
It can be seen in table 13 that *OKS* fails to pass the significance test in a regression but still shows an inverted U-shape (figure 7). The possible reason is that technology innovation by EMNEs improves only when reverse technology spillovers occur through outward knowledge sourcing. M&As, as one approach for outward knowledge sourcing, can be driven not only by the desire to acquire advanced technology, but also by the opportunity to produce for niche markets, reducing the emphasis on technological innovation. Therefore, H3 is partly accepted.

Table 13. Estimation of change of OKS

Variable	(1)	(2)
OKS	0.001 (0.006)	0.011 (0.013)
OKS2		0.000 0.000
Constant	308.300*** (54.500)	299.800*** (55.300)
Number of observations	1 355	1 355

Source: Authors' estimations.
Note: *** $p < 0.01$.

Figure 7. Regression of change of outward knowledge sourcing (OKS)



Source: Authors' estimations.

6.4 Moderating effect test

We use indigenous innovation as a moderator variable to test the influence mechanism of indigenous innovation when policy incentives affect innovation performance. The interaction terms *lnlinnoiwi* and *lnlinnoiwo* of *IINNO*, *IWI* and *IWO* are generated and used as threshold variables to establish the moderating effect for inward and outward knowledge sourcing. As shown in table 14, *IWI* with indigenous innovation is suitable for double-threshold regression, whereas *IWO* with indigenous innovation fails to pass the threshold regression. The possible reason is that the main purpose of *IWI* for knowledge sourcing is to take advantage of knowledge spillovers. To reduce the crowding-out effect of FDI, promotion of indigenous innovation is a key solution.

Table 14. Threshold effect test

Threshold variable	Threshold	F-statistic	Probability	Crit10	Crit5	Crit1
lnlinnolWI	Single	10.370	0.070	9.430	11.256	14.384
	Double	9.590	0.090	9.086	10.915	12.842
lnlinnolWO	Single	6.530	0.270	8.991	10.893	16.161
	Double	7.010	0.237	9.152	10.700	13.450

Source: Authors' estimations.

The results in table 15 show that when the moderating variable (enterprise R&D investment) is at different levels, the impact of inward policy incentives on enterprise innovation performance differs significantly. The R&D investment of enterprises first promotes the main regression, and the promotion effect weakens after the R&D investment increases to a certain level. When R&D investment continues to increase, the promotion effect appears again but its degree is reduced. Subsidies help loosen financial constraints, thereby boosting firms' ability to appropriate new external technologies. The Government incentives contributed to rises in R&D investment for promoting indigenous innovation in general. However, the weakened effect trend implies that the subsidies support raises the issue of "picking the winners", i.e. the Government has chosen to subsidize enterprises that have strong innovation capabilities rather than to promote innovation.

H4 is accepted because of the enhancement of the policy effect of *IKS* on innovation.

Table 15. Moderating effect of R&D investment for innovation performance

Policy WO Inward	
lnlinnolWI ($\gamma \leq 28.7114$)	0.1220*** (0.0461)
lnlinnolWI ($28.7114 < \gamma \leq 34.7231$)	0.0256 (0.0427)
lnlinnolWI ($34.7231 < \gamma$)	0.1070** (0.0485)
lnsize	0.1830*** (0.0591)
lnCapRD	0.1470** (0.0640)
LnIWI	0.7340*** (0.1260)
Constant	-1.4920*** (0.5760)
Number of observations	733
R-squared	0.195

Source: Authors' estimations.
Note: *** $p < 0.01$, ** $p < 0.05$.

6.5 Robustness

6.5.1 Robustness test of lagged treatment

In order to avoid the influence of the endogeneity of the model on the empirical results, all explanatory variables are lagged one, two and three periods. The results show that the two models with *IWI* and *IWO* as threshold variables maintain the same number of thresholds, which is a double threshold.

For *IWI*, the significance of the threshold variable remains highly consistent, indicating that the previous results are robust. Moreover, in the three intervals separated by the threshold variable, the threshold coefficient is the same as that without lag, showing an upward trend. For *IWO*, the significance of the threshold variable is not consistent, but it is relatively stable in general. To sum up, we can judge that the overall threshold regression has a certain robustness.

6.5.2 Robustness test of the U-shaped relationship

In order to prevent the possibility of some extreme observations leading to results more directly, we adopted the practices of some scholars (Barnett and Salomon, 2006; McCann and Vroom, 2010; Souder et al., 2012), excluding some outliers from the sample and re-estimating the model, and found that the main results were still the same. For the U-shaped relationship between *IKS* and enterprise innovation performance that has been preliminarily verified, we add a cubic term to the equation to test whether this relationship may be S-shaped rather than U-shaped. The result shows that a cubic term does not improve the fitting of the model, and the reliability of the quadratic relationship is further verified.

7. Conclusion and policy implications

This study, based on quantitative analysis, deepens the comprehension of the role of IFDI and OFDI in the innovation of emerging-market enterprises through knowledge sourcing. Taking a different approach to measure the function of policy incentives as institutional windows of opportunities, we examine to what extent and in which cases Chinese digital companies' innovation performance is improved by sourcing knowledge through IFDI and OFDI.

The research results show that the impacts of inward and outward knowledge sourcing on innovation performance are significant. The two policy windows remained open and expanded further without any sign of closure, indicating that Chinese digital enterprises are encouraged to conduct international knowledge sourcing under consistent policy stimulations. For both FDI and OFDI, the advanced technology brought by knowledge sourcing continuously and effectively improves the innovation level of enterprises. On the one hand, in the digital industry, the acceleration in iteration of technology forces firms to continuously acquire knowledge, engage in learning and innovate to remain competitive. Attracting FDI as a means to acquire technologies is still one of the core policies for stimulating knowledge-sourcing channels. On the other hand, OFDI creates reverse knowledge spillovers to emerging markets, which diversifies knowledge-sourcing channels for bringing innovation to the next level.

For inward sourcing, the window opened for the first time in 2014 and again in 2016. For outward sourcing, the window also opened for the first time in 2014 and then again after 2018. It is evident that the institutional windows of opportunity for knowledge sourcing and innovation are much prolonged. Notably, the effective time of the windows of opportunity, which both started in 2014, lags the release of the policies, possibly indicating that not all releases can become windows of opportunity, which can be formed only in triggering conditions. From 2014, Chinese firms seized on institutional windows of opportunity for technology

catch-up through intentional knowledge sourcing in the wave of digitalization. In addition, the results show that – unlike as argued in prior research – Chinese firms first relied on attracting FDI to bring in technology and then used OFDI to springboard, and that IFDI and OFDI jointly promoted the acquisition of external technologies.

From the threshold regression coefficient, we can see that enterprise innovation performance is more sensitive to inward policy incentives than outward ones. This may be because, compared with improving innovation performance, the innovation orientation of outward policy incentives is weak where enterprises use investment to carry out non-innovation activities such as marketing. At the same time, outward knowledge sourcing of Chinese MNEs often has higher operating costs than that of domestic enterprises. A fairer and more convenient overseas business environment and unimpeded international trade channels will help improve innovation performance. It is important for government policymaking to deepen economic and trade cooperation with overseas countries, especially developed countries and countries with key technologies, promoting multi-country investments for scale (UNCTAD, 2017).

In the heterogeneity analysis, we find that for enterprises of different ownership, the threshold effect brought by policy incentives is evident. At the knowledge-sourcing level, SOEs and private firms perform similarly at home and abroad. It is worth noting that for bringing-in policy incentives, the innovation performance of SOEs has a relatively significant positive relationship with enterprise size, while the relationship with R&D investment is weak. In contrast, the expansion of enterprise scale does not improve innovation performance but had an observable positive relationship with R&D investment. As for "go global" policy incentives, for private enterprises, scale becomes a decisive factor, and the relationship between R&D investment and innovation performance is not significant. For SOEs, in contrast, R&D investment has a certain negative impact on innovation performance. To sum up, we believe that policy incentives should be adjusted according to enterprise ownership and the institutional environment.

In the U-test, there is a robust U-shaped relationship between *IKS* and innovation performance, but the U-shaped relationship between *OKS* and innovation performance is not significant. The diminishing effect of *IKS* for innovation indicates a crowding-out effect of foreign capital. Simply relying on a single direction of knowledge sourcing is insufficient for sustainable innovation. *OKS* occurs at the beginning of EMNEs' search for advanced technology search outside, which they expand through OFDI later on to develop indigenous innovation capability.

By adding the moderator, the process mechanism of knowledge sourcing is made much clearer. Under the stimulus of FDI incentives, R&D investment enhanced the positive effect of inward knowledge sourcing on firms' technology innovation.

The result explains the importance of in-house R&D in technology innovation. R&D investment reflects the willingness of firms to engage in indigenous innovation, which may further improve their absorptive capacity for knowledge sourcing.

To promote knowledge sourcing for innovation by EMNEs, we present the following insights:

(1) Active implementation of policy windows of opportunity for MNEs.

The internationalization of technology spillovers by MNEs has important implications for policymaking. UNCTAD (2005) stresses the need for coherent national policies to ensure greater benefits from this evolution. With the acceleration of economic development and globalization, China has been actively integrating into the global economy. It has put forward the strategy of the bringing-in window to encourage foreign enterprises to invest in Chinese enterprises and trade for advanced technology for innovation. The "trading market for technology" strategy attracted foreign capital, but the real effect of inward knowledge sourcing on technological innovation appeared much later, after the policy launched. This indicates that a bringing-in window opened in preparation for building up the absorptive capacity of domestic enterprises and expanding technology spillovers in the early stage, thereby generating an agglomeration effect that attracts more inflows of technology and knowledge. The MLP promulgates policies, laws and legislation to sustain the capability-building of domestic firms, so that they can better utilize foreign technology develop their core technologies. These policies create new industrial clusters and market segments and attract more competitive foreign investment, leading to an agglomeration effect of foreign investment.

The "going global" window brought opportunities for Chinese firms to not only integrate into the international market and achieve economies of scale, but also narrow the gap with technologically developed enterprises. Moreover, their OFDI has indeed brought about better innovation.

(2) Seizing the policy windows for knowledge sourcing and innovation

Responding to the institutional window by utilizing the favourable policies allows EMNEs to acquire knowledge for innovation. Through a series of policy arrangements, strategic knowledge seeking can be activated. The construction of innovative institutional mechanisms can adapt to or promote technological progress, e.g. launching targeted policies. The launching of policies is not the start of an opportunity window; only when firms engage in knowledge-sourcing activities can the window take effect. The incentives of policies play a complementary role in promoting innovation. In other words, the opening of the opportunity window does not necessarily lead to the realization of innovation, but depends on firms actively taking advantage of the window.

In the process of sourcing knowledge, identifying and seizing a potential opportunity window is the key to promoting technology innovation. The identification of the window itself is highly competitive; that is, only if latecomers anticipate the existence of an opportunity window earlier than their competition can they capture the value of opportunity. In other words, identifying policy windows depends not only on attributes of the window, but also on subjective judgement of innovation capability (or knowledge absorptive capacity) and selection of knowledge-sourcing modes. In building a deeply integrated national open innovation system, the Government should adapt measures to expand the width of such windows.

(3) Strengthening internal R&D investment to make policy incentives more effective for knowledge sourcing

Both the Government and enterprises should increase their financial investment in R&D to encourage indigenous innovation. R&D investment has a positive effect on promoting technological innovation under strong policy guidelines. In the process of sourcing knowledge from developed countries, R&D investment intensity enables policies to trigger knowledge seeking more effectively. This may bring more opportunities for EMNEs seeking more advanced technology. However, government support for R&D expenses of enterprises can have drawbacks. The possibility of "picking the winners" lowers the technology catch-up effect of incentives and makes enterprises take advantage of loopholes such as rent-seeking behaviour, or cheating subsidies through a large number of low-quality innovations. Therefore, governments should implement dynamic adjustments to the selection criteria for R&D-subsidized firms according to their knowledge-seeking motives, enabling accurately targeted incentives under the policy window, and take relevant measures to fundamentally improve indigenous innovation ability by supporting domestic enterprise development in the digital economy, by improving facilitation of innovative financing approaches (UNCTAD, 2017). In addition, because of current international competition tensions in technology, the effectiveness of government support for international knowledge sourcing is affected by the external market, in the digital innovation ecosystem in particular. Thus, the policy incentives for international knowledge sourcing are weakened, which requires enhancing support for investment in indigenous innovation.

(4) The design of future incentive policies for developing countries

Future policies could follow these three rules: first, for a sustainable window effect, policy tools should co-evolve with the country's science and technology strategies, balanced between international business and innovation. Second, to make sure firms see and seize opportunity windows, governments should combine the use of top-down initiatives and reward incentives. Third, policymakers should consider the heterogeneity between the target audiences of new policies, which can be pertinent for the internationalization of SOEs and private enterprises, respectively.

As a final observation, and recognizing that one of the limitations of this study is that it has not fully incorporated the implications of ongoing tensions in international technology competition, future research on policies supporting technological development in the current innovation ecosystem will have to consider the external influence on knowledge sourcing brought about by changes in laws on foreign investment in technology sectors and in digital competition, particularly in developed countries.

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Do human capital and institutional environment constrain the impact of foreign direct investment flows on economic growth in Africa?*

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Abstract

This paper investigates the role of human capital and institutional quality in the nexus of foreign direct investment (FDI) and economic growth in 46 African countries between 2002 and 2018. Based on panel data modelling, the empirical findings suggest that FDI in itself does not promote economic growth in Africa; however, we observe that human capital and institutional quality play a supportive role in enhancing the positive spillover effect of FDI on economic growth in upper-middle-income countries in the region. The findings for low-income and lower-middle-income countries are mostly not significant. Given the initial conditions and absorptive capacity constraints in these countries, the positive spillover effects of FDI might be limited. From a policy perspective, the findings call for special attention by policymakers to improving the quality of their human capital and strengthening their institutions to maximize the benefits of FDI.

Keywords: Africa, economic growth, foreign direct investment inflows, human capital, institutions

JEL classification codes: F21, F43, J24, O43, O55

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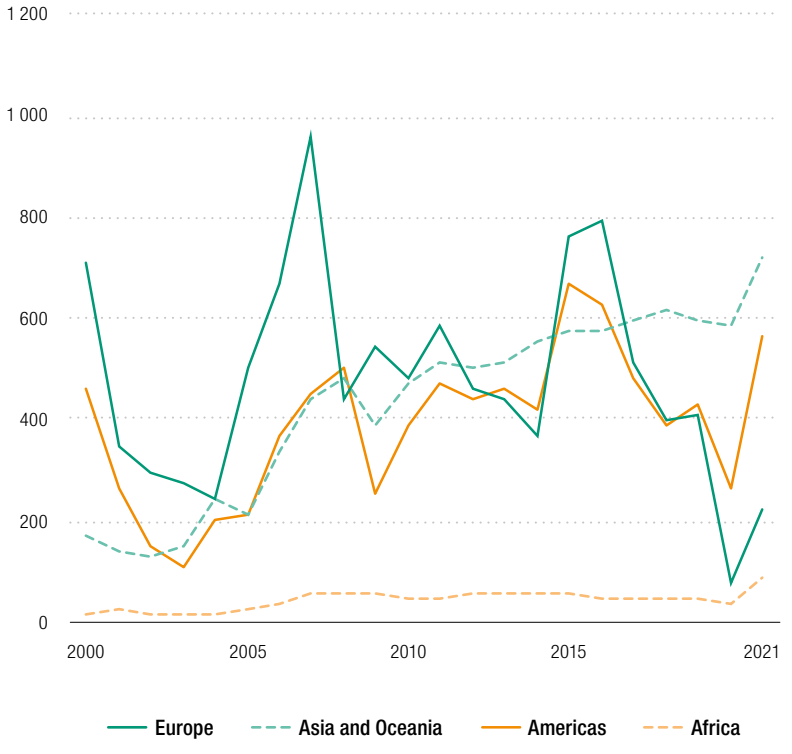
1. Introduction

Foreign direct investment (FDI) plays a critical role in growth in developing countries. It is a source of employment generation, skill acquisition and transfer of technology know-how, and new export potential (Borensztein et al., 1998; Iamsiraroj, 2016; Li and Liu, 2005). Since attracting FDI can contribute to economic growth, developing economies provide various forms of incentives to attract and increase FDI (Alvarado et al., 2017).

Policymakers in African countries, as in other emerging economies, promote FDI attraction through targeted policies. Despite considerable efforts to attract FDI, records show that FDI flows to Africa, compared with other regions, remain low (figure 1).

Figure 1. Foreign direct investment inflows by region, 2000–2021

(Billions of dollars)



Source: UNCTAD (2022).

Despite the theoretical prescriptions of the positive spillover effect of FDI to host countries, empirical findings at both the micro and macro levels show mixed outcomes. Whereas some studies have found a positive association between FDI and economic growth (e.g. Bekere and Bersisa, 2018; Dinh et al., 2019), others have found a negative or insignificant relationship between FDI and economic growth (e.g. Akinlo, 2004; Ehigiamusoe and Lean, 2019). Studies on the FDI-growth nexus suggest that the mixed findings are attributable to certain characteristics and conditions of the host nations, including the quality of institutions (e.g. Brahim and Rachdi, 2014; Mullings, 2018; Slesman et al., 2015), good governance (e.g. Raza et al., 2019), and human capital development (e.g. Anetor, 2020; Völlmecke et al., 2016), financial development (e.g. Yeboua, 2019).

This study explores the role of institutions and human capital in the FDI-growth nexus in the context of Africa. It aims to examine whether the impact of FDI on economic growth is determined by the quality of institutions and human capital of the host economy. Quality institutions are built to promote equity and fairness in the distribution of resources. Institutions, according to North (1991), are the underlying determinants of economic performance. In the context of his study, institutions are concerned with formal institutions because they are easy to identify, operationalize, analyse and evaluate (Bentkowska, 2021). Human capital, in contrast, is the set of intangible resources embedded in the workforce of a country (Goldin, 2016). Recent studies also suggest that the positive spillover of FDI is contingent on the absorptive capacity of the recipient country. This implies that the growth benefits of FDI in Africa are conditioned on the degree to which the human capital can adopt and implement the technologies made available through FDI (Anetor, 2020).

Studies on the role of institutions in the FDI-growth nexus exist (e.g. Adams and Opoku, 2015; Asamoah et al., 2019). Similarly, some researchers have explored the role of human capital in the relationship between FDI and growth (e.g. Su and Liu, 2016). However, to the best of our knowledge, there are no studies that simultaneously investigate the moderating roles of both institutions and human capital in the FDI-growth nexus in Africa. This study aims to determine whether the economic growth effect of FDI is conditioned on institutions and human capital in 46 African countries, at various income levels.

The rest of the paper is organized as follows: Section 2 presents the literature review. Section 3 presents the model specification. Section 4 describes the data and methodology of the study. Section 5 discusses the empirical findings. Section 6 presents the conclusions and policy implications, as well as some limitations of the study.

2. Literature review and hypotheses

The economic activities contributing to long-term growth have been explained by theories ranging from neoclassical, new growth to endogenous growth theories. Research shows support for the premise that FDI is a driver of economic growth (Bekere and Bersisa, 2018; Dinh et al., 2019; Iamsiraroj and Ulubaşoğlu, 2015), but the literature is not conclusive. FDI intuitively provides the platform through which technological know-how is transferred from developed to developing countries. According to Kinoshita (1998) and Sjöholm (1999), the technological spillover effect of FDI on the economy passes through four major channels: imitation, competition, linkages and training. Hermes and Lensink (2003), however, found that the technology spillover of FDI depends on the absorptive capacity of the recipient country. In other words, the technology spillover of FDI is only possible when human capital in the host country is available and receptive.

According to the institutional FDI fitness theory (Williams and Witter, 1998), the extent to which FDI flows into a host nation largely depends on its institutional idiosyncrasies, policies and their effective implementation capacity. This implies that countries with a strong institutional framework tend to attract more FDI than countries with weak institutions.

This study follows the neoclassical growth models and FDI institutional fitness theory to investigate the moderating roles of human capital and institutional characteristics in attracting FDI. The neoclassical theory assumption of exogenous technical know-how provides a strong basis for the relevance of FDI in galvanizing greater output and productivity of a nation, and the institutional FDI fitness theory argues for the relevance of institutional sagacity, governance and policy implementation capacity.

Empirical studies on the role of institutions in the relationship between FDI and economic growth also exist (e.g. Agbloyor et al., 2016; Asamoah et al., 2019; Brahim and Rachdi, 2014; Hayat, 2019; Shittu et al., 2020; Slesman et al., 2015). Employing panel smooth transition regression modeling, Brahim and Rachdi (2014) studied the FDI–economic growth nexus in 19 countries of the Middle East and North Africa from 1984 to 2011 and confirmed that the influence of FDI on economic growth is contingent on institutional development. Hayat (2019) employed the GMM (generalized method of moments) estimation method for panel data on 104 countries, which comprises low-income, lower-middle-income and upper-middle-income countries, to evaluate the impact of institutional quality in the FDI–growth nexus between 1996 and 2015. The study found that both FDI and institutional quality enhance stronger economic growth in low- and lower-middle-income countries. Shittu et al. (2020) investigated the relationship between FDI, globalization, political governance and economic growth in West Africa between 1996 and 2016 using the autoregressive distributed lag model. The study found that political governance stimulates a positive impact of

FDI on economic growth in a region. Slesman et al. (2015) used panel data on 80 countries, comprising advanced, emerging and developing countries, between 1975 and 2005 to ascertain whether the relationship between FDI and economic growth is conditioned on the quality of institutions in the host country. The study showed that FDI influences growth positively only in those countries with high-quality institutions.

In contrast, Agbloyor et al. (2016) employed GMM with Weidmeijer corrected standard errors and orthogonal deviations to investigate the role of institutions in the relationship between FDI and economic growth in sub-Saharan African countries between 1996 and 2010. The study found no evidence that the quality of institutions enhances the positive impact of FDI on economic growth. In the same vein, Asamoah et al. (2019) studied the role of institutions in the relationship between trade openness, FDI and economic growth in 34 countries in sub-Saharan Africa between 1996 and 2016 using the structural equation modelling estimation technique. The study found no significant effect of institutional quality on FDI, as the effect of FDI increases monotonically without institutions.

Despite the mixed evidence on the role of institutions in the FDI–growth nexus, in light of the FDI institutional fitness theory, which predicts that institutions enhance the effect of FDI in bringing about growth, we test the following alternative hypothesis:

Hypothesis 1: The impact of FDI on economic growth is conditioned on the institutional quality of the host country.

Some studies argue that the effect of FDI on economic growth is conditioned on the human capital of the host economy (Agbola, 2013; Anetor, 2020; Li and Tanna, 2019; Su and Liu, 2016). They concluded that FDI by itself cannot translate into growth, but that economic growth can only be achieved when FDI interacts with the knowledgeable human capital of the host country. Su and Liu (2016) used panel data from 230 cities in China from 1991 to 2010 to determine whether human capital plays a significant role in the relationship between FDI and economic growth. The study noted that the interactive effect of FDI and human capital on economic growth is positive. Anetor (2020) used the system GMM to study the moderating role of human capital in the FDI–growth nexus in 28 sub-Saharan African countries from 1999 to 2017 and found that the human capital plays a complementary role with FDI in propelling economic growth.

Li and Tanna (2019) used panel data for 51 low- and lower-middle-income countries between 1984 and 2010 to investigate the link between FDI and total factor productivity growth. The study, which applied the system GMM technique of estimation, found that the impact of FDI on productivity growth depends on absorptive capacities. Agbola (2013) examined the Ghanaian economy between 1965 and 2008 to determine whether the impact of FDI on economic growth is contingent on human capital. Employing the fully modified ordinary least squares technique, the study found that human capital enhances the impact of FDI on economic growth.

Contrary to other studies, Gui-Diby (2014) found that the lack of human resources did not constrain the positive impact of FDI on economic growth, using system GMM panel data modelling to study the FDI-–nexus in 50 countries in Africa during 1980–2009. Adefabi (2011) investigated the relationship between FDI, human capital and growth in 24 sub-Saharan African countries between 1970 and 2006 using the fixed effects model. The study found a weak complementarity effect of FDI and human capital on economic growth; hence, Adefabi concluded that the positive spillover effect of FDI on growth does not depend on human capital.

Despite the somewhat mixed empirical evidence, this paper tests the hypothesis based on the related literature that human capital plays an important role in the materialization of the positive spillover effect of FDI on economic growth:

Hypothesis 2: The relationship between FDI and economic growth is conditioned on the quality of human capital in the host country.

3. Model specification

Following the theoretical review, the study specifies two econometric models, each aimed at addressing each of the hypotheses. Model 1, which specifies that the impact of FDI on economic growth is conditioned on the institutional quality of the host country, can be expressed as follows:

$$GDPPCG_{it} = \gamma + \theta FDI_{it} + \lambda(FDI_{it} * INS_{it}) + \alpha INS_{it} + \sum_{j=1}^{n} \Phi_j X_{it} + \mu_{it} \quad (1)$$

Where:

$GDPPCG_{it}$ = growth rate of gross domestic product (GDP) per capita.

FDI_{it} = FDI net inflows measured as a percentage of GDP.

INS_{it} = institutions and is measured by six governance indicators: voice and accountability (*VOA*), political stability (*POS*), government effectiveness (*GOE*), regulatory quality (*REQ*), rule of law (*RUL*) and control of corruption (*COC*).

$FDI_{it} * INS_{it}$ = interaction of FDI with institutional variables. If $\lambda > 0$, it denotes that FDI and institutions are complementary; if $\alpha < 0$, it implies that FDI and institutions are substitutes, indicating that the relationship between FDI and economic growth is not conditioned on the institutional quality of the host country.

X_{it} = vector of control variables comprising trade openness (*TOP*), government expenditure (*GXP*), inflation (*INF*), population growth (*PGR*), gross capital formation (*GCF*) and foreign exchange rate (*FEX*).

μ_{it} = stochastic term.

i = country.

t = year.

Hypothesis 2 proposes that the impact of FDI on economic growth is conditioned on the human capital of the host country. As a result, the study specifies the following model:

$$GDPPCG_{it} = \theta + \beta FDI_{it} + \alpha(FDI_{it} * HCP_{it}) + \lambda HCP_{it} + \sum_{j=1}^{n} \Phi_j X_{it} + \mu_{it} \quad (2)$$

Where:

$GDPPCG_{it}$ = growth rate of gross domestic product (GDP) per capita.

FDI_{it} = FDI net inflows measured as a percentage of GDP.

HCP_{it} = human capital and it is proxy by secondary school enrolment (*SSE*), measured as percentage ratio of the people who enrolled for secondary education to the gross enrolment; and government expenditure on education as a percentage of GDP (*GXE*).

$FDI_{it} * HCP_{it}$ = the interaction of FDI with human capital. If $\alpha > 0$, it indicates that the marginal effect of human capital on FDI exerts a positive impact on economic growth. If $\alpha < 0$, it suggests that the marginal effect of human capital on FDI does not seem to exert a positive impact on economic growth.

X_{it} = vector of control variables comprising trade openness (*TOP*), government expenditure (*GXP*), inflation (*INF*), population growth (*PGR*), gross capital formation (*GCF*) and foreign exchange rate (*FEX*).

μ_{it} = stochastic term.

i = country.

t = year.

4. Data and methodology

The study used panel data from 46 African countries between 2002 and 2018 and analysed the countries based on income level by adopting the World Bank's classifications of low-income, lower-middle-income and upper-middle-income. The classification includes 19 low-income countries, 21 lower-middle-income countries and 6 upper-middle-income countries (appendix table 1). The choice of countries selected is majorly constrained by data availability. The sources of the variables used for the study as well as their measurement are reported in appendix table 2.

The estimation technique adopted in this study is the fixed effect (FE) model because the Hausman test, which indicates whether the fixed or random effect model is more suitable, indicates that the FE model is the appropriate one to deploy for the study. A major advantage of the FE model is that it allows us to control for all time-invariant omitted variables.

5. Empirical results and discussion

Table 1 presents the summary statistics of low-income countries, lower-middle-income countries and upper-middle-income countries in Africa. The descriptive statistics show that the mean score of the growth rate of GDP per capita (*GDPPCG*) in low-income countries was 2.20 percent, whereas the average score in lower-middle-income countries and upper-income countries were 2.10 per cent and 1.83 per cent, respectively, between 2002 and 2018. The average score for voice and accountability (*VOA*) is -0.77, -0.46 and -0.05 for low-income, lower-middle-income and upper-middle-income countries respectively. This suggests that the degree of freedom of expression in Africa is very low and that this is more pronounced in low-income countries.

The mean score for political stability (*POS*) is -0.86 and -0.49 for low-income and lower-middle-income countries, respectively. However, the average score in upper-middle-income countries exhibits a positive value of 0.46, indicating that the political atmosphere is relatively stable. The average score of government effectiveness (*GOE*) is -0.97, -0.64 and -0.06 for low-income, lower-middle-income and upper-middle-income, respectively. The negative mean scores are an indication that the quality of public service, as well as the quality of the institutional framework, is low.

Regulatory quality (*REQ*), which indicates the ability of policymakers to formulate and execute sound economic policies that will engender development of the private sector, is weak: the mean scores are -0.80, -0.65 and -0.01 for low-income, lower-middle-income and upper-middle-income countries, respectively. Rule of law (*RUL*) records an average score of -0.85, -0.64 and -0.07 for low-income, lower-middle-income and upper-middle-income countries, respectively. This suggests that the extent to which the Constitution is considered supreme above all, including government officials, is low. Control of corruption (*COC*), which reflects the ability of the government to fight the use of government funds for private gains, exhibits negative mean scores of -0.81, -0.58 and 0.10 across all countries.

The mean score for secondary school enrolment (*SSE*) is 25.75, 46.44 and 56.61 percent for low-income, lower-middle-income and upper-middle-income countries, respectively. The average score for government expenditure on education as a percentage of GDP (*GXE*) is 12.64, 12.66 and 17.19 for low-income, lower-middle-income and upper-middle-income countries, respectively. These results imply that upper-middle-income countries have a higher level of human capital than low-income and lower-middle-income countries.

Table 1. Descriptive statistics

Variable	Low-income countries					Lower-middle-income countries					Upper-middle-income countries				
	Number of observations	Mean	Standard deviation	Minimum	Maximum	Number of observations	Mean	Standard deviation	Minimum	Maximum	Number of observations	Mean	Standard deviation	Minimum	Maximum
GDPPCG	323	2.200	5.120	-36.560	28.680	357	2.100	3.590	-18.490	18.070	102	1.83	5.72	-12.98	32.17
FDI	323	4.210	5.820	-4.850	46.490	357	4.070	6.230	-6.370	50.000	102	4.01	4.1	-4.02	27.76
Institutional variable (*INS*)															
VOA	323	-0.770	0.530	-1.840	0.340	357	-0.460	0.620	-1.670	1.000	102	-0.050	0.980	-2.000	0.940
POS	323	-0.860	0.810	-2.700	0.830	357	-0.490	0.720	-2.260	1.040	102	0.460	0.490	-0.520	1.200
GOE	323	-0.970	0.440	-1.850	0.270	357	-0.640	0.470	-1.780	0.640	102	-0.060	0.830	-1.700	1.060
REQ	323	-0.800	0.420	-1.860	0.250	357	-0.650	0.480	-2.240	0.340	102	-0.010	0.780	-1.560	1.130
RUL	323	-0.850	0.510	-1.820	0.150	357	-0.640	0.630	-1.850	1.080	102	-0.070	0.450	-0.940	0.730
COC	323	-0.810	0.430	-1.560	0.760	357	-0.580	0.530	-1.440	0.950	102	-0.100	0.860	-1.830	1.220
Human capital variable (*HCP*)															
SSE	323	25.750	16.260	0.000	61.850	357	46.440	26.470	0	99.61	102	56.610	40.020	0.000	109.440
GXE	323	4.030	4.000	0.000	17.670	357	10.750	10.360	0	51.37	102	11.530	12.690	0.000	40.600
Control variable															
TOP	323	57.810	24.660	0.000	138.900	357	68.460	34.830	0.000	165.650	102	90.520	26.420	0.000	144.670
GXP	323	12.640	4.850	0.000	28.680	357	12.660	7.460	0.000	41.890	102	17.190	5.690	0.000	28.010
INF	323	6.730	8.310	-27.790	63.290	357	6.560	9.120	-60.500	98.220	102	4.790	2.790	-1.410	12.700
PGR	323	2.790	0.610	0.260	4.630	357	2.210	0.840	-0.620	3.710	102	2.090	1.300	0.050	4.650
GCF	323	21.020	9.400	0.000	60.160	357	21.770	1.990	0.000	50.780	102	24.510	7.600	0.000	41.410
FEX	323	1 055.58	1 643.35	2.020	9 088.32	357	274.080	620.180	0.000	9 686.77	102	186.600	247.450	4.690	693.710

Source: Authors' estimations using data from World Bank (2021a).

5.1 Moderating role of institutions in the FDI–growth nexus in low-income countries

Table 2 depicts the regression results of the impact of FDI mediated by institutional variables on economic growth in low-income countries (LICs). Looking across the models, the sign of the coefficients of FDI are generally negative and non-significant, or negative and significant, which seems to indicate that FDI flows into LICs tend to have either a non-discernible or adverse effect on economic growth (e.g. Bekere and Bersisa, 2018; Dinh et al., 2019; Iamsiraroj and Ulubaşoğlu, 2015; Sunde; 2017; Zekarias, 2016). Nevertheless, the finding lends credence to studies that found that FDI does not enhance economic growth (Alvarado et al., 2017; Makiela and Ouattara, 2018; Sokhanvar, 2019). A plausible explanation for the outcome is that FDI flows to Africa – and especially LICs in Africa – are mostly resource-seeking; that is, motivated by the natural resource endowments of the host country to complement their operations (Makoni, 2019).

The coefficients for the interaction terms between FDI and GOE, RUL, and COC are negative and statistically significant. Although our findings differ from most previous studies (e.g. Brahim and Rachdi, 2014; Slesman et al., 2015), they are line with some others (e.g. Asamoah et al., 2019) showing that institutional quality does not play a significant role in enhancing the impact of FDI on economic growth.

The regression estimates of the control variables are also presented in the table. It is important to mention that the regression estimates of all the control variables are similar across all the models. The coefficients of trade openness (*TOP*) in columns 1–6 are positive and statistically significant, suggesting that the more LICs reduce the various forms of trade restrictions, the stronger the growth of the economy. The results also show that the coefficients of population growth variable (*PGR*), as reported in columns 1–6, are all positive and statistically significant at the 1 per cent level. Multinational corporations (*MNCs*) usually prefer countries with large population sizes as investment destinations, not just because of the potential demand for their goods and services, but because they offer an opportunity to access labour more easily.

Table 2. Moderating role of institutions in the FDI–economic growth nexus in low-income countries

Variable	Fixed effect					
	GDPPCG [1]	GDPPCG [2]	GDPPCG [3]	GDPPCG [4]	GDPPCG [5]	GDPPCG [6]
FDI	-0.05 (-0.50)	-0.03 (-0.40)	-0.32* (-1.74)	-0.09 (-0.56)	-0.36** (-2.03)	-0.32* (-1.87)
FDI*VOA	-0.06 (-0.49)	-	-	-	-	-
VOA	4.77*** (3.49)	-	-	-	-	-
FDI*POS	-	-0.03 (-0.50)	-	-	-	-
POS	-	0.87 (1.27)	-	-	-	-
FDI*GOE	-	-	-0.33* (-1.81)	-	-	-
GOE	-	-	1.24 (0.75)	-	-	-
FDI*REQ	-	-	-	-0.11 (-0.54)	-	-
REQ	-	-	-	1.12 (0.64)	-	-
FDI*RUL	-	-	-	-	-0.36** (-2.19)	-
RUL	-	-	-	-	-1.01 (-0.65)	-
FDI*COC	-	-	-	-	-	-0.34** (-1.96)
COC	-	-	-	-	-	0.56 (0.35)
TOP	0.05* (1.73)	0.06** (2.07)	0.05* (1.82)	0.55* (1.94)	0.06** (2.18)	0.05* (1.95)
GXP	-0.06 (-0.58)	0.01 (0.10)	0.03 (0.31)	0.01 (1.12)	-0.04 (-0.41)	0.01 (0.08)
INF	-0.06 (-1.43)	-0.05 (-1.23)	-0.05 (-1.28)	-0.05 (-1.18)	-0.05 (-1.15)	-0.05 (-1.31)
PGR	2.99*** (3.68)	3.52*** (4.30)	3.68*** (4.53)	3.64*** (4.50)	3.71*** (4.65)	3.64*** (4.50)
GCF	0.05 (1.12)	0.03 (0.68)	0.04 (0.81)	0.03 (0.69)	0.05 (1.03)	0.04 (0.85)
FEX	-0.001 (-1.34)	-0.0004 (-1.08)	-0.0004 (-0.95)	-0.0003 (-0.90)	-0.0004 (-1.02)	-0.0004 (-0.80)
Intercept	-4.64 (-1.43)	-10.20*** (-3.60)	-10.2*** (-3.1)	-10.30*** (-3.20)	-12.10*** (-3.90)	-10.70*** (-3.00)
R^2 within	0.144	0.113	0.118	0.110	0.127	0.120
R^2 between	0.053	0.024	0.006	0.011	0.001	0.013
R^2 overall	0.008	0.013	0.023	0.017	0.025	0.020
Number of observations	323	323	323	323	323	323

Source: Authors' estimations using data from World Bank (2021a and 2021b).
Note: ( ) represent t-statistics; *, **, ***, indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

5.2 Moderating role of institutions in the FDI–growth nexus in lower-middle-income countries

Table 3 shows the regression results of the impact of the interaction of FDI and institutional variables on economic growth in lower-middle-income countries (LMICs). The sign of all the coefficients of FDI are positive, but they are mainly not statistically significant, implying inconclusive evidence on the contribution of FDI to economic growth in LMCs. All the signs of the coefficients of the interaction between FDI and the various institutional indicators are positive but again not statistically significant. This finding is in line with Agbloyor et al. (2016) and Anetor et al. (2021).

Table 3. Moderating role of institutions in the FDI–economic growth nexus in lower-middle-income countries

	Fixed effect					
Variable	**GDPPCG [1]**	**GDPPCG [2]**	**GDPPCG [3]**	**GDPPCG [4]**	**GDPPCG [5]**	**GDPPCG [6]**
FDI	0.04 (0.62)	0.02 (0.50)	0.19* (1.81)	0.12 (1.15)	0.07 (1.29)	0.09 (1.11)
FDI*VOA	-0.01 (-0.10)	-	-	-	-	-
VOA	0.00 (0.00)	-	-	-	-	-
FDI*POS	-	-0.05 (-0.64)	-	-	-	-
POS	-	2.03*** (2.97)	-	-	-	-
FDI*GOE	-	-	0.17 (1.56)	-	-	-
GOE	-	-	0.86 (0.65)	-	-	-
FDI*REQ	-	-	-	0.08 (0.85)	-	-
REQ	-	-	-	1.68 (1.38)	-	-
FDI*RUL	-	-	-	-	0.04 (0.71)	-
RUL	-	-	-	-	-0.997 (-0.79)	-
FDI*COC	-	-	-	-	-	0.04 (0.57)
COC	-	-	-	-	-	2.20 (1.62)
TOP	0.01 (0.44)	0.01 (0.79)	0.01 (0.89)	0.01 (0.90)	0.00 (0.33)	0.01 (0.96)
GXP	-0.13** (-2.11)	-0.12** (-2.09)	-0.14** (-2.33)	-0.15** (-2.48)	-0.11* (-1.78)	-0.16*** (-2.58)
INF	-0.01 (-0.62)	-0.01 (-0.22)	-0.01 (-0.60)	-0.01 (-0.55)	-0.02 (-0.70)	-0.01 (-0.58)

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Table 3. Moderating role of institutions in the FDI–economic growth nexus in lower-middle-income countries (Concluded)

Variable	Fixed effect					
	GDPPCG [1]	GDPPCG [2]	GDPPCG [3]	GDPPCG [4]	GDPPCG [5]	GDPPCG [6]
PGR	3.28*** (3.68)	3.15*** (3.64)	3.45*** (3.87)	3.24*** (3.74)	3.28*** (3.78)	3.25*** (3.69)
GCF	0.03 (1.10)	0.02 (0.79)	0.03 (0.90)	0.03 (1.20)	0.03 (0.95)	0.03 (1.16)
FEX	-0.001* (-1.73)	-0.001* (-1.68)	-0.001* (-1.79)	-0.001* (-1.75)	-0.001* (-1.71)	-0.001* (-1.87)
Intercept	-4.55** (-2.32)	-3.49* (-1.84)	-4.76** (-2.51)	-3.68* (-1.87)	-5.25** (-2.45)	-3.42* (-1.74)
R^2 within	0.058	0.084	0.071	0.071	0.061	0.068
R^2 between	0.007	0.013	0.030	0.057	0.007	0.034
R^2 overall	0.007	0.014	0.015	0.019	0.008	0.016
Number of observations	357	357	357	357	357	357

Source: Authors' estimations using data from World Bank (2021a and 2021b).
Note: ( ) represent t-statistics; *, **, ***, indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

5.3 Moderating role of institutions in the FDI–growth nexus in upper-middle-income countries

Table 4 presents the regression results of the impact of the interaction of FDI and institutional variables on economic growth in upper-middle-income countries. The coefficients of FDI are negative but are not statistically significant; but in column 2, the coefficient is both negative and statistically significant, which seems to indicate that FDI flows into UMICs tend to have mainly an indiscernible, but in certain cases adverse effect on economic growth. This result is in line with the outcome of previous studies (e.g. Bermejo et al., 2018; Sokhanvar, 2019) that found an inverse relationship between FDI and economic growth. It implies that FDI flows to Africa, in some cases, have not been beneficial, and that resource-seeking investments can, in some cases, hinder the economic development of host nations (Asamoah et al., 2019).

The results also show that all the signs of the coefficients of the interactions between FDI and institutional variables (except for political stability) are positive and statistically significant. This result, unlike those for low-income and lower-middle-income countries, indicates that the relatively strong institutional quality in upper-middle-income countries effectively works in tandem with FDI inflows in enhancing economic growth. This outcome is consistent with prior studies (e.g. Raza et al., 2019). One interpretation of the result – and of the contrast with the results for LICs and LMICs – is that a country with relatively high institutional quality would create a more viable environment for conducting business and more easily attract MNCs.

This would invariably provide the host nation with latent and overt benefits necessary to enhance growth. In a nutshell, we conclude that institutional quality strengthens the association between FDI and economic growth in upper-middle-income countries. As a result, the hypothesis that the relationship between FDI and economic growth is conditioned on the quality of institutions is valid for upper-middle-income countries.

Table 4. Moderating role of institutions in the FDI–economic growth nexus in upper-middle-income countries

	Fixed effect					
Variable	**GDPPCG [1]**	**GDPPCG [2]**	**GDPPCG [3]**	**GDPPCG [4]**	**GDPPCG [5]**	**GDPPCG [6]**
FDI	-0.07 (-0.36)	-0.51*** (-3.35)	-0.08 (-0.39)	-0.06 (-0.30)	-0.04 (-0.20)	-0.06 (0.33)
FDI*VOA	0.30** (2.60)	-	-	-	-	-
VOA	9.29** (2.40)	-	-	-	-	-
FDI*POS	-	0.32 (1.08)	-	-	-	-
POS	-	1.03 (0.38)	-	-	-	-
FDI*GOE	-	-	0.34** (2.20)	-	-	-
GOE	-	-	2.78 (0.77)	-	-	-
FDI*REQ	-	-	-	0.38** (2.31)	-	-
REQ	-	-	-	0.15 (0.06)	-	-
FDI*RUL	-	-	-	-	0.72*** (2.86)	-
RUL	-	-	-	-	-4.66 (-1.27)	-
FDI*COC	-	-	-	-	-	0.34** (2.46)
COC	-	-	-	-	-	1.64 (0.61)
TOP	-0.10** (-2.20)	-0.09*** (-2.60)	-0.06* (-1.98)	-0.08** (-2.60)	-0.09*** (-2.71)	-0.08** (-2.60)
GXP	-1.2*** (-10.20)	-1.24*** (-9.10)	-1.27*** (-10.30)	-1.3*** (-9.74)	-1.25*** (-9.43)	-1.20*** (-2.70)
INF	-0.13 (-0.76)	0.01 (0.06)	-0.06 (-0.37)	-0.03 (-0.14)	-0.03 (-0.20)	-0.09 (-0.51)
PGR	-0.12 (-0.08)	-0.37 (-0.24)	0.46 (0.29)	0.21 (0.13)	-0.84 (-0.53)	-0.31 (-0.21)
GCF	0.01 (0.13)	0.04 (0.41)	0.02 (0.26)	0.03 (1.20)	0.04 (0.40)	0.01 (1.16)
FEX	-0.010 (-1.15)	-0.003 (-0.22)	-0.01 (-0.69)	-0.004 (-0.30)	-0.010 (-0.53)	-0.010 (-0.90)

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Table 4. Moderating role of institutions in the FDI–economic growth nexus in upper-middle-income countries (Concluded)

Variable	Fixed effect					
	GDPPCG [1]	GDPPCG [2]	GDPPCG [3]	GDPPCG [4]	GDPPCG [5]	GDPPCG [6]
Intercept	33.30*** (6.20)	32.03*** (5.60)	30.85*** (5.52)	31.05*** (5.20)	33.80*** (6.06)	34.40*** (6.10)
R^2 within	0.683	0.642	0.663	0.657	0.664	0.660
R^2 between	0.329	0.018	0.087	0.046	0.021	0.162
R^2 overall	0.184	0.312	0.391	0.308	0.310	0.421
Number of observations	102	102	102	102	102	102

Source: Authors' estimations using data from World Bank (2021a and 2021b).
Note: ( ) represent t-statistics; *, **, ***, indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

5.4 Moderating role of human capital in the FDI-growth nexus in low-income, lower-middle-income and upper-middle-income countries

Table 5 reports the regression results of the impact of the interaction of FDI and human capital (proxied by secondary school enrolment (SSE) and government expenditure on education (GXE)) on economic growth in low-income-countries (LICs), lower-middle-income countries (LMICs) and upper-middle-income countries (UMICs), using the FE model.

For LICs, the sign of the coefficient of FDI is positive but not statistically significant, providing no significant evidence affirming the positive influence of FDI on economic growth in Africa, contrary to the findings of previous studies (such as Bekere and Bersisa, 2018; Dinh et al., 2019). The result is in line with other prior studies (e.g. Ehigiamusoe and Lean, 2019; Makiela and Ouattara, 2018) that concluded that there is a negative or no significant association between FDI and economic growth. It can be seen from the results that the coefficient of the sign of the interactive terms of FDI and human capital (proxied by secondary school enrolment) on the one hand, and the coefficient of the interaction of FDI and human capital (proxied by government expenditure on education), on the other hand, is negative and statistically insignificant (columns 1–2). This is contrary to expectation, as human capital is supposed to support FDI in driving economic growth. Although the result is contrary to previous studies (e.g. Völlmecke et al., 2016), interestingly, it is line with some research (e.g. Gui-Diby, 2014) noting that the effect of FDI on growth is not contingent on human capital. A possible explanation for this is that the low level of human capital and its absorptive capacity in LICs precludes the ability to benefit from the positive spillover benefits of FDI (such as technology). In the same vein, the interactive term of FDI and human capital is statistically insignificant in LMICs, even though the sign of the coefficient of the interactive term is positive

(columns 3–4). For UMICs the sign of the coefficient of the interactive term of FDI and human capital (measured by secondary school enrollment) and the coefficient of the interaction of FDI and human capital (proxied by government expenditure on education) is positive and statistically significant at the 5 per cent level (columns 5–6). This presupposes that the conditioning effect of FDI on economic growth depends on human capital. In other words, human capital plays a supportive role in enhancing the positive spillover effect on economic growth in UMICs. This result conforms to the a priori expectation and supports prior studies (e.g. Anetor, 2020) that concluded that the impact of FDI on growth is contingent on human capital. An explanation is that the absorptive capacity of human capital in UMICs is relatively higher than in LICs and LMICs because the average percentage of government expenditure on education and the average rate of enrolment in schools are relatively higher in UMICs than in LICs and LMICs (table 1).

In conclusion, the role of human capital in the FDI–growth relationship is significant and critical in upper-middle-income countries, but less evident in low-income countries and lower-middle-income countries. Consequently, the hypothesis that the relationship between FDI and economic growth is conditioned on the quality of human capital is verified for only upper-middle-income countries.

Table 5. Moderating role of human capital in the FDI–economic growth nexus in low-income, lower-middle-income and upper-middle-income countries

	Fixed effect					
Variable	**GDPPCG (1)**	**GDPPCG (2)**	**GDPPCG (3)**	**GDPPCG (4)**	**GDPPCG (5)**	**GDPPCG (6)**
FDI	0.018 (0.14)	0.042 (0.51)	-0.009 (-0.08)	0.004 (0.07)	-0.534*** (-3.91)	-0.501*** (-3.80)
FDI*SSE	-0.001 (-0.23)	-	0.001 (0.48)	-	0.008** (2.39)	-
SSE	0.004 (0.15)	-	-0.032* (-1.71)	-	0.002 (0.04)	-
FDI*GXE	-	-0.015 (-0.99)	-	0.005 (0.83)	-	0.038** (2.26)
GXE	-	0.048 (0.34)	-	-0.083 (-1.63)	-	-0.131* (-1.98)
TOP	0.056* (1.89)	0.057** (1.97)	0.002 (0.17)	-0.0001 (-0.01)	-0.08** (-2.52)	-0.072** (-2.30)
GXP	0.017 (0.18)	0.032 (0.33)	-0.115* (-1.95)	-0.112* (-1.87)	-1.190*** (-9.52)	-1.213*** (-9.92)
INF	-0.052 (-1.25)	-0.015 (-1.23)	-0.017 (-0.65)	-0.012 (-0.48)	-0.05 (-0.27)	-0.023 (-0.14)
PGR	3.709*** (4.50)	3.729*** (4.65)	3.414*** (3.92)	3.694*** (3.90)	-0.222 (-0.15)	0.132 (0.09)
GCF	0.029 (0.61)	0.026 (0.54)	0.040 (1.38)	0.041 (1.37)	0.020 (0.21)	0.004 (0.04)

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Table 5. Moderating role of human capital in the FDI–economic growth nexus in low-income, lower-middle-income and upper-middle-income countries (Concluded)

Variable	Fixed effect					
	GDPPCG (1)	GDPPCG (2)	GDPPCG (3)	GDPPCG (4)	GDPPCG (5)	GDPPCG (6)
FEX	-0.0003 (-0.87)	-0.0003 (-0.86)	-0.001 (-1.62)	-0.001* (-1.73)	-0.02 (-1.05)	-0.009 (-0.69)
Intercept	-11.544*** (-4.23)	-11.844** (-4.41)	-3.46* (-1.75)	-4.615** (-2.35)	33.32*** (5.61)	32.93*** (5.77)
R^2 within	0.108	0.111	0.067	0.066	0.655	0.654
R^2 between	0.014	0.016	0.011	0.008	0.222	0.025
R^2 overall	0.016	0.016	0.008	0.007	0.436	0.345
Number of observations	323	323	357	357	102	102

Source: Authors' estimations using data from World Bank (2021a and 2021b).
Note: ( ) represent t-statistics; *, **, ***, indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

6. Conclusions and policy implications

This study investigated the role of human capital and institutional quality in the FDI–economic growth nexus in 46 African countries between 2002 and 2018 by employing an FE model. The results do not unambiguously support evidence from previous studies that FDI enhances economic growth in low-income countries and lower-middle-income countries in the region.

Our study also sought to examine the role of the quality of institutions in enhancing the impact of inward FDI on economic growth. We find that institutional quality plays a complementary role in facilitating positive spillover effects of FDI on economic growth in upper-middle-income countries in Africa. In contrast, we find no significant effects of the quality of institutions, at the margin, on the economic growth impact of FDI in the low-income and lower-middle-income countries. It is possible that institutional frameworks in these countries are below a certain "threshold" of quality, limiting their ability to provide a suitable platform for the types of FDI with potentially higher spillover and growth impact, e.g. non-resource-seeking FDI.

We also investigated the role of human capital in the relationship between FDI and economic growth. We find that human capital plays a crucial role in supporting the positive spillover effect of FDI on economic growth in upper-middle-income countries of Africa. However, again, we find no significant effects of human capital, at the margin, on the economic growth impact of FDI. The same "quality threshold" explanation may apply. The low level of human capital in these countries can be adduced to the twin problem of low budgetary allocation to education and low

average rate of school enrolment by the citizenry, as evident in the descriptive statistics. As a result, their absorptive capacity is low and the economy is unable to capture the positive spillover effects of FDI.

From a policy perspective, the findings call for special attention by policymakers to improving the quality of human capital by increasing their budgetary allocation to education to a minimum of 26 per cent, as recommended by UNESCO, and by granting scholarships to indigent students and providing free education at both the primary and secondary levels. Policymakers should strengthen their institutional framework by promoting citizen participation, accountability, transparency and an enabling legal framework.

It is not a misplaced result to have human capital and institutional factors facilitating the positive spillover effect of FDI on growth in upper-middle-income countries. This is because they are countries leading the pack in the Human Development Index and GDP per capita in the entire African region. There is no doubt that a well-developed workforce requires significant investment in capacity development and education, while institutions too require human capacity. Both human capital and strong institutions contemporaneously help to attract FDI, which in turn brings forth economic growth.

The governments of lower-middle-income and low-income countries must embark on social reforms that will bring about a social safety net for out-of-school children and encourage basic education. There is a need to expedite institutional reforms conducive to FDI attraction, including those related to trade and investment facilitation and promotion, as well as to review legal trade and investment frameworks.

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Appendix table 1. List of African countries included in the sample

Low-income countries (19)	Lower-middle-income countries (21)	Upper-middle-income countries (6)
Burkina Faso	Angola	Botswana
Central African Republic	Algeria	Equatorial Guinea
Chad	Benin	Gabon
Congo, Democratic Republic of the	Cameroon	Mauritius
Ethiopia	Cabo Verde	Namibia
Gambia, The	Comoros	South Africa
Guinea	Congo	
Guinea-Bissau	Côte d'Ivoire	
Liberia	Egypt	
Madagascar	Ghana	
Malawi	Kenya	
Mali	Lesotho	
Mozambique	Mauritania	
Niger	Morocco	
Rwanda	Nigeria	
Sierra Leone	São Tomé and Principe	
Sudan	Senegal	
Togo	Tanzania, United Republic of	
Uganda	Tunisia	
	Zambia	
	Zimbabwe	

Source: Authors' compilation, based on World Bank (2021a) classification according to income level.

Appendix table 2. Data sources and measurement of variables

Variable	Description	Growth rate of GDP per capita	Source
GDPPCG	Economic growth	Growth rate of GDP per capita	World Bank (2021a)
FDI	Foreign direct investment	Percentage ratio of FDI net inflows (i.e. new investment inflows less disinvestment) in the reporting economy to GDP	World Bank (2021a)
Institutional variable (*INS*)			
VOA	Voice and accountability	Perception as to how much citizens can participate in the selection of their government. It also measures the degree of freedom of expression and freedom of association, ranging between -2.5 and 2.5 (weak to strong governance performance).	World Bank (2021b)
POS	Political stability	Perception of the likelihood of political instability, politically motivated violence, and terrorism. It ranges between -2.5 and 2.5 (weak to strong governance performance).	World Bank (2021b)
GOE	Government effectiveness	Perception of the quality of public services, the quality of policy formulation, and the credibility of the government's commitment to such policies. It ranges between -2.5 and 2.5 (weak to strong governance performance).	World Bank (2021b)
REQ	Regulatory quality	Perception of the ability of policymakers to formulate and execute sound economic policies that will engender the development of the private sector. It ranges between -2.5 to 2.5 (weak to strong governance performance).	World Bank (2021b)
RUL	Rule of law	Perception of the extent to which citizens have confidence in and abide by the rule of the country. It ranges between -2.5 to 2.5 (weak to strong governance performance).	World Bank (2021b)
COC	Control of corruption	Perception of the degree to which public power us used for private gain. It ranges between -2.5 to 2.5 (weak to strong governance performance).	World Bank (2021b)
Human capital variable (*HCP*)			
SSE	Secondary school enrolment	Percentage ratio of secondary enrolment to gross enrolment	World Bank (2021a)
GXE	Government expenditure on education	Percentage ratio of government expenditure on education to GDP	World Bank (2021a)

/…

Appendix table 2. Data sources and measurement of variables (Concluded)

Variable	Description	Growth rate of GDP per capita	Source
Control variable			
TOP	Trade openness	Percentage ratio of the sum of exports plus imports of goods to total output	World Bank (2021a)
GXP	Government consumption expenditure (per cent GDP)	Total expenses and net acquisition of non-financial assets	World Bank (2021a)
INF	Inflation	Consumer price index, reflecting annual percentage change in cost to average consumer of acquiring a basket of goods and services	World Bank (2021a)
PGR	Population growth	Annual growth rate	World Bank (2021a)
GCF	Gross capital formation	Percentage ratio of gross capital formation to GDP	World Bank (2021a)
FEX	Foreign exchange rate	Annual average based on monthly average (local currency units relative to the United States dollar)	World Bank (2021a)

Source: Authors' compilation.

Appendix table 3. Moderating role of institutions in the FDI–economic growth nexus in low-income countries

Variable	Random effect					
	GDPPCG [7]	GDPPCG [8]	GDPPCG [9]	GDPPCG [10]	GDPPCG [11]	GDPPCG [12]
FDI	-0.03 [-0.35]	0.01 [0.14]	-0.28* [-1.70]	-0.08 [-0.57]	-0.35** [-2.05]	-0.27* [-1.73]
FDI*VOA	-0.12 [-0.98]	-	-	-	-	-
VOA	0.95 [1.03]	-	-	-	-	-
FDI*POS	-	-0.04 [-0.62]	-	-	-	-
POS	-	0.21 [0.41]	-	-	-	-
FDI*GOE	-	-	-0.36** [-2.04]	-	-	-
GOE	-	-	2.30** [2.32]	-	-	-
FDI*REQ	-	-	-	-0.18 [-0.94]	-	-
REQ	-	-	-	0.43 [0.37]	-	-
FDI*RUL	-	-	-	-	-0.37** [-2.51]	-
RUL	-	-	-	-	0.57 [0.63]	-
FDI*COC	-	-	-	-	-	-0.37** [-2.21]
COC	-	-	-	-	-	2.07** [2.13]
TOP	-0.01 [-0.77]	-0.01 [-0.59]	-0.01* [-0.62]	-0.01 [-0.66]	-0.02 [-1.08]	-0.01 [-0.87]
GXP	-0.04 [-0.51]	-0.02 [-0.32]	-0.06 [-0.78]	-0.02 [-0.21]	-0.05 [-0.68]	-0.05 [-0.68]
INF	-0.02 [-0.60]	-0.02 [-0.66]	-0.02 [-0.59]	-0.03 [-0.67]	-0.01 [-0.40]	-0.02 [-0.50]
PGR	1.63*** [2.60]	1.84*** [3.02]	1.14** [2.10]	1.81*** [3.00]	1.73*** [3.08]	1.42*** [2.63]
GCF	0.08 [1.86]	0.07* [1.68]	0.09** [2.1]	0.08* [1.80]	0.08* [1.90]	0.08** [1.96]
FEX	0.000 [0.21]	0.000 [0.28]	0.00 [0.11]	0.00 [0.21]	0.000 [0.48]	0.0001 [0.41]
Intercept	-2.17 [-0.86]	-3.50 [-1.56]	0.65 [0.30]	-3.30 [-1.30]	-2.10 [-1.01]	-0.40 [-0.19]
R^2 within	0.085	0.079	0.062	0.076	0.076	0.069
R^2 between	0.048	0.062	0.256	0.080	0.220	0.204
R^2 overall	0.053	0.053	0.082	0.056	0.086	0.081
Number of observations	323	323	323	323	323	323

Source: Authors' estimations using data from World Bank (2021a and 2021b).
Note: [ ] represent z-statistics; *, ** and *** indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

Appendix table 4. Moderating role of institutions in the FDI-economic growth nexus in lower-middle-income countries

Variable	Random effect					
	GDPPCG [1]	GDPPCG [2]	GDPPCG [3]	GDPPCG [4]	GDPPCG [5]	GDPPCG [6]
FDI	0.05 [1.07]	0.02 [0.55]	0.12 [1.45]	0.10 [1.20]	0.05 [1.02]	0.05 [0.76]
FDI*VOA	0.04 [0.75]	-	-	-	-	-
VOA	0.23 [0.53]	-	-	-	-	-
FDI*POS	-	0.01 [0.20]	-	-	-	-
POS	-	0.56 [1.48]	-	-	-	-
FDI*GOE	-	-	0.11 [1.24]	-	-	-
GOE	-	-	0.82 [1.44]	-	-	-
FDI*REQ	-	-	-	0.08 [0.96]	-	-
REQ	-	-	-	0.98** [2.02]	-	-
FDI*RUL	-	-	-	-	0.02 [0.42]	-
RUL	-	-	-	-	-0.46 [-1.02]	-
FDI*COC	-	-	-	-	-	0.03 [0.52]
COC	-	-	-	-	-	0.64 [1.10]
TOP	-0.01 [-0.99]	-0.01 [-1.26]	-0.01 [-1.16]	-0.01 [-1.07]	-0.01 [-1.28]	-0.01 [-1.18]
GXP	0.00 [0.01]	0.00 [0.10]	0.01 [0.36]	0.01 [0.13]	-0.00 [-0.09]	0.01 [0.15]
INF	0.01 [0.54]	0.02 [0.75]	0.01 [0.66]	0.01 [0.62]	0.01 [0.35]	0.01 [0.64]
PGR	0.34 [1.22]	0.36 [1.27]	0.60** [2.08]	0.35 [1.34]	0.31 [1.08]	0.52* [1.70]
GCF	0.03 [1.27]	0.03 [1.27]	0.01 [0.39]	0.01 [0.59]	0.03 [1.40]	0.02 [0.93]
FEX	-0.000 [-1.55]	-0.000 [-1.56]	-0.000 [-1.26]	-0.000 [-1.18]	-0.000* [-1.76]	-0.000 [-1.42]
Intercept	1.29 [1.44]	1.57 [1.72]	1.30 [1.46]	1.96** [2.14]	1.09 [1.16]	1.31 [1.47]
R^2 within	0.017	0.032	0.026	0.027	0.020	0.025
R^2 between	0.232	0.170	0.341	0.400	0.147	0.222
R^2 overall	0.035	0.040	0.052	0.057	0.031	0.039
Number of observations	357	357	357	357	357	357

Source: Authors' estimations using data from World Bank (2021a and 2021b).

Note: [ ] represent *z*-statistics; *, ** and *** indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

Appendix table 5. Moderating role of institutions in the FDI–economic growth nexus in upper-middle-income countries

Variable	Random effect					
	GDPPCG [1]	GDPPCG [2]	GDPPCG [3]	GDPPCG [4]	GDPPCG [5]	GDPPCG [6]
FDI	0.46*** [2.70]	0.15 [-0.99]	0.51*** [2.92]	0.46** [2.52]	0.44** [0.01]	0.38** [2.15]
FDI*VOA	0.47*** [3.81]	-	-	-	-	-
VOA	1.61 [0.69]	-	-	-	-	-
FDI*POS	-	0.08 [0.30]	-	-	-	-
POS	-	3.86** [2.56]	-	-	-	-
FDI*GOE	-	-	0.61*** [3.90]	-	-	-
GOE	-	-	-3.10 [-1.15]	-	-	-
FDI*REQ	-	-	-	0.58*** [3.37]	-	-
REQ	-	-	-	-3.41 [-1.50]	-	-
FDI*RUL	-	-	-	-	0.88*** [3.30]	-
RUL	-	-	-	-	-0.44 [-0.21]	-
FDI*COC	-	-	-	-	-	0.46*** [3.13]
COC	-	-	-	-	-	1.71 [1.15]
TOP	-0.03 [-1.06]	-0.06** [-2.54]	-0.05** [-1.90]	-0.05** [-2.29]	-0.04* [-1.71]	-0.02 [-0.97]
GXP	-0.95*** [-9.50]	-0.78*** [-7.50]	-0.90*** [-9.40]	-0.95*** [-8.70]	-0.98*** [-8.70]	-0.90*** [-9.20]
INF	-0.17 [-0.95]	-0.07 [-0.35]	-0.16 [-0.86]	-0.14 [-0.77]	-0.18 [-0.96]	-0.22 [-1.20]
PGR	3.38*** [2.70]	2.20*** [3.20]	1.37 [0.99]	1.12 [0.96]	1.90*** [2.90]	0.2.9*** [3.70]
GCF	-0.14* [-1.66]	-0.13* [-1.70]	-0.06 [-0.69]	-0.06 [-0.66]	-0.11 [-1.45]	-0.19** [-2.20]
FEX	-0.020*** [-3.70]	-0.020*** [-4.60]	-0.030*** [-5.50]	-0.02*** [-5.60]	-0.02*** [-4.80]	-0.02*** [-4.20]
Intercept	20.30*** [5.10]	21.70*** [7.30]	25.10*** [6.00]	26.40*** [6.51]	24.90*** [8.80]	22.90*** [8.30]
R^2 within	0.592	0.569	0.587	0.581	0.583	0.588
R^2 between	0.491	5645.000	0.497	0.441	0.440	0.523
R^2 overall	0.575	0.539	0.564	0.546	0.551	0.568
Number of observations	102	102	102	102	102	102

Source: Authors' estimations using data from World Bank (2021a and 2021b).
Note: [ ] represent z-statistics; *, ** and *** indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

Appendix table 6. Moderating role of human capital in the FDI-economic growth nexus in low-income, lower-middle-income and upper-middle-income countries

	Random Effect					
	Low-income countries		Lower-middle-income countries		Upper-middle-income countries	
Variable	GDPPCG [1]	GDPPCG [2]	GDPPCG [3]	GDPPCG [4]	GDPPCG [5]	GDPPCG [6]
FDI	0.028 [0.21]	0.089 [1.08]	-0.050 [-0.50]	0.039 [0.73]	-0.384*** [-2.68]	-0.181 [-1.29]
FDI*SSE	0.001 [0.15]	-	0.002 [0.89]	-	0.014*** [3.93]	-
SSE	0.011 [0.43]	-	-0.018 [-1.46]	-	-0.091*** [-2.65]	-
FDI*GXE	-	-0.009 [-0.65]	-	-0.001 [-0.20]	-	0.051*** [2.69]
GXE	-	0.205* [1.85]	-	-0.010 [-0.34]	-	-0.160** [2.35]
TOP	-0.016 [-0.94]	-0.006 [-0.32]	-0.011 [-1.57]	-0.009 [-1.20]	-0.062*** [-2.90]	-0.040 [-1.63]
GXP	-0.032 [-0.42]	-0.020 [-0.25]	0.000 [0.01]	-0.004 [-0.11]	-0.936*** [-9.73]	-0.859*** [-8.54]
INF	-0.024 [-0.64]	-0.040 [-1.04]	0.018 [0.76]	0.009 [0.38]	-0.137 [-0.75]	-0.092 [-0.48]
PGR	1.853*** [3.19]	2.090*** [3.51]	0.084 [0.27]	0.234 [0.76]	1.267* [1.74]	1.835** [2.43]
GCF	0.075* [1.75]	0.043 [0.94]	0.036* [1.70]	0.031 [1.38]	-0.057 [0.78]	-0.084 [-1.10]
FEX	0.0001 [0.35]	0.000 [0.04]	-0.001* [-1.84]	-0.001* [-1.73]	-0.028*** [-5.36]	-0.023*** [-5.62]
Intercept	-3.606* [-1.81]	-4.730** [-2.32]	2.622** [2.31]	1.684* [1.77]	32.451*** [6.61]	23.710*** [7.82]
R^2 within	0.069	0.081	0.015	0.018	0.589	0.591
R^2 between	0.111	0.106	0.258	0.141	0.611	0.371
R^2 overall	0.058	0.066	0.035	0.028	0.582	0.530
Number of observations	323	323	357	357	102	102

Source: Authors' estimations using data from World Bank (2021a and 2021b).

Note: [ ] represent z-statistics; *, ** and *** indicate significance at 10 per cent, 5 per cent and 1 per cent levels, respectively.

Does language affect the location choice of developing-economy MNEs? The case of Moroccan outward FDI*

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Abstract

The present paper investigates the effect of linguistic distance on location decisions of Moroccan outward foreign direct investment (FDI) using panel data on 54 host countries from 2007 to 2021 and the robust weighted least squares estimation method. The results show that the higher the share of French- and Arabic-speaking populations, the more the host country attracts FDI from Morocco. Also, the results show that the higher the share of the English-speaking population, the less the host country attracts FDI because English-speaking countries tend to adopt institutional structures (the Anglo-Saxon way of governance) that differ from the French model inherited by Morocco during its colonization. For Spanish, there is no effect on the location decisions of Moroccan multinational enterprises because of the language's marginalization at the formal level. The study highlights important policy considerations for home and host countries in terms of investment policy and investment promotion, language-in-education policies, and the role of international cultural and linguistic institutes in home and host countries.

Keywords: foreign direct investment, internationalization, knowledge-capital model, language distance, multinational enterprises, psychical distance, robust least squares

JEL classification codes: C23, F21, F23, Z19

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1. Introduction

Globalization presents itself as a lasting and inevitable phenomenon, having reframed the functioning of the world economic scene through the removal of economic, social and cultural borders, greater competition and the emergence of new challenges on a global scale. Since 2000, the Moroccan economy has shown continuous and sustainable growth with low inflation levels. This growth finds its sources in tourism, private investment and attempts at industrialization, with a strong dependence on the agriculture sector. This trend has been accompanied by an increasing openness of the Moroccan economy through the intensification of trade flows and outward and inward foreign direct investment (FDI).

Statistics show that Moroccan outward FDI reached $360 million in 2020, representing 28 per cent of its inward FDI in 2022 (Morocco, Exchange Office, 2022). In addition, the African continent receives the most Moroccan outward FDI (67.6 per cent in 2020, 63.2 per cent in 2019 and 49.4 per cent in 2018), making Morocco the second largest African investor in sub-Saharan Africa after South Africa and the leading African investor in West Africa (Dafir, 2021). Furthermore, at the sectoral level, the presence of Morocco in sub-Saharan Africa is more marked in the banking sector, with a share of 40 per cent of the total stock in sub-Saharan Africa, followed by telecommunication (34 per cent), insurance (13 per cent) and industry (6 per cent) (Morocco, Exchange Office, 2017).

According to Toumi (2009), the location of FDI could be explained in part by cultural considerations that may influence the decision-making of multinational enterprises (MNEs). Besides shared history and traditions, these considerations could cover other issues, such as a shared language, an essential factor for understanding the behaviour of MNEs and their location choice. Moreover, and in the same perspective, Ghemawat (2001) emphasizes the concept of distance by developing the CAGE (cultural, administrative, geographic and economic) model as a strategic managerial method to assess and evaluate the differences between locations when opting for internationalization so as to better execute the internalization process abroad. In addition to the geographical distance, Ghemawat (2001) added the administrative, economic and cultural distances and other proxy aspects.

According to Hymer (1976), every MNE suffers from foreignness liabilities, which consist of all the obstacles and difficulties to be overcome when carrying out FDI in a host country. Therefore, the weight of liabilities of foreignness is a factor that influences the decision of MNEs in locating activities abroad. In other words, the success of the internationalization of the MNE scrupulously depends on the human side, of which the language spoken by the country of origin and the host country is the main element to ensure good communication, establish trust and acquire relevant information. Denk et al. (2012) and Rana and Elo (2017) defend

that hypothesis by arguing that the liabilities of foreignness constitute the additional costs that MNEs have to face relative to their local competitors when operating in international markets and foreign locations.

In particular, one could say that linguistic distance increases foreignness liabilities because of the uncertainties in cross-border operations with economic agents of the host country, and especially FDI, which is more sensitive to the difference in language than are other modes of internationalization such as franchising and trade (Berry et al., 2010). The higher the linguistic distance, the higher the information costs, which makes it harder to build the legitimacy of the MNE in the host country. To this end, ignoring domestic language complicates knowledge transfer to the local subsidiary and hinders verbal communication, which deteriorates the performance of the MNE international network and hence the flow of FDI (Denk et al., 2012; Elo and Ivanova-Gongne, 2021; Rana and Elo, 2017; Piekkari et al., 2022).

As a result, linguistic distance proves to be a factor that MNEs consider before any location decision, where empirical studies support the hypothesis that language has a specific effect on the location of FDI, although it is not the most relevant determinant of outward FDI (Ristolainen et al., 2021; Westney et al., 2022).

The first to mention language as a location factor is Kogut and Singh (1988), in developing a new way of operationalizing cultural distance; however, the authors did not consider language as an independent factor. Marschan-Piekkari et al. (1997) called language the forgotten factor in the international business literature (Charles and Marschan-Piekkari, 2002; Piekkari and Zander, 2005; Piekkari et al., 2014). Luo and Shenkar (2006) explained that researchers did not give much attention to linguistic distance because they viewed language as a dimension of culture, which explains why it was unnecessary to focus on language as an explanatory factor of internationalization isolated from culture. Therefore, the research gap in the context of this paper is the insufficiency of the literature dealing with the effect of shared language on the FDI location choices of emerging countries. This paper aims to fill this gap and contribute to knowledge in the field by determining the effect of language distance between Morocco and host countries on Moroccan MNEs' location choices through their FDI, using an empirical model and a panel econometric estimation method. In addition, the paper adds a novel contribution by by analysing decisions by non-English-speaking firms in the context of the hegemony of the English language in international business.In Morocco, the linguistic context is multicultural. It is a territory in which several languages coexist. This linguistic diversity is confirmed by the presence, alongside Arabic and Berber – the mother tongues spoken by the vast majority of Moroccans – of other lingua franca languages linked to colonial history and globalization. More than 69 per cent of the population speaks French, the first foreign language established in Morocco; Spanish speakers follow.

English, spoken by more than 14 per cent of Moroccans, established itself as a contemporary language of openness, explained by the trend of cultural standardization on a global scale.

The main objective of this study is to inform public decision makers in host and home countries of the role of language as a determinant of FDI location choice and to provide them with concrete results that enable them to understand the issue of linguistic distance and its policy implications where decision makers in the home country have to promote outward FDI and decision makers in the host country have to attract inward FDI.

The rest of the paper is organized as follows: the second section presents the linguistic context in Morocco, and the third section lays out the theoretical background and review of the literature regarding the effect of language on FDI. The fourth section explains the research design and the empirical method. The fifth section discusses empirical results, and the sixth section presents the conclusion of the study and its policy implications.

2. Context of languages in Morocco

The linguistic configuration of Morocco is has continuously evolved in parallel with social, economic and political transformations. The complexity of these transformations has led to the emergence of a plurilingual country (Daniel and Ball, 2009).

Indeed, changes in language policy in Morocco have led to the coexistence of several languages, namely Arabic, Amazigh (Berber), French, English and Spanish, albeit with significant differences in use and institutional recognition. The Constitution of 2011 revised the status of languages. It formalized the Amazigh language, after centuries of stigmatization and separation; however, the use of Amazigh remains limited to Berber speakers, and it could not be institutionalized, despite the efforts made to integrate it into the education system as well as the efforts of the Royal Institute of Amazigh Culture. According to the General Census of Population and Housing (RGPH), only about 27 per cent of the population speaks Amazigh while more than 90 per cent speak Arabic.

Standard Arabic remains the official language of Morocco. Although it is a language learned at school, it is also the language of the media, the press and religious rituals. It is the main base of the Arabic commonly spoken in Morocco (Darija) alongside Amazigh, French and Spanish. French was integrated into the range of languages in Morocco during the French Protectorate at the beginning of the 20th century. It is the only originally foreign language that is read, written and spoken in the linguistic landscape in Morocco. Its omnipresence in the media, public administration and the economy, as well as education, is justified by its roots in the language practices

of Moroccans, as well as by its institutionalization, distinguished by its coexistence with Arabic. According to the General Population and Housing Census,[1] French is written and spoken by almost 70 per cent of the population.

Spanish shares with French the same reason for existence in the country, imposition during the colonization era by France and Spain in the first half of the 20th century (Daniel and Ball, 2009). The presence of Spanish is limited: it is much more present in the northern and Rif provinces and in the southern provinces because of the Spanish colonization of these areas. Various surveys and statistics show that the share of the population that speaks Spanish does not exceed 10 per cent.

English is the only language spoken in Morocco that does not have a colonial source. Its expansion is explained by the effects of globalization and the growing openness of Morocco.

3. Theoretical framework and literature review

3.1 Language distance in firm internationalization theories

This paper argues that linguistic proximity or distance explains FDI location choice and that its fundamental theoretical framework is grounded in firm internationalization models (Ghemawat (2001)). Dunning (1988) introduced the OLI (ownership, location, internalization) paradigm and asserts that sociocultural and institutional factors constitute elements of specific advantages of host countries (*Location*) that maximize firm-specific advantages (*Ownership*). The OLI paradigm explains a firm's internationalization by considering determinants of FDI location choice. Making a successful internalization (*I*) requires finding a country (*Location*) that has advantages that allow the MNE to maximize its specific advantages (*Ownership*). To identify location-specific advantages to location, Dunning (1988) proposed a paradigm called Environment-Systems-Policies (ESP): "Systems" refers to social and cultural factors within host economies that may attract foreign investors. As this paper deals with the language factor, we could say that linguistic distance is one of the sociocultural factors strengthening foreignness liabilities. Hence, we consider linguistic similarity between the host and the home country as a comparative advantage, as it reduces market imperfections (Denk et al., 2012; Piekkari et al., 2022). A low linguistic distance reduces transaction costs caused by differences in social norms and business climate and by informational asymmetry. In addition, it reduces market risks related to consumer choices and behaviour (Denk et al., 2012; Piekkari et al., 2014; Rana and Elo, 2017).

[1] Morocco, Haut-Commissariat au Plan, "Présentation des principaux résultats du RGPH 2014", 13 October 2015, https://rgph2014.hcp.ma.

Firm internationalization theories help us to understand the behaviour of FDI depending on a firm's own experiences and motives. In this matter, Johanson and Vahlne (1977) developed the Uppsala model, according to which the internationalization process is sequential and linear. According to the authors, the success of firm internationalization through horizontal FDI depends on experience and knowledge gained about local customs and understanding of domestic consumer behaviour. In other words, MNEs internationalize to host countries where information asymmetry and psychic distance are non-significant. Johanson and Vahlne (1977) defined psychic distance "as the sum of the factors preventing the flow of information from and to the market. Examples are differences in language, education, business practices, culture and industrial development" (Johanson and Vahlne, 1977, p. 64). Those factors may limit the MNE from acquiring more relevant information about the sociocultural structure of the host country, worsen the information asymmetry and cripple the internationalization process. We argue that language is one of the psychic distance factors. Our study suggests that language plays a significant role in narrowing psychic distance, which explains the positive effect of language similarity on FDI. Nevertheless, the Uppsala model focuses only on horizontal and market-seeking FDI, sensitive to consumer choices and behaviour. We argue that vertical FDI is also affected by psychic distance.

Johanson and Mattsson (1987) developed the social network model, in which firm internationalization is a cumulative process during which relationships with foreign actors are established and continuously maintained to achieve objectives. Therefore, internationalization success depends more on the ability to create a network than on a specific advantage. In other words, the international process is a product of interactions, development and maintenance of relationships over time: a firm's internationalization is the product of a social network internationalization.

The social network theoretical model suggests that the firm is part of several social networks. By establishing financial, technological and market relations, the firm gradually widens its networks outside national borders. This network approach focuses on the issues and opportunities associated with establishing relationships with foreign partners, such as clients, suppliers and governments.

The social network theoretical model helps us understand the effect of linguistic distance on firm internationalization success and FDI location choice. The international business literature has documented the economic benefits of linguistic similarity. The existence of the same language for expatriates and local agents in a host country strengthens interpersonal relationships and friendships that promote communication (Fan et al., 2017). In addition, theoretical literature such as the social identity theory and self-categorization has highlighted the difficulties that expatriates face when information asymmetry and communication problems are significantly relevant, especially when employees have different social identities than expatriates (Makela et al., 2012). In other words, higher linguistic proximity

means that expatriates encounter fewer problems related to the management of a local branch than they would in a linguistically distant country.

The theory of social networks explains the contribution of linguistic proximity to internationalization success through elements of personal relationships such as shared language. The associated interactions of expatriate executives with local entities can extend to employees, suppliers, customers, competitors and governments (Gao, 2003). Indeed, sharing the same language is an essential categorical factor for establishing social networks. Therefore, the importance of language-based social networks lies in their intermediation between expatriate executives and local agents to facilitate the exchange and sharing of the most relevant information to streamline economic operations linked to buying, selling and acquiring relevant information. All these assets reduce foreignness liabilities.

On the basis of the last two models, Dunning and Lundan (2008) revisited the OLI paradigm, admitting that FDI is differently sensitive to the existence of a language distance depending on its type and motivation. The types of FDI motivation, from most sensitive to least sensitive to language, are as follows:

- Market-seeking FDI: These investments are highly motivated by common language insofar as language facilitates the adaptation of products to the tastes or needs of local consumers. Plus, when it comes to commercial customs practices, legal procedures and marketing strategies, not being familiar with the local language puts the MNE at a disadvantage relative to local firms. This type of FDI is associated with horizontal FDI. In addition, there is a thesis that language creates the market. This reverse causality is defended by the anti-globalization thesis of the "McDonaldization" of the world economy, which argues that American and British MNEs use the English language to create new markets and consumers, which by default eliminates local competition and imposes the tastes and habits of the English-speaking world on the host country (Heller, 2010).
- Efficiency-seeking FDI: These investments are less sensitive to language insofar as the MNE can make its investments in a country that does not have a common language. According to Marchan-Piekkari et al. (1997), local employees of the MNE may act passively towards their colleagues from the country of origin and may turn to translators within the firm to convey their messages. Communication obstacles can have consequences for the efficiency and performance of the firm: after having carried out a merger and acquisition, linguistic distance can prevent the MNE from effectively monitoring and understanding the post-acquisition activities of the firm and its personnel and how to operate successfully in the host country, which can lead to behavioural uncertainty (Dow et al., 2016). As a result, MNEs invest in countries that are geographically, culturally and linguistically close.

- Strategic asset–seeking FDI: With these investments MNEs opt to develop strategic resources in a foreign country and exploit competitive advantages such as business intelligence, technological know-how and management expertise. Thus, the existence of local employees with language skills and appropriate techniques can make FDIs slightly language-sensitive (Heller, 2010).
- Natural resource-seeking FDIs: These investments are the least sensitive to language because natural resources exist only in certain countries. If an MNE wants to exploit or monopolize these resources, it has to invest in them even if the host country is linguistically distant.

3.2 Mediating factors between language distance and FDI location choice

The literature shows an indirect effect of distance or proximity and FDI location choice through various transmission channels, as follows:

Language distance deteriorates communication: First of all, according to Harzing and Pudelko (2013), when an MNE develops internationally by investing in a new territory, it encounters specific challenges to overcome, which may include a language barrier, which is a form of communication barrier that complicates and slows the process of transmitting verbal messages and hence increases the costs of communication (Krone et al., 1987). These communication barriers are of two types: geographical and linguistic. Geographic barriers are caused by the physical distance between the home country and the host country, which increases the opportunity cost of direct face-to-face communication between home- and host-country employees. In addition, it may increase the direct costs of transmitting messages between these remote employees using tools such as telephone, video calls and mail (Welch and Welch, 2008). Therefore, a language barrier occurs when a common language does not exist between expatriates and local employees, making repeated verbal communication harder. Monks (1996) conducted an empirical analysis of nine subsidiaries owned by a French MNE based in Ireland. According to the investigation, a human resources manager of a subsidiary admitted that the local Irish employees rarely give special attention to documents and notes received in French. A lack of language proficiency can lead to distractions for employees because they have to translate instead of focusing on their assigned tasks. Marschan-Piekkari et al. (1997), conducted a study on a Taiwanese branch of an English-speaking MNE, in which one of the Taiwanese managers declared that despite his low mastery of the English language, he was responsible for all communication between the subsidiary and the parent firm. However, because poor translation can alter the intended meaning of a message and sabotage the functioning of the MNE and its subsidiary in the host country, it can negatively

affect the performance of the MNE and its international development. To this end, language barriers incur additional costs of verbal communication so that employees understand messages transmitted by various means (Welch and Welch, 2008). Among the means often used is the use of expatriate translators who master the language of the host-country company. In addition, language barriers manifest in two components, maternal language barriers and foreign language barriers. According to Dow and Karunaratna (2006), maternal language barriers occur when home-country employees and host-country employees are not proficient in each other's native language, which means that even basic verbal messages can lead to misinterpretation and misunderstanding. Therefore, the smaller the share of employees from the home country and from the host country who can understand each other's maternal language and the more their languages differ, the higher the maternal language barrier and the costs of communication. Similarly, foreign language barriers arise if the employees from the host country do not master the lingua franca used within the firm of the country of origin. As a result, the less the lingua franca is used in the home country and mastered by employees from the host country, the higher the barrier to communication .

Language proximity indicates similar culture: Several authors argue that the linguistic distance between the MNE's country of origin and the host country is not only a question of ignorance of the linguistic system but also a matter of cultural dimension (Holden, 1989). In other words, the absence of a common language between the expatriates of the MNE and the local employees affects not only the understanding of the transmitted messages but also the understanding of the local culture, like the social norms and the preferences of local consumers. In addition, Ford (1989) argues that psychologically close foreign markets share a common language with the home economy and hence the same cultural traits. So, the degree of success in firm internationalization depends on mastery of the local language. In other words, the more linguistically distant the foreign market is from the country of origin of the investment, the more that ignoring the local language hinders intercultural communication and can prevent the MNE from penetrating a new foreign market (Barner-Rasmussen et al., 2014; Fredriksson et al., 2006; Ivanova-Gongne et al., 2022a; Ivanova-Gongne et al., 2022b; Swift, 1991).

Language similarity boosts trust: According to Xu and Shenkar (2002), MNEs must acquire institutional legitimacy in the host country to understand appropriate behaviour and align its practices to the host country's social norms. In particular, linguistic distance can complicate communications between the MNE and economic agents of the host country (employees, suppliers, customers) and result in filtering and distortion of the messages transmitted. This miscommunication and misinterpretation could therefore produce persistent distrust of the host country towards the MNE (Kostova and Zaheer, 1999) and harm its efforts to build legitimacy. Consequently, the caution of MNEs when faced with a significant

language barrier may explain their decision to localize their FDI. Furthermore, Welch et al. (2005) claim that trust is hard to establish when stakeholders do not share a common language.

Language similarity as a signalling effect: Buckley et al. (2005) argue that communication and the exchange of information between actors in the host country and country of origin are harder to establish if the language spoken in them differs and that therefore information asymmetry will make management of the subsidiary more difficult for managers from the country of origin, which can harm performance. Linguistic knowledge thus influences a firm's internationalization process, which helps decision makers discover exploitable opportunities in the host country. So, knowing the domestic language makes feasible both internationalization and achievement of the projected performance, enabling the company to generate more FDI in its successful subsidiary. This increase in FDI constitutes a signalling effect for other MNEs and causes an additional increase in FDI. And vice versa, poor performance resulting from ignorance of the local language reduces the signalling effect for other direct investors. By studying the cases of three MNEs, Makela et al. (2007) showed that sharing a common language (maternal language or lingua franca) strengthens ties and interpersonal relationships in a foreign subsidiary, which can lead to improved employee performance, which, again, can make other MNEs more aware of similar situations.

Language proximity ameliorates information asymmetry: Hau (2001) studied a sample of 756 German financial operators (traders) located in 23 cities in 8 European countries. He found that German operators working in non-German-speaking cities make less profit than those in German-speaking cities. Along the same lines, he concluded that German traders working in German-speaking cities generate more profit than their colleagues who do not speak German. The author explained this result as showing that sharing a common language reduces informational asymmetry in business networks, including information on suppliers, distributors, equipment costs and market conditions. These elements are essential to analysing the projected profitability of an investment. In addition, a foreign investor would want to secure enforcement of contracts and protection of property rights. However, the absence of a common language as well as institutional and cultural distance can create barriers to investment. Anwar (2009) concluded that outward FDI from India to developing countries is primarily market-seeking and asset-seeking. He found that such FDI is more oriented towards countries where English is a second language, like in India. Also, informational asymmetry is relevant after mergers and acquisitions because linguistic distance makes it difficult for MNEs to manage local subsidiaries without acquiring feedback on the internal environment from the previous managers of the subsidiary. In addition, linguistic distance negatively influences the management of employees in the local subsidiary and communication with local suppliers and customers.

Language barriers can create frustration, conflict, mistrust and resistance between foreign employees and local ones (Vidal Suárez and López-Duarte, 2013). All these difficulties arising from the liabilities of foreignness contribute to inflating the transaction costs related to FDI.

3.3 Empirical studies of the effect of language on FDI

Empirical studies have found an investment bias in favour of countries speaking the same language. Demirbag et al. (1998) concluded that outward FDI from Turkey favours Central Asian countries where Turkish is spoken. Lundan and Jones (2001) argue that the English language shared by Commonwealth countries explains the increase in bilateral FDI between them because of the reduction in costs caused by the foreignness liabilities. Goldberg et al. (2005) studied the role of the English language in the movement of inward and outward FDI for the United States. They concluded that English as a global language positively affects the country's outward FDI but does not affect its inward FDI. Chiswick and Miller (2005) found that the existence of an official language linguistically close to English is more likely to increase United States FDI. Aggarwal (2008) found that FDI inflows to India come from English-speaking countries. Hejazi and Ma (2011) examined the impact of seven languages (English, Dutch, French, German, Italian, Spanish and Swedish) on bilateral FDI stocks between 30 member countries of the Organisation for Economic Co-operation and Development (OECD). They used English as a global language (lingua franca) dummy variable and seven dummy variables to signify sharing the same mother tongue. The results indicate that sharing a common maternal language positively affects FDI and that sharing English as a lingua franca has a superior positive impact compared with other languages. Oh et al. (2011) analysed outward FDI from 28 OECD member countries to 115 countries (28 OECD countries and 87 non-OECD countries) using linguistic dummy variables (English, French, Spanish and Arabic) and Melitz's index (2008), which measures the degree of direct communication by calculating the percentage of people in a country who can communicate directly through a given language. The authors found that the shared mastery of a language positively affects flows of outgoing FDI. Konara and Wei (2014) studied the case of bilateral FDI between 29 OECD countries and 111 partner countries from 1986 to 2008. Their results show a significant negative relationship between linguistic distance and bilateral FDI flows. In other words, the less different the country is linguistically, the more it tends to receive FDI flows. Furthermore, they found a dynamic negative effect of language on bilateral FDI flows, as this effect increases over time. Holtan and Brynstesen (2019) studied inward FDI in five Southeast Asian countries (Indonesia, Malaysia, the Philippines, Singapore and Thailand). They concluded that a global language holding official status in a country does not contribute more to the attractiveness of FDI in that country. Feng et al. (2019) have studied the effect of various aspects

of language on bilateral FDI using the gravity model. They found that bilateral FDI tends to be higher between countries that share the same official language, native languages or linguistically proximate languages. The authors explain the positive effect of sharing native language by ethnic ties and trust as the strongest predictor of FDI. However, this effect is valid only for English-speaking countries, not for countries sharing the same non-English or European native languages.

4. Research design and methodology

4.1 Sample description

Our empirical study works with panel data of 54 countries[2] during the period 2007–2021. The sample selection excluded countries that accounted only for a minor share of Moroccan outward FDI, with a threshold of MAD 1 million of outward stock of FDI.

4.2 Variables description and conceptual model

We aim to identify the effect of common languages on the location decision of Moroccan firms in host countries. FDI is the practical proxy variable usually used when investigating MNE location choice. In particular, the variable used for the empirical analysis is the flow of outward FDI of Moroccan investors.

For the main explanatory variables related to common languages, we use four languages. The first is standard Arabic (Ar), the official language spoken in Morocco. The other languages are foreign languages commonly spoken in Morocco, which are French (Fr), English (Eng), and Spanish (Sp). We measure the linguistic distance or proximity by the percentage of the population that speaks the language in the host country.

Our data on Moroccan FDI are mixed and do not distinguish between vertical and horizontal FDI, which leads us to use the knowledge-capital model (KCM) introduced by Markusen and Venables (1998). That conceptual model aims to identify the type of FDI by computing other location factors of FDI: trade tariffs,

[2] Algeria, Andorra, Austria, Bahrain, Belgium, Benin, Brazil, Burkina Faso, Cameroon, the Central African Republic, Chad, Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Denmark, Egypt, France, Gabon, Ghana, Germany, Guinea, Guinea-Bissau, India, Jordan, Kenya, Kuwait, Lebanon, Luxembourg, Madagascar, Mali, Malta, Mauritius, Mauritania, Monaco, Niger, Nigeria, Norway, the Netherlands, Portugal, Qatar, Rwanda, Saudi Arabia, Senegal, Singapore, Slovakia, Spain, Sweden, Switzerland, the United Republic of Tanzania, Togo, Tunisia, Uganda, the United Arab Emirates, the United Kingdom and the United States.

market size, distance and factor endowment. In other words, location factors explain the type of FDI. According to the KCM, horizontal FDI is affected positively by market size, tariffs and geographical distance. Vertical FDI is affected negatively by distance and tariffs and positively by input endowment.The variables included in the empirical model are described in table 1.

Table 1. Description of variables

Variable name	Label	Detailed description and measurement	Data source
Foreign direct investment	FDI	Flow of outward investment where the equity ownership of at least 10 per cent,reflects a lasting interest by a resident in one economy in a firm resident in another economy (OECD, 2008), measured in current United States dollars	Morocco, Exchange Office (2022)
Arabic/French/ Spanish/English languages	Ar/Fr/ Sp/Eng	The percentage of the population in the host country who speak the language	Marcoux et al. (2022); Marcoux et al. (2022); WorldData.info[a]
Geographical distance	Dist	The geographical distance between Morocco and host countries in kilometers, as the direct linear distance between the centres of mass (or geographical centres)	Distance Calculator[b]
Revealed comparative advantage	RCA	Proxy for factor endowment of host countries using the RCA, based on the Ricardian trade model, to indicate the competitiveness of a country that has on other countries, the RCA being the exports share of a product j in the total exports of a given country divided by the exports share of the product in the total exports of a zone reference	World Integrated Trade Solution[c]
Weighted average tariffs effectively applied	Tar	Average of effectively applied rates weighted by the product import shares corresponding to each partner country	World Integrated Trade Solution[d]
Gross domestic product	GDP	Proxy for market size, measured by GDP at purchaser's prices in current United States millions of dollars, indicating the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products; calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources	World Bank[e]
Human capital index	HCI	A measure of labour productivity based on health and education systems, with the final index score ranging from zero to one and measuring the productivity as a future worker of a child born today relative to the benchmark of full health and complete education	World Bank[f]

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Table 1. Description of variables (Concluded)

Variable name	Label	Detailed description and measurement	Data source
Ease of doing business	DBI	Simple average of all sub-indicators (starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency), ranging from 0 for the worst business climate to 100 for the best business climate	World Bank[g]
Institutional quality	IQ	Proxy for institutional quality, using the rule of law index, which reflects agents' confidence in abiding by rules of society regarding contract enforcement, property rights protection, police effectiveness, and judiciary system; index range between -2.5 for weak rule of law and 2.5 for strong rule of law	World Bank[h]

Source: Authors' elaboration from data accessed on 15 March 2022.
[a] www.worlddata.info/languages/english.php.
[b] https://distancecalculator.globefeed.com/Distance_Between_Countries.asp.
[c] https://wits.worldbank.org.
[d] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.
[e] https://databank.worldbank.org/metadataglossary/worldwide-governance-indicators/series/RL.EST).
[f] https://databank.worldbank.org/source/human-capital-index.
[g] https://archive.doingbusiness.org/en/data.
[h] https://databank.worldbank.org/source/worldwide-governance-indicators.

4.3 Empirical model

To identify the effect of language distance on Moroccan choice for FDI location, we formulate the general hypothesis using the gravity model to measure the sensitivity of Moroccan outward FDI flows to linguistic distance (Feng et al., 2019). Thus, the dependent variable is FDI regressed by the independent variables relative to the language within the sample countries. In addition, we use control variables within the conceptual framework of KCM to understand the investment behaviour of Moroccan MNEs. The empirical model is as follows:

$$FDI_{it} = A.Dist^{\beta_1}{}_{it}.RCA^{\beta_2}{}_{it}.GDP^{\beta_3}{}_{it}.Tar^{\beta_4}{}_{it}.HCI^{\beta_5}{}_{it}.DBI^{\beta_6}{}_{it}.IQ^{\beta_7}{}_{it}.Ar^{\beta_8}{}_{it}.Fr^{\beta_9}{}_{it}.Sp^{\beta_{10}}{}_{it}.Eng^{\beta_{11}}{}_{it}.u_{it}$$

After the logarithmic transformation:

$$Log(FDI_{it}) = \alpha_{it} + \beta_1 Log(Dist_{it}) + \beta_2 Log(RCA)_{it} + \beta_3 Log(GDP)_{it} + \beta_4 Log(Tar)_{it} + \beta_5 Log(HCI)_{it} + \beta_6 Log(HDI)_{it} + \beta_7 Log(IQ)_{it} + \beta_8 Ar_{it} + \beta_9 Fr_{it} + \beta_{10} Sp_{it} + \beta_{11} Eng_{it} + \varepsilon_{it}$$

FDI_{it} denotes the flow of outward Moroccan FDI in millions of dirham, converting to dollars at an annual exchange rate,[3] into host country i in year t. $Dist_{it}$ denotes the geographical distance in kilometers between Morocco and host country i. RCA_{it} indicates the revealed comparative advantage of country i in year t. GDP_{it} denotes the gross domestic product in current United States millions of dollars in host country i in year t. Tar_{it} indicates the weighted average tariffs effectively applied on Morocco exports by host country i in year t. HCI_{it} indicates the human capital index of country i in year t. DBI_{it} indicates the ease of doing business score of country i in year t. IQ_{it} indicates the institutional quality of country i in year t. Ar_{it}, Fr_{it}, Eng_{it} and Sp_{it} indicate the percentage of the population speaking the language of country i in year t; α_{it} denotes the specific fixed effect of each country to control for the omitted factors relatively stable over time; and ε_{it} is the normally distributed error term.

The general hypothesis is that the greater the percentage of the population within the host country who speak the same language as Morocco, the more FDI is attracted to that host country.

4.4 Estimation method

We chose the robust least squares (RLS) estimation method because ordinary least squares estimators are much less robust under the existence of observations outside the norm for our regression model. Thus, outliers would not accurately reflect the underlying statistical relationship between the dependent and explanatory variables. In other words, outliers tend to pull the least squares fit too far in their direction by receiving much more weight than they deserve.

Although the weight attached to each observation is supposed to be, on average, 1/*n* in a data set within observations, the outliers may receive considerably more weight, leading to distorted estimates of the regression coefficients. This distortion results in outliers that are difficult to identify since their residuals are much smaller than they would be if the distortion were not present.

Thus, the estimators of RLS reduce the influence of these outliers to provide better data by down-weighting the outliers, which makes their residuals larger and easier to identify. In particular, we use the M-estimation technique elaborated by Huber (1973) that addresses dependent variables, i.e. FDI outliers, where there are large residuals because its values differ noticeably from the regression model norm. Consequently, robust weighted least squares (RWLS) provides an alternative to

[3] Considering the low average rate of inflation in Morocco between 2008 and 2022, at 1.57 per cent, the conversion of dirhams to dollars at an annual exchange rate would not be biased during the estimations.

other least squares estimation methods by requiring less restrictive assumptions regarding normality and homoscedasticity, using the Welsch function as the best of other weight functions (Yulita et al., 2018).

5. Empirical result and discussion

Before estimating the empirical model, table 2 presents the descriptive statistics of the variables.

Table 2. Descriptive statistic of model variables

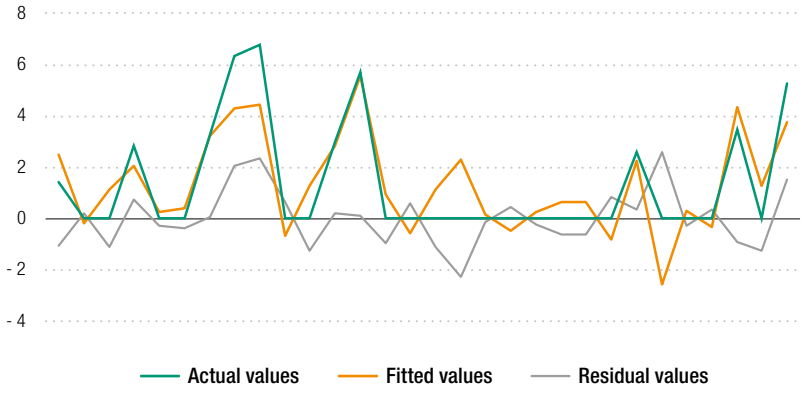
Variable	Mean	Median	Maximum	Minimum	Standard deviation	Number of observations	Jarque-Bera statistic
FDI	12.24	0.23	541.70	0.00	41.41	810	241 002.30***
Dist	5 734.94	3 955.50	71 658	940.00	9 403.14	810	6 4637.47***
RCA	128.99	131.00	199.00	52.00	29.49	459	24.73***
GDP	724 000	47 300	21 400 000	697	2 450 000	755	61 573.09***
Tar	5.37	1.93	37.96	0.00	6.57	505	264.48***
HCI	0.56	0.55	0.89	0.29	0.17	188	16.47***
DBI	61.10	61.30	89.50	26.90	15.40	549	28.99***
IQ	0.19	-0.09	2.445	-1.85	1.16	742	59.44***
Ar	0.16	0.00	0.99	0.00	0.31	810	578.83***
Fr	0.26	0.15	0.97	0.00	0.27	810	181.28***
Eng	0.37	0.24	0.98	0.01	0.35	810	91.65***
Sp	0.04	0.00	0.99	0.00	0.06	810	25 691.52***

Source: Authors' estimation.
Note: ***, **, * indicate a significant level at 1, 5 and 10 per cent, respectively.

The mean and the median of the variables are notably far apart, which indicates the non-random distribution of these variables. In addition, Jarque-Bera's statistic confirms by rejecting the null hypothesis that the variables are distributed randomly at the significance level of 1 per cent. Those results indicate that we need the method estimation of RLS that deals with normality issues besides heteroscedasticity. In addition, the minimum values of some variables are inferior to 1, which constitutes an issue when conducting logarithmic transformation. Thus, we add +1 when transforming FDI, Tar, HCI, Ar, Fr, Eng and Sp and +3 to IQ, so all the values are superior to 1.

Before interpreting the empirical estimations, we check the robustness of the model and its significance. We re-run the model using a colonial heritage dummy (1 = French, 0 = countries not colonized by France) instead of the language variables. The findings show that countries that share a French colonial history are more likely to attract Moroccan outward FDI than those with other colonial heritages.[4] The results tally with those of our model with the language variables (table 6). We also test for heteroscedasticity, which is the central bias that the model encounters regarding spurious regression. As explained in the previous section, the RLS method allows us to produce unbiased estimators and reliable results without heteroscedasticity. In other words, heteroscedasticity increases the variance of the coefficient estimates, which could falsely declare them to be statistically significant. Thus, to eliminate the problem of heteroscedasticity, we use weighted regression, in particular RWLS, by assigning a proper weight to each observation based on the variance of its fitted value. In other words, RWLS gives small weights to outliers with higher variance, to shrink their squared residuals. Heteroscedasticity is present when there is an unequal scatter of residuals or error terms, i.e. a systematic change in their spear over the range of measured values. Its detection can be conducted by observing the residual, actual and fitted plots, as presented in figure 1.

Figure 1. Scatterplot of residual, actual and fitted values of the dependent variable



Source: Authors' estimation.

[4] The results are available from the authors upon request.

We notice how the residuals are distributed normally and spread randomly. This confirms the absence of heteroscedasticity and autocorrelation in the model. In addition, the actual and fitted values of Log(FDI+1) are aligned with each other. That indicates that the model is robust and fits well the observed data. We use the correlogram for residuals and Q-statistic to check if there is autocorrelation between residuals and supposed white noise. Table 3 presents the results.

Table 3. Q-statistic results

Lag specification	AC	PAC	Q statistic	P-value
1	0.105	0.105	0.3675	0.544
2	-0.050	-0.062	0.4548	0.797
3	-0.169	-0.159	1.4730	0.689
4	-0.051	-0.020	1.5705	0.814
5	0.098	0.093	1.9376	0.858
6	-0.164	-0.223	3.0080	0.808
7	0.076	0.125	3.2473	0.861
8	-0.017	-0.027	3.2593	0.917
9	0.002	-0.050	3.2595	0.953
10	-0.050	-0.041	3.3804	0.971
11	-0.076	-0.024	3.6696	0.979
12	0.018	-0.047	3.6876	0.988
13	0.031	0.060	3.7406	0.994
14	0.019	-0.032	3.7611	0.997
15	0.012	0.018	3.7696	0.998
16	-0.062	-0.065	4.0313	0.999

Source: Authors' estimation.

The results show that all Q statistics are non-significant for all lag specifications. In other words, the Q test does not reject the null hypothesis that there is no autocorrelation of errors. It confirms the previous finding that the distribution of residuals is random. In the next step, we investigate the normality assumption; table 4 presents the results.

Table 4. Normality tests

Mean	Median	maximum	Minimum	Skewness	Kurtois	Jarque-Bera	Probability
0.016297	0.086663	2.662827	-2.256701	0.466132	3.133710	1.108743	0.574433

Source: Authors' estimation.

Starting with the Jarque-Bera test, it seems that we cannot reject the null hypothesis that the residuals are normally distributed. In addition, the value of skewness indicates that the probability distribution of errors is asymmetrical, which confirms the random distribution of error terms. And, the value of the Kurtois statistic equals 3, which indicates that the distribution is mesokurtic.

The last assumption is that there no collinearity between explanatory variables. Collinearity between the predictors makes their coefficients less exact, causes estimation biases and creates overfitting problems. In other words, highly correlated independent variables make it hard to select the variables for the model because changing explanatory variables could affect the value of coefficients, hence making them unstable and difficult to interpret. Thus, checking multicollinearity makes it possible to avoid such estimation problems. We plot the covariance matrix of all independent variables as presented in table 5.

The results show that there is no significant association between the explanatory variables, which indicates the absence of collinearity between these variables.

The estimates show that sharing the Arabic language, the official language in Morocco, between Morocco and host countries is an FDI location factor. In particular, the variable Ar positively affects Moroccan FDI at the significance level of 1 per cent. An increase of 1 per cent in the Arabic-speaking population of the host country leads to an increase in FDI outflows from Morocco by 0.64 per cent. Therefore, having Arabic as a common language makes it easier for MNEs to adapt to the host economy because of cultural proximity. Equally, the estimates show that sharing the French language – the most spoken foreign language in Morocco – between Morocco and host countries is an FDI location factor. In particular, the variable Fr positively affects Moroccan FDI at the significance level of 1 per cent. An increase of 1 per cent in the French-speaking population of the host country causes an increase in FDI outflows from Morocco of 4.15 per cent. Having French as a common language makes it easier for Moroccan MNEs to adapt to the host economy, mainly to avoid communication barriers and institutional distance.

However, the results show that sharing the Spanish language is not an FDI location factor as the variable Sp has no significant effect on FDI. Having Spanish as a common language does not matter for Moroccan investors because of its limited use in the Moroccan educational system and other public institutions.

Table 5. Coefficient covariance matrix

	LOG(Dist)	LOG(RCA)	LOG(PIB)	LOG(Tar)	LOG(HC)	LOG(DB)	LOG(IQ)	Ar	Fr	Sp	Eng
LOG(Dist)	1	0.003809	0.000715	-0.000124	0.004380	-0.010604	0.003357	-0.002138	0.000768	0.000178	-0.004285
LOG(RCA)	0.003809	1	-0.004648	0.001401	0.075442	-0.067582	0.011693	-0.009556	-0.015188	-0.006748	-0.011406
LOG(PIB)	0.000715	-0.004648	1	-0.000167	-0.012984	0.000729	0.001114	0.001490	0.000788	-0.003737	-0.003080
LOG(Tar)	-0.000124	0.001401	-0.000167	1	0.013975	0.001332	-0.000263	0.001124	-0.002167	0.001174	-0.002186
LOG(HCl)	0.004380	0.075442	-0.012984	0.013975	1	-0.272678	-0.116632	0.017438	-0.053759	-0.029936	-0.012197
LOG(DB)	-0.010604	-0.067582	0.000729	0.001332	-0.272678	1	-0.089382	-0.003643	0.027432	0.027066	0.023732
LOG(IQ)	0.003357	0.011693	0.001114	-0.000263	-0.116632	-0.089382	1	0.001452	-0.011720	-0.007384	-0.027652
Ar	-0.002138	-0.009556	0.001490	0.001124	0.017438	-0.003643	0.001452	1	0.007025	0.006673	0.007848
Fr	0.000768	-0.015188	0.000788	-0.002167	-0.053759	0.027432	-0.011720	0.007025	1	0.014522	0.021483
Sp	0.000178	-0.006748	-0.003737	0.001174	-0.029936	0.027066	-0.007384	0.006673	0.014522	1	0.028984
Eng	-0.004285	-0.011406	-0.003080	-0.002186	-0.012197	0.023732	-0.027652	0.007848	0.021483	0.028984	1

Source: Authors' estimation.

Table 6. The effect of language proximity/distance on outward FDI from Morocco

Variable	Coefficient	Stabdard error	Z-statistic
C	-3.800685***	0.158912	-23.91687
Log(Dist)	0.736614***	0.056022	13.14862
Log(RCA)	4.676195***	0.280628	16.66335
Log(GDP)	0.800714***	0.038504	20.79560
Log(Tar)	0.991815***	0.046214	21.46151
Log(HCI)	6.253190***	1.098648	5.69171
Log(DBI)	-2.411838***	0.523067	-4.61095
Log(IQ)	-3.213013***	0.323170	-9.94219
Ar	0.647031***	0.160432	4.03305
Fr	4.152561***	0.189599	21.90176
Sp	0.346503	0.298598	1.16043
Eng	-4.642093***	0.243853	-19.03647
R^2	0.654750		
Adjusted R^2	0.447640		
Rw^2	0.762058		
Adjusted Rw^2	0.762058		
Sample	1 810		
Included Observations	30		
Rn^2 statistic	4 359***		

Source: Authors' estimation.

Note: ***, **, * indicate a significant level at 1, 5 and 10 per cent, respectively. Estimation method: RWLS with M-estimate. The covariance type for the estimate is the Huber type with Welsch function for the weight. Scale used is Huber. The dependent variable is Log(FDI). In order to avoid estimation error due to non-positive and zero values, some variables are transformed as follows: Log(FDI+1), Log(Tar+1); Log(HCI+1) and Log(IQ+3).

In addition, estimates show that sharing the English language between Morocco and host countries is a deterrent to FDI. In particular, the variable *Eng* negatively affects Moroccan FDI at the significance level of 1 per cent. An increase of 1 per cent in the English-speaking population of the host country causes a decrease in FDI outflows from Morocco by 4.64 per cent. Therefore, when English is the dominant language in the host country, it is difficult for Moroccan MNEs to adapt to the host economy because of the significant institutional distance between French- and Arabic-speaking countries and Anglo-Saxon culture.

Furthermore, it seems that Moroccan outward FDI is mostly horizontal because the estimations show that GDP, tariffs, distance and revealed comparative advantage positively affect FDI at the significance level of 1 per cent, where an increase of 1 per cent in their value causes an increase in Moroccan FDI by 0.80 per cent, 0.99 per cent, 0.73 per cent and 4.67 per cent, respectively.

General discussion: The empirical results show that language constitutes a foreignness liability for Moroccan MNEs when investing abroad, which confirms the general hypothesis that linguistic distance hinders outward FDI in host economies. In other words, the closer the host country is linguistically, the more it receives FDI inflows from the source economy. Furthermore, the estimates demonstrate that Moroccan outward FDI flows are more sensitive to French linguistic proximity than to Arabic because sharing the same institutional structure is more relevant than cultural proximity. Morocco inherited formal institutions from its former colonizer, i.e. France, which makes it easier for MNEs to adapt to a host country that shares the same colonial legacy and hence the same methods of structuring business and legal systems. Sharing the Arabic language may make adapting easier on the communication and trust level, but not on the institutional level, which is the greatest determinant of FDI location choice. Despite the common understanding of English as a global language, the English-speaking world is more likely to adopt an Anglo-Saxon approach to governance and doing business, an approach that differs distinctively from the francophone system. Thus, English linguistic proximity deters Moroccan FDI as it signals to Moroccan MNEs the existence of a different mindset and way of conducting business and trade. Finally, speaking Spanish does not affect Moroccan FDI, which is reasonable considering that Morocco marginalized the role of the Spanish language after its independence.[5]

According to the conceptual framework of the KCM, the results show that Moroccan FDI is horizontal and mostly market-seeking, which means that Moroccan MNEs operate in sales of final goods and services, where they are required to understand local languages. According to the estimates, the gross domestic product (GDP) of host countries positively affects outward FDI, with an increase in GDP of 1 per cent leading to an increase in FDI outflows of 0.80 per cent. The tariffs applied by host countries on Moroccan goods positively affect outward FDI, with an increase of 1 per cent causing an increase in FDI outflows by 0.99 per cent. This result confirms that FDI is horizontal. This type of investment is tariff-jumping FDI, where higher customs duties lead MNEs to adopt an FDI strategy instead of an export strategy, creating the goods directly in the host country. Equally, geographical distance positively affects Moroccan FDI because distant host countries imply higher logistical and transportation costs, which is a feature of horizontal FDI that

[5] *El País*, "Morocco's diminishing interest in learning Spanish", 17 January 2018.

seeks to produce final goods in the host country to avoid surcharges – contrary to vertical FDI, which is more sensitive to geographical distance because of the international division of production. In other words, it seems that Moroccan MNEs invest horizontally in host countries that are linguistically closer, even if they are geographically distant. Finally, higher revealed comparative advantage attracts Moroccan FDI because MNEs that adopt a horizontal strategy seek countries where domestic labour is highly productive. Previous studies of the effect of language on FDI location choice have demonstrated the role of a common language in attracting FDI. Our paper studies outward FDI from a developing country such as Morocco and compares the effect of sharing a native language such as Arabic and a foreign language inherited from its past colonizer, i.e. France. Interestingly, the empirical work shows that having French as a common language is more impactful than having Arabic as a common language, which indicates the prevalence of an institutional mediator over a cultural one, especially for MNEs from countries with a common past colonizer.

6. Conclusions and policy implications

The present paper constitutes a novelty in the literature dealing with the effect of language proximity on FDI location choice by analysing a different context: MNEs from developing and African countries such as Morocco. Previous studies have focused only on MNEs from developed and emerging economies and on European languages such as English for the most part. This paper considers Spanish and French as inherited foreign languages from past colonizers (France and Spain), Arabic as the official language and English as a global language.

Many factors influence the decision of MNEs about investing abroad. In particular, the characteristics of the host country, such as cultural and linguistic distances, can constitute an obstacle for the foreign investor. Indeed, as an element of the psychic distance, language generates an asymmetry of information capable of hampering the internationalization process and causing additional costs.

Thus, we build our central hypothesis, suggesting that shared language is a factor that determines FDI location choice, based on previous studies that have shown the essential role of language in the development of MNEs abroad. When the host country and the home country share the same spoken language, FDI is attracted more than when the spoken language is different. Our study attempted to identify the effect of common languages on the choice of location of outward Moroccan FDI into 54 host countries by using a gravity model to measure the sensitivity of these FDI flows to linguistic distance. We found that language is indeed an obstacle to Moroccan MNEs, as the language spoken in the host and origin countries is different, thus confirming the central hypothesis. Indeed, the results show that the flows of outward Moroccan FDI to the countries under study are more sensitive to

linguistic proximity for French than for Arabic, returning to the fact that Morocco inherited the institutional structure of the Republic of France. As for Spanish, sharing this language has no significant effect on Moroccan FDI location choice. However, in countries where English predominates, it acts as a deterrent to Moroccan FDI due to the institutional differences between the French governance model and the Anglo-Saxon one.

The results of this study thus make it possible to provide stakeholders, in both the home and the host country, with answers that will serve and guide appropriate policies. In this sense, linguistic differences must be considered when investing abroad, and when aiming to attract inward foreign investment.

Regarding the policy implications related to outward FDI, public officials can establish a liaison office in a host country to support MNEs in their activity and facilitate their internationalization, with particular emphasis on core markets where language differences have a detrimental effect on outward FDI performance. In addition, given that language is associated with culture, public decision makers in the home country may wish to consider establishing cultural institutes or language training centres in the target host countries, which could be advantageous for MNEs wishing to invest in these countries. Developing countries may not have the resources for establishing a comprehensive international network of such institutions, but may wish to target core potential growth markets where linguistic distance proves to be an obstacle for the home country's outward FDI flows. At the host country level, the attractiveness to inward FDI requires adapting incentive measures to attract potential MNEs, by coordinating local language policies with those relating to investments, as well as integrating foreign languages in education.

For Moroccan decision makers, the results of the study imply different policies for each language. The effect of sharing the French language is more relevant than sharing the Arabic language owing to institutional aspects related to the language. Investing in an Arabic-speaking host country would not spare Moroccan MNEs from other transaction costs because sharing the Arabic languages implies only a cultural approximate whereas institutional distance is the most important factor.

On the one hand, decision makers should work on institutional cooperation between Arabic-speaking countries to enhance the flow of bilateral FDI by seeking a greater degree of coordination of their investment policy framework, through multilateral organizations of Arabic-speaking countries such as the Gulf Cooperation Council. On the other hand, having French as a common language seems very impactful because sharing the same colonial heritage makes it easier to conduct business and to understand the institutional climate. Policymakers should exploit this asset and cooperate more with those French-speaking countries, especially in terms of investment promotion and facilitation, with a view to safeguard and further grow Moroccan outward FDI into these countries.

Finally, the results show that speaking English has a negative effect on Moroccan FDI, which is reasonable given the institutional distance between Morocco and predominantly English-speaking countries. To surpass this barrier, Moroccan policymakers should seek to coordinate investment policy frameworks with English-speaking countries to reduce the complexity resulting from the institutional differences between the two ways of doing business and regulating.

Regarding the geographical distribution of outward FDI, the findings of the study seem to suggest the implementation of policies and actions with a view to further diversifying outward FDI beyond the emphasis on France, in countries where Spanish and English are the main or important language. This explains the strategy of the Moroccan Minister of National Education to generalize the teaching of English in the first year of middle schools in 2024, the second year in 2025 and the third year in 2026.[6] In addition, Morocco and Spain are evaluating the possibilities of including Spanish in Moroccan schools to strengthen cooperation in educational matters within the bilateral working group on education, vocational training and higher education.[7]

The limitation of this paper is that it uses macroeconomic data to test the effect of language on FDI location choice, which limits our understanding of the mechanisms leading to investment based on the linguistic factor. To enrich the results, a firm-level analysis could be undertaken in future projects. Future research could tackle the moderating role of sharing a common past colonizer on the effect of language on bilateral FDI. In addition, it could focus on the mediating role of sharing culture and trust, especially through diaspora communities in host countries. Finally, and as our study has shown, future studies need to pay greater attention to multilingual home-country contexts, and extending beyond the scope of this study, also to multilingual host-country contexts.

[6] Le Matin, L'enseignement de l'anglais dans les collèges généralisé entre 2024 et 2026", 19 October 2022.

[7] LesEco.ma, "Enseignement: la langue espagnole aura bientôt la cote au Maroc", 27 October 2022.

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Fourth Industrial Revolution and FDI from SMEs: The Case of the Republic of Korea*

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Abstract

The impact of Fourth Industrial Revolution (4IR) technologies on enterprises' internationalization strategies is ambiguous. Although digital technologies lower information and transaction costs and facilitate international coordination of overseas activities, automation technologies can push enterprises to reshore foreign operations. This paper analyses the impact of 4IR technologies on the foreign investment decisions of small and large enterprises in one of the most technologically advanced countries in the world: the Republic of Korea. The results indicate differential impact across enterprise sizes and technologies. The propensity of SMEs to invest overseas upon the adoption of 4IR technologies, especially digital technologies, increases relatively more than that of larger firms. The results have important implications for investment and development policies in the region. The findings highlight the key role of FDI by Korean SMEs in the technological development of neighbouring Asian economies, calling for increased attention to smaller players in investment promotion.

Keywords: digital economy, foreign direct investment (FDI), Fourth Industrial Revolution (4IR), multinational enterprises (MNEs), small and medium-sized enterprises (SMEs), technology

JEL classification codes: C43, F23, H25, L86, O31

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1. Introduction

Small and medium-sized enterprises (SMEs) are important contributors to the economies of many nations, particularly in developing economies. On average, across sectors and geographies, SMEs represent more than 90 per cent of businesses and generate 7 out of 10 formal jobs.[1] Yet relatively few SMEs engage in international trade, and even fewer invest abroad. International trade and investment activities benefit productivity and can bring gains for both home and host economies, including the achievement of the Sustainable Development Goals (SDGs), notably inclusive and sustainable economic growth, employment, and decent work for all (SDG 8), as well as sustainable industry and innovation (SDG 9).

Compared with larger companies, SMEs face considerable – longer-term – barriers to internationalizing. Owing to their limited size, SMEs do not benefit to the same degree from economies of scale, face more difficulties accessing financial resources as well as managerial and technical skills, and are often more affected by bureaucracy and poor infrastructure than larger firms. In addition, relative to large firms, SMEs have less bargaining power, relatively higher compliance costs and smaller networks. These specific challenges hamper SME growth and, in particular, their internationalization process (UNCTAD, forthcoming).

Over the last decades, Korean companies have been increasing their participation in the global economy, first through exports and then gradually through increasing outward FDI (Buckley et al., 2022; Kim et al., 2018; Moon, 2016). In recent years, the Republic of Korea obtained a position among the top 10 investor countries worldwide. In 2021, it reached a record high of over $60 billion in outward FDI, or 4 per cent of global flows (UNCTAD, 2022). Small and medium-size enterprises (SMEs) made a significant contribution to these investments. According to the Korean Statistical Office, SME investments accounted for 8–9 per cent of Korean outward FDI in 2012–2014, growing to about 25 per cent in 2019–2021.

Since the 1970s, the Korean Government has invested in technologies and research. Nowadays the country is, alongside Israel, the biggest spender on R&D worldwide, at more than 4 per cent of its GDP. In 2017 the Government introduced a new five-year

[1] The definition of what constitutes an SME varies significantly across national and international sources. Some definitions are exclusively based on the number of employees of a firm, or its annual turnover (UNCTAD, forthcoming). The number of employees is the most common criterion, yet the maximum thresholds differ across countries or regions. For example, the Organisation for Economic Co-operation and Development (OECD) uses the 250-employee threshold to define SMEs; in the World Bank Enterprise Surveys, the sample is limited to enterprises with fewer than 100 employees. In the European Union and the United Kingdom, an SME is defined as an enterprise that employs fewer than 250 people and has an annual turnover not exceeding €50 million, and/or an annual balance sheet total not exceeding €43 million (European Commission, 2020). In the United States, the threshold is 499 employees (USITC, 2010).

plan, called the Fourth Industrial Revolution (4IR), aimed at mobilizing all players in the Korean economy to work towards become a leading country in 4IR technologies. These technologies distinguish themselves from the digital revolution of previous decades in terms of velocity, scope and systems impact and include the Internet of Things (IoT), cloud computing, big data, 5G, artificial intelligence, blockchain, 3D printing, robotics and virtual or augmented reality. Focus areas of the five-year plan were the education of the workforce and making SMEs the technological foundation of the country.[2] As a result, in 2019, Korean SMEs could rely on the best information and communications infrastructure across OECD countries and a relatively high uptake of 4IR technologies (Bianchini and Kwon, 2021).

Technology adoption can have an important role in fostering outward FDI. Information and communication technologies (ICT) have been shown to facilitate exports, especially of SMEs (Aspelund and Moen, 2008; Hagsten and Kotnik, 2017). The use of ICT allows new channels for marketing as well as for sales and may reduce distance, entry-related, and more generally information costs, thereby lessening SMEs' networking disadvantage – factors that are particularly crucial for smaller firms with limited resources (Lohrke et al., 2006; Martens, 2013; Morgan-Thomas and Jones, 2009). There is little research analysing the specific impact of the 4IR on SME internationalization, aside from a few studies analysing a special type of SMEs – the so-called "born globals" – which in contrast to other firms do not internationalize incrementally but compete globally from inception (Bell et al., 2004; Rialp et al., 2012; UNCTAD, 2017). Not surprisingly, born global SMEs are typically high-tech or digital companies, supporting the idea that 4IR can help the internationalization process.

Yet, not all 4IR technologies are expected to promote internationalization. Automation technologies including the Internet of Things, robotics and 3D printing increase labour productivity, lower production costs and in turn weaken the drive for efficiency-seeking FDI (UNCTAD, 2020). Empirical evidence on the relation between the adoption of 4IR technologies and foreign investment is scarce. This relationship is likely to vary across industries, the specific technologies used and possibly also the size and or productivity of firms.

This paper analyses how the adoption of 4IR technologies can affect SMEs' decision to invest abroad. The paper contributes to two underresearched streams of literature: It addresses the impact of 4IR technologies on international production across different technologies, and it looks at the differential impact on SMEs. We analyse how the probability of investing abroad and the intensity of the investment relates to the adoption of 4IR technologies, using the Republic of Korea's Survey of Business Activities over the period 2017–2020.

[2] Schwab, Klaus (2016). "The Fourth Industrial Revolution: What it means, how to respond", 14 January, www.weforum.org.

The empirical results confirm that the adoption of technology had different and contrasting effects on SMEs and on larger, more established MNEs. 4IR technologies facilitated FDI by SMEs, but they had a dampening effect on the growth of international production networks of larger firms. Smaller companies quickly adopted digitalization technologies and leveraged this technological advantage in laggard economies to gain market presence, in particular in the services sector. At the same time, their smaller size slowed the adoption of automation technologies. As a consequence, their growth strategy has been to search for neighboring low-cost production economies. Despite having different motivations, both manufacturing and services SMEs have become key actors in regional integration processes, with much of their investments flowing to developing economies in South-East Asia and other less advanced economies.

The results have relevant policy implications. The findings confirm UNCTAD's predictions about declining trends in international investments in large manufacturing projects while highlighting the potential for SMEs to become a valuable alternative for the development of emerging economies (UNCTAD, 2022).. In the case of the Republic of Korea, SMEs have accounted for almost three quarters of projects (opening of subsidiaries; data from the National Statistics Office), mostly in neighboring, less advanced economies. Against this backdrop, trade and investment promotion agencies would do well to increase their attention to smaller players and to provide support services that lower the barriers for SMEs to internationalize.[3]

The findings of the paper also provide support for the idea that digitalization technologies can facilitate internationalization by lowering information costs and easing the coordination of foreign operations. For countries to reap the benefits, key elements are adequate digital infrastructure and platforms to enable smaller players to join regional and global value chains.

The paper is structured as follows. Section 2 describes the data and presents key stylized facts. The empirical model and results are presented in section 3. The final section concludes and briefly discusses policy implications.

2. Data and stylized facts

2.1 Data

The paper uses the Republic of Korea's Survey of Business Activities, which covers the period from 2006 to 2020. The survey has several major advantages in studying the effect of FDI on 4IR technology adoption. First, the data covers

[3] For in-depth policy recommendations, see UNCTAD (forthcoming).

all firms that have more than 50 employees and have capital stock larger than ₩300 million Korean won (approximately $250,000) and contains questions related to the adoption of each of the specific technologies included in the 4IR definition. Second, it allows for tracking individual firms through time without concerns about dropouts, other than the shutdown of businesses. Finally, the data set includes several variables on foreign subsidiaries (host country, total stock of capital invested and functionality of subsidiaries).

Throughout this paper, we define "SME" on the basis of the following criteria, as per the official definition by the Ministry of SMEs and Start-ups. In our analysis, we apply these criteria depending on the sector and year.

1. *Independence*: No more than 30 per cent of the shares is owned by a parent company, whose value of total assets exceeds ₩500 billion (about $380 million) either in the Republic of Korea or abroad. Also, a firm should not be a part or a subsidiary of companies belonging to enterprise groups that are subject to the limitations on mutual investment.
2. *Size*:
    - Number of employees: less than 300[4]
    - Total capital stock less than ₩8 billion[5] (about $6 million)
    - Total asset value less than ₩500 billion (about $380 million)
    - Total yearly turnover less than ₩150 billion (about $110 million)

Table 1 presents summary descriptive statistics on 12,900 firms for the year 2019 in the data set. We focus on the overall distribution of size indicators and patterns of outward FDI by looking at the subsidiaries abroad, and we disaggregate the sample by SME status to compare the size difference and FDI destinations. SMEs and larger firms differ in many dimensions other than size. On average, large enterprises hire 6 times more employees; they have 15 times larger yearly turnover and have 30 times larger value of total assets. SMEs and large enterprises also exhibit significant differences across sectors. SMEs are more concentrated in manufacturing (54 per cent versus 39 per cent), where the main difference is driven by the greater number of large enterprises in the finance/insurance and retail/wholesale sectors. In relation to FDI, on average, SMEs have 0.42 foreign subsidiaries, as compared with the 1.13 in large enterprises.

[4] The number of employees applies to firms in the data set before 2015. This data is for the manufacturing sector only. Depending on the sector, the benchmark for the number of employees varies from 50 to 300.

[5] For manufacturing, construction, transportation and mining sectors prior to 2015. The threshold varied from ₩8 billion to ₩3 billion across sectors.

Table 1. Descriptive statistics

	SMEs			Large enterprises		
	Count	Mean	Standard deviation	Count	Mean	Standard deviation
Firm size						
Total employees	7 586	105.59	63.63	5 314	619.47	2 414.38
Yearly turnover (millions of dollars)	7 586	26.07	23.84	5 314	407.91	2 314.16
Total assets (millions of dollars)	7 586	35.11	43.01	5 314	1 079.21	11 332.40
Subsidiaries						
Number of foreign subsidiaries	7 586	0.42	1.03	5 314	1.13	3.24
Sector						
Agriculture	7 586	0.00	-	5 314	0.00	-
Mining	7 586	0.00	-	5 314	0.00	-
Manufacturing	7 586	0.54	-	5 314	0.39	-
Energy	7 586	0.00	-	5 314	0.01	-
Water/sewage	7 586	0.01	-	5 314	0.01	-
Construction	7 586	0.05	-	5 314	0.04	-
Retail/wholesale	7 586	0.08	-	5 314	0.16	-
Transportation	7 586	0.06	-	5 314	0.05	-
Food/lodging	7 586	0.03	-	5 314	0.03	-
Information/telecommunication	7 586	0.08	-	5 314	0.09	-
Finance/insurance	7 586	0.01	-	5 314	0.06	-
Real estate	7 586	0.02	-	5 314	0.02	-
Science/technology	7 586	0.05	-	5 314	0.04	-
Facility maintenance	7 586	0.03	-	5 314	0.07	-
Public affairs	7 586	0.01	-	5 314	0.01	-
Education	7 586	0.00	-	5 314	0.00	-
Health care	7 586	0.02	-	5 314	0.02	-
Arts and sports	7 586	0.01	-	5 314	0.00	-
4IR technology use						
Internet of things	7 508	0.03	-	5 586	0.04	-
Cloud	7 508	0.05	-	5 586	0.08	-
Big data	7 508	0.03	-	5 586	0.08	-
Mobile	7 508	0.02	-	5 586	0.04	-
Artificial intelligence	7 508	0.03	-	5 586	0.05	-
Blockchain	7 508	0.01	-	5 586	0.01	-
3D printing	7 508	0.01	-	5 586	0.02	-
Robotics	7 508	0.01	-	5 586	0.02	-
Augmented or virtual reality	7 508	0.01	-	5 586	0.02	-

Source: Republic of Korea, Survey of Business Activities, 2019.

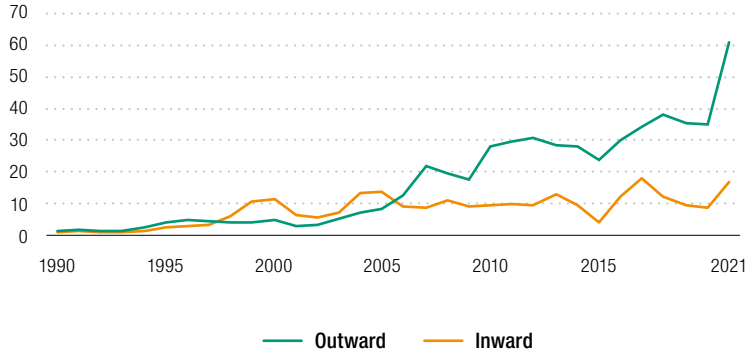
Note: The number of observations includes all observations in the panel that the data set spans. The dummy variables for technology usage (4IR technology use) are constructed for each type of technology if a firm is utilizing the technology during the survey year for (i) company operation (e.g. marketing, sales, organization management) or (ii) product/service development.

Companies from the Republic of Korea are important investors in neighbouring economies, benefitting from several trade agreements with investment provisions. The Republic of Korea joined fourteen other Asia-Pacific countries in signing the Regional Comprehensive Economic Partnership (RCEP), which by some measures, is the biggest regional trade and investment agreement in the world. The RCEP entered into force on 1 January 2022, strengthening Asia-Pacific economic integration. The investment provisions in the agreement mostly consolidate existing market access as contained in a myriad of bilateral agreements. Importantly, the provisions related to market access and disciplines in trade, services and e-commerce are highly relevant for regional value chains and market-seeking investment.

The country is signatory to 18 other free trade agreements with ASEAN, Australia, Canada, Central America (Partial), Chile, China, Colombia, the European Free Trade Association, the European Union, India, New Zealand, Peru, Singapore, the Republic of Türkiye, the United Kingdom, the United States and Viet Nam. It is also a signatory of over 100 investment treaties (bilateral, regional, multilateral), with substantive provisions on technology and measures friendly to FDI.

The Republic of Korea has become a key global investor over the years, ranking among the top 10 such investors (UNCTAD, 2022). Korean outward FDI started increasing since 1995 and boomed after 2005, when the country became a net outward investor (figure 1). The main destinations and drivers have also changed over the years, with more FDI driven by market-seeking motives towards large developed and emerging economies and less by efficiency-seeking in low-cost neighbouring economies (Buckley et al., 2022; Kim et al., 2018).

Figure 1. Republic of Korea: outward and inward FDI (Billions of dollars)

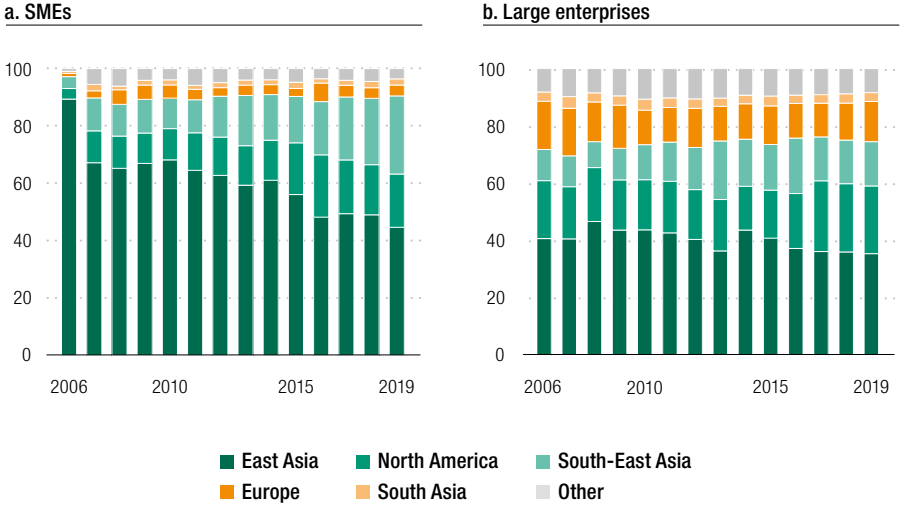


Source: UNCTAD.

Preferred locations for investments are determined by different drivers across firm sizes. In recent years, most of the FDI by SMEs from the Republic of Korea was efficiency-seeking and into South-East Asia. Motivated by the increasing production costs in the Republic of Korea, manufacturing SMEs invested in cheaper neighbouring locations in the region, first in China and more recently in Viet Nam and Indonesia. In contrast, FDI by large enterprises was relatively more motivated by network- and market-seeking drivers (figure 2). The difference in the pattern of FDI is mainly attributed to the difference in industry sectors between SMEs and large enterprises. As shown in table 1, over half of Korean SMEs are manufacturing firms. Their main motivation for internationalizing to South-East Asia has been rising costs for domestic production and labour (see also Kwak et al., 2017). The largest manufacturing sectors among SMEs are electronics (13 per cent), machinery and equipment (13 per cent) and vehicle parts (11 per cent). This explains the distinct geographical patterns of FDI between SMEs and large enterprises.

The data allows the measurement of the effect of 4IR technologies, including IoT, cloud computing, big data, 5G, artificial intelligence, blockchain, 3D printing, robotics and augmented/virtual reality. In the data set, the dummy variable for technology use is constructed for each type of technology if a firm is utilizing the technology during that survey year for (i) company operation (e.g. marketing, sales, organization management) or (ii) product or services development.

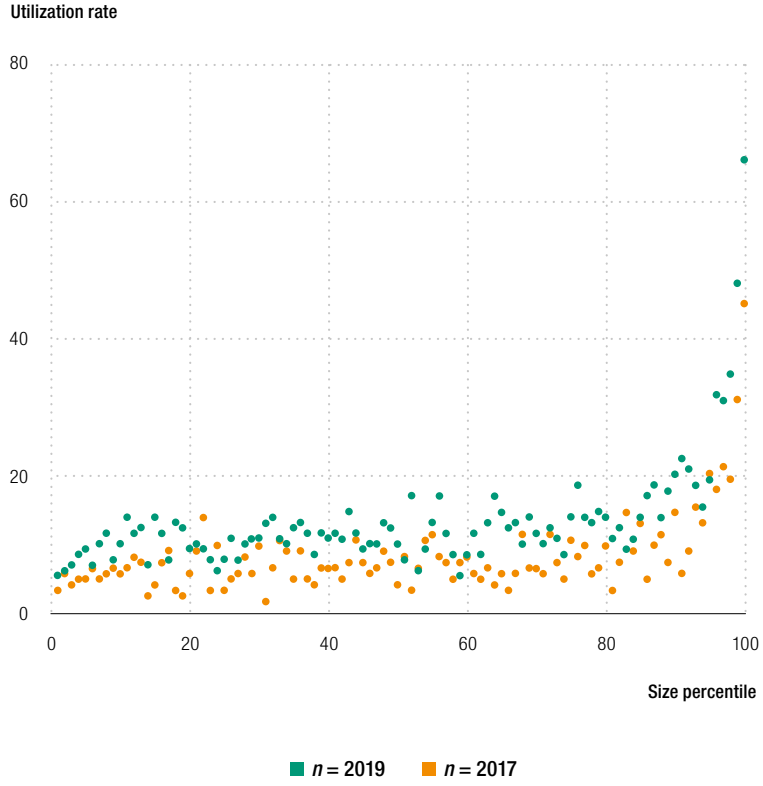
Figure 2. Share of FDI stock by region (Percentage)



Source: Republic of Korea, Survey of Business Activities, 2006–2019.

Figure 3 shows the significant disparity between larger and smaller firms in adoption of 4IR technology. In the figure, the share of firms that have adopted 4IR technology is plotted with respect to each size percentile, by turnover. Whereas firms below the 80th percentile in turnover remain overall homogeneous in adoption rate, large firms (above the 95th percentile in turnover) have adoption rates that are substantially higher than smaller firms. Moreover, although the average rate of adoption has increased over time for firms in all size percentiles, the increase in adoption rate has been bigger for firms in the top percentiles. To sum up, not only are large firms more likely to adopt 4IR technologies, but they are also faster to adopt technological innovation.

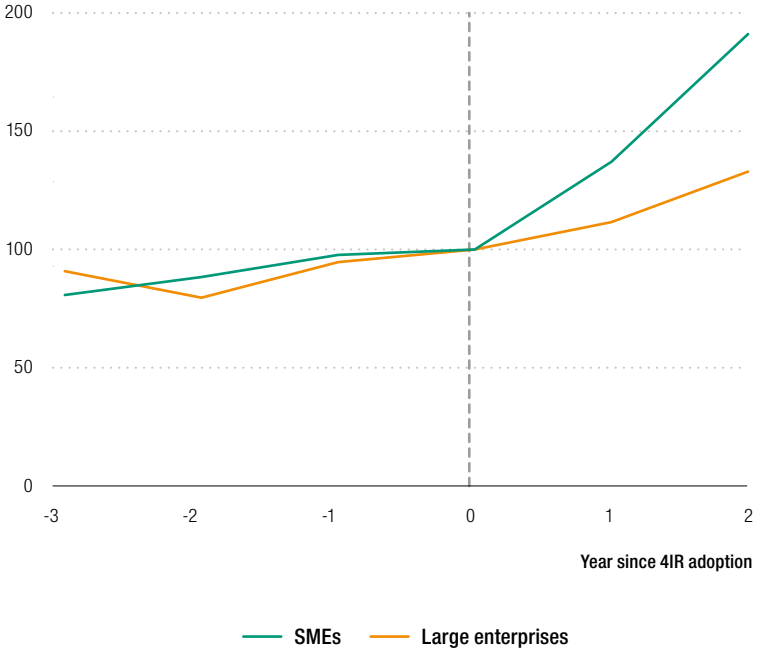
Figure 3. Share of firms adopting 4IR technologies, by size (Percentage)



Source: Republic of Korea, Survey of Business Activities, 2017 and 2019.

Note: Utilization rate refers to the percentage of firms utilizing 4IR technology (IoT, could computing, big data, artificial intelligence, blockchain, 3D printing, robotics, augmented or virtual reality) in each percentile. Size percentile is based on yearly turnover reported in the Survey of Business Activities.

Figure 4. 4IR technology adoption and FDI stock, index (year 0 = 100)

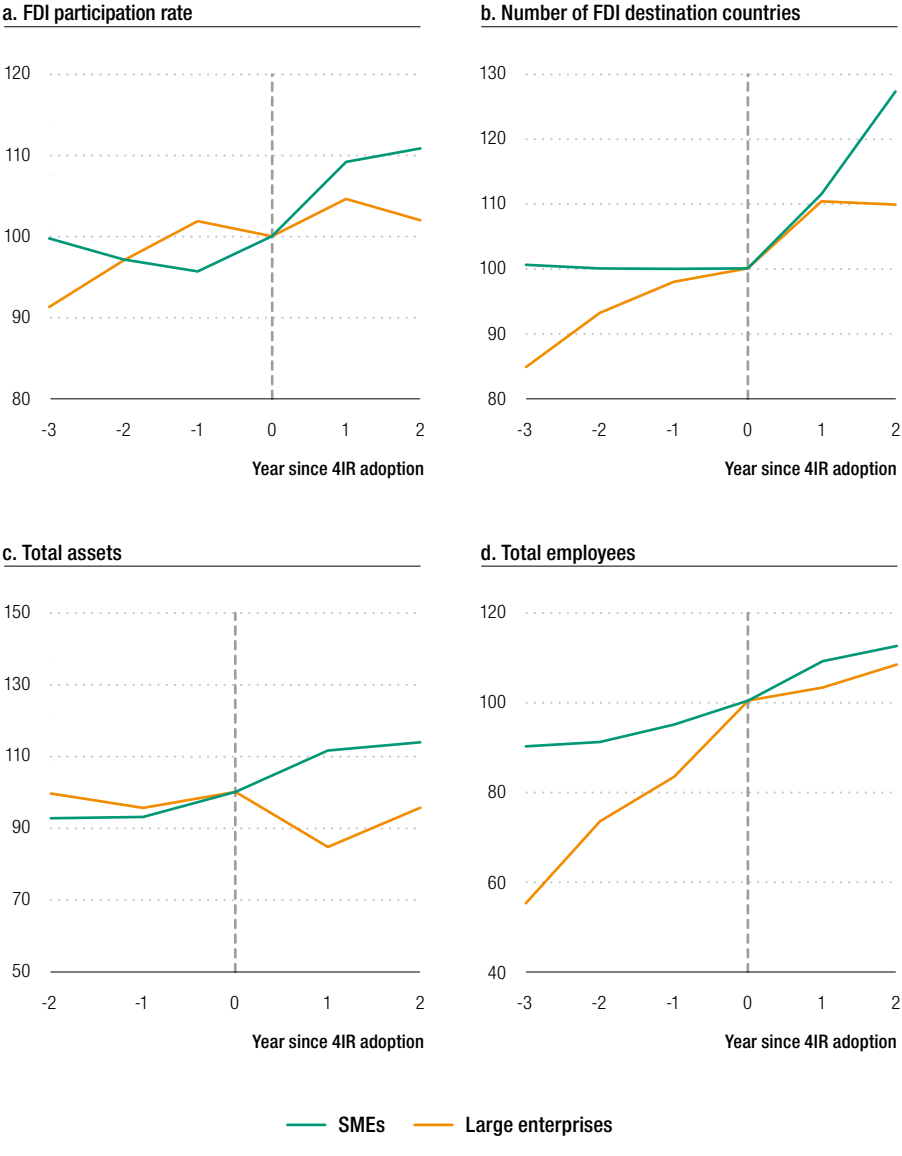


Source: Republic of Korea, Survey of Business Activities, 2015–2020.

Note: The vertical dashed line represents the period when firms started using 4IR technologies (Internet of things, cloud computing, big data, artificial intelligence, blockchain, 3D printing, robotics, virtual or augmented reality). Total stock of FDI is normalized to year 0 level (i.e. year 0 = 100).

As the first step, we explore whether the firms that adopt 4IR technologies are also more likely to invest abroad. A basic analysis of the data describes positive trends of firms' foreign investment associated with the adoption of 4IR technologies. Figure 4 shows a sharp increase in outward FDI stock following the adoption of 4IR technologies, which is especially sizeable for SMEs. In other words, technology adoption contributes more to outward FDI by SMEs than by large firms. In addition, further analysis of alternative performance indicators reveals that adoption of 4IR technologies is positively correlated with extensive margins of FDI (i.e. numbers of investments and destinations) by SMEs and in general with company productivity. Panels a and b in figure 5 present the FDI participation rate and the number of FDI destinations countries by SMEs and large enterprises. Not only do the extensive margins of FDI increase substantially following the adoption of 4IR technologies, but the growth is faster among SMEs. It is also worth noting that these changes are accompanied by growth in firm size (total assets and employees, panels c and d).

Figure 5. 4IR technology adoption and firm performance indicators, index
(year 0 = 100)



Source: Republic of Korea, Survey of Business Activities, 2015–2020.

Note: The vertical dashed line in each graph represents the period when firms started using 4IR technologies (Internet of things, cloud computing, big data, artificial intelligence, blockchain, 3D printing, robotics, virtual or augmented reality). FDI participation rate, number of invested countries, total assets and FDI participation rate are normalized to year 0 level (i.e. year 0 = 100).

2.2 The Fourth Industrial Revolution and SMEs

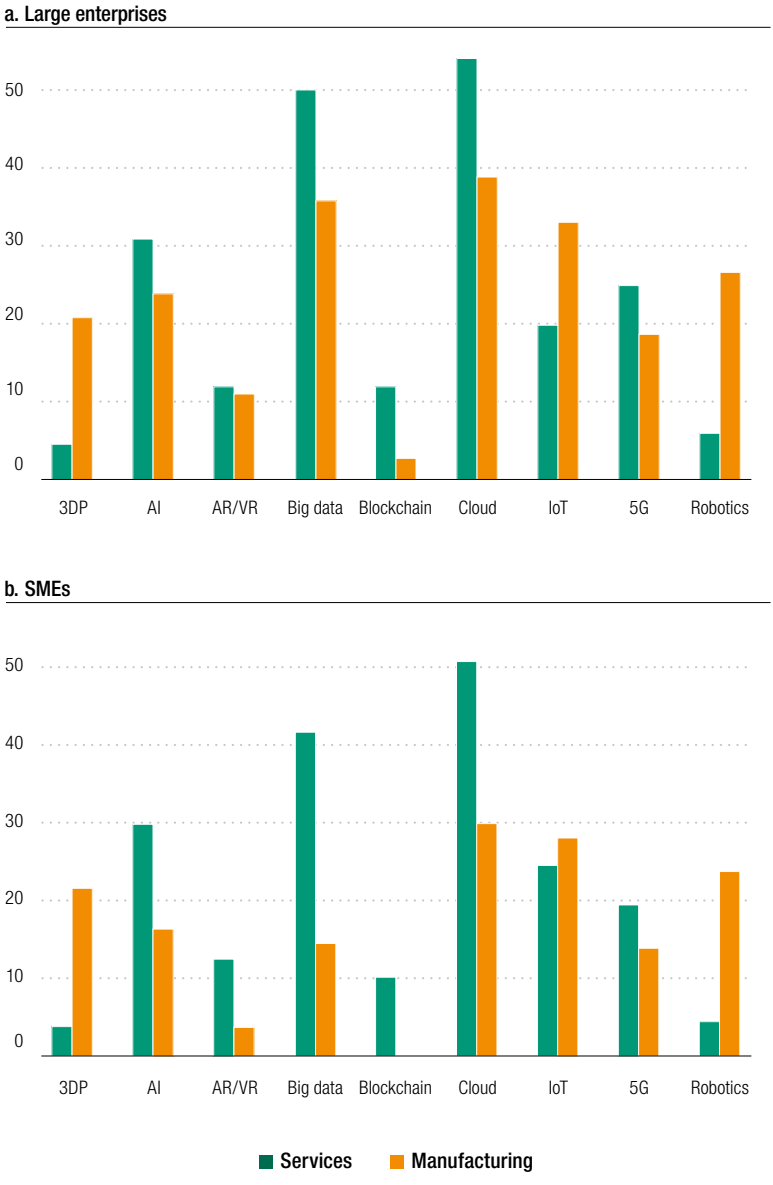
In this section, we further explore the 4IR technologies adopted by SMEs and large enterprises, to identify which type of technologies are most likely to be driving the changes in investment decisions. In figure 6, we consider only firms that are utilizing 4IR technology, and compare the adoption of each technology by firm size) and (services and manufacturing sectors). The graphs depict two clear patterns. First, there is a clear distinction in the type of technologies adopted by firms in the services and manufacturing sectors. The most widely used type of technology among manufacturing firms are IoT, robotics and 3D printing. IoT is used to optimize production processes, improve workplace safety and predict potential malfunctions with predictive maintenance.[6] Robotics and 3D printing are at the heart of the process of automation of manufacturing. Automation reduces the competitive advantage of low-cost manufacturing locations, lowering the incentive for efficiency-seeking FDI. Because of technical and economic feasibility, not all industries are affected in the same way (UNCTAD, 2020). For example, in textiles and apparel, the application of robots and 3D are not yet technically feasible.

In the services sector, a larger share of firms are using big data, cloud computing and artificial intelligence. These technologies are part of what is called digitalization. The application of digital technologies results in more integrated production processes, a reduction in governance and transaction costs, and improved access to foreign markets for SMEs, especially in the services sector (UNCTAD, 2017 and 2020). Although these latest technologies are grouped under the term "Fourth Industrial Revolution", figure 6 shows the impact of the different technologies on the firms' investing decisions may vary across sectors. In addition, there is a distinctive pattern of technology adoption across sizes. In the manufacturing sector, SMEs' utilization rates are significantly lower than larger firms. For instance, robotics is used by 36 per cent of firms among large enterprises, whereas only 14 per cent of SMEs use robots. In the services sector, not only do SMEs exhibit higher adoption rates than SMEs in the manufacturing sector, but the gaps in the rate of technology adoption are smaller for nearly all types of technology.

In figure 7, we present the rate of utilization of each technology *among all firms* in the data. We disaggregate the data by FDI engagement: (i) "FDI firms" (firms with at least one foreign subsidiary) and (ii) "non-FDI firms" (those that do not have any foreign subsidiary.) The overall pattern of technology use is similar between FDI and non-FDI firms: Cloud computing, big data, artificial intelligence and IoT are the popular technologies that are adopted by firms. FDI firms are in general more technologically advanced; however, the disparity in the adoption rates between

[6] *Forbes*, "How IoT is playing a key role in production uptime", 10 October 2022.

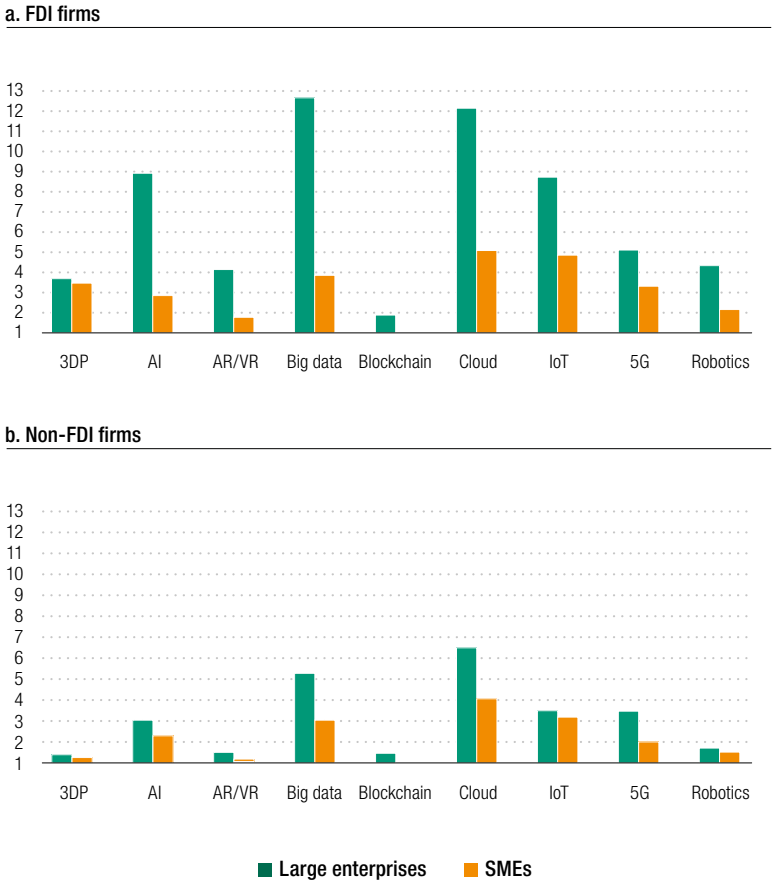
Figure 6. 4IR technologies adopted: share of firms using each technology among firms adopting any 4IR technology, by sector (Percentage)



Source: Republic of Korea, Survey of Business Activity, 2019.
Note: 3DP = 3d printing, AI = artificial intelligence, AR/VR = augmented or virtual reality, cloud = cloud computing, IoT = Internet of things.

SMEs and large enterprises are higher for FDI firms. For instance, the utilization gap between big data, artificial intelligence and cloud computing are noticeably larger among FDI firms, which are most often adopted among the services firms (as in figure 6). This is not only a representation of the existing technology gap between SMEs and larger firms in the services sector, but also an indication that there is much greater room to grow for firms in the services sector. As we will see in section 3, this is in line with larger benefits for firms in the services sector that use 4IR.

Figure 7. 4IR technologies adopted, by firm size and FDI participation (Percentage)



Source: Republic of Korea, Survey of Business Activity, 2019.

Note: 3DP = 3D printing, AI = artificial intelligence, AR/VR = augmented or virtual reality, cloud = cloud computing, IoT = Internet of things. FDI-firms refers to firms that had at least one foreign subsidiary in 2019. Non-FDI firms refers to firms that did not have any foreign subsidiaries in 2019.

3. Specification and regression results

To analyse the growth in FDI stock upon the adoption of 4IR technologies, we perform a set of linear regressions with various fixed effects and firm characteristics as controls. We propose the following specification, in which the various measures of FDI are regressed on a set of dummy variables (SME and 4IR utilization) and additional explanatory variables:

$$Y_{it} = \beta_1 + \beta_2 SME_{it} + \beta_3 4IR_{it} + \beta_4 SME_{it} \cdot 4IR_{it} + X_{it}\gamma + \alpha_t + \alpha_i + \alpha_k + \varepsilon_{it} \quad (1)$$

where Y_{it} is a measure of FDI at the extensive (a 0-1 variable if the firm invests abroad or not) or intensive (log of FDI) margins, SME_{it} is a dummy variable to indicate SME status (as per legal definition in the Republic of Korea) in year t by firm i, $4IR_{it}$ is a dummy variable to indicate the adoption status in year t by firm i, X_{it} is a vector of firm characteristics to control for additional variations in firm sizes (number of employees, turnover, total assets) and α_t, α_k and α_i refer to time, adoption year-[7], and firm-fixed effects, respectively.

Table 2 shows the basic regression results, which look at the extensive margin of FDI – firms' decision to invest and the number of countries with outward investment. First, the decision to adopt any 4IR technology is negatively associated with the decision to participate in FDI: In table 2, the estimated coefficients of 4IR utilization are negative and especially so in the manufacturing sector (columns 3 and 4). This is in line with the empirical evidence that looks at the relationship between automation and reshoring, and finds that automation increases the pace of reshoring (Artuc et al., 2019; Faber, 2018). In contrast, for SMEs such negative effects are cancelled out. The estimated coefficients of the interaction term (4IR utilization × SME) are as large as the coefficients of 4IR utilization, which means that SMEs did not adopt automation to lower domestic costs and reshore production. In the services sector, the 4IR technology even promoted the internationalization of SMEs to more countries (column 6).

In table 3, we investigate the effect of 4IR utilization on the intensive margins. To further disentangle the main drivers for FDI we distinguish FDI stock by the level of technology of FDI destination countries. In order to classify countries into two groups – technologically "advanced" economies (in terms of 4IR technology) and "lagging" economies – we use the Readiness Index from Readiness for the Future of Production by the World Economic Forum (WEF, 2018). Using this taxonomy, 16 countries fall in the advanced group and 83 in the lagging group (appendix table A.1). Along the internal margins of FDI, we also observe similar patterns:

[7] *n* year following the adoption (= Current year (*t*) – Technology adoption year).

The decision to use 4IR technologies is negatively associated with the size of the FDI stock. Yet, the estimated coefficient of the interaction term 4IR utilization × SME is positively significant to the extent that the negative correlation is cancelled out for SMEs. Although these positive effects are observed regarding different types of FDI stock – whether the destination countries are technologically more advanced or lagging – the additional positive effects on SMEs are more strongly associated when the destination is technologically lagging. This clearly indicates the main motivation of manufacturing SMEs investing abroad is efficiency seeking.

We investigated if the different technologies affected firms differently in the manufacturing and the services sectors. In this analysis, we define sector-specific 4IR technologies as follows: Manufacturing-specific 4IR technologies include IoT, robotics, and 3D printing, which are the most popular types of technology, typically adopted by manufacturing firms for automation (see figure 6a). Services-specific 4IR technologies include big data, cloud and artificial intelligence (see figure 6b). Table 4 shows the results of alternative regression specifications, where we consider only the impact of manufacturing-specific 4IR technologies

Table 2. Regression results, extensive margin

	All		Manufacturing		Services	
	(1) FDI dummy	(2) Number of countries	(3) FDI dummy	(4) Number of countries	(5) FDI dummy	(6) Number of countries
SME	-0.13*** (0.04)	-0.22 (0.14)	-0.17*** (0.05)	-0.25 (0.17)	-0.06 (0.09)	-0.13 (0.28)
4IR utilization	-0.05* (0.02)	-0.22** (0.11)	-0.07** (0.03)	-0.25* (0.13)	-0.06 (0.04)	-0.16 (0.13)
4IR utilization × SME	0.04** (0.02)	0.19*** (0.07)	0.07* (0.03)	0.19** (0.09)	0.04** (0.02)	0.23** (0.08)
Constant	0.40*** (0.02)	1.20*** (0.14)	0.49*** (0.03)	1.53*** (0.28)	0.31*** (0.04)	1.05*** (0.15)
Observations	5 567	5 567	2 988	2 988	2 369	2 369
R^2	0.734	0.759	0.751	0.779	0.720	0.750
Year fixed effects	yes	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes
Adoption year fixed effects	yes	yes	yes	yes	yes	yes
Controls	yes	yes	yes	yes	yes	yes

Source: Authors' estimation based on Survey of Business Acitvities, Republic of Korea.

Note: All regressions include firm characteristics (yearly turnover, total assets, total number of employees) as explanatory variables. Statistical significance is indicated by *($p < 0.1$), **($p < 0.05$), ***($p < 0.01$). Standard errors are clustered at industry level.

Table 3. Regression results, intensive margin

	All			Manufacturing			Services		
	(1) ln(FDI total)	(2) ln(FDI advanced)	(3) ln(FDI lagging)	(4) ln(FDI total)	(5) ln(FDI advanced)	(6) ln(FDI lagging)	(7) ln(FDI total)	(8) ln(FDI advanced)	(9) ln(FDI lagging)
SME	-2.94***	-0.41	-2.70***	-3.90***	-0.49	-3.54***	-1.37	-0.17	-1.15
	(0.83)	(0.56)	(0.69)	(1.04)	(0.73)	(1.05)	(2.02)	(1.90)	(1.41)
4IR utilization	-1.19**	-0.85*	-1.05**	-1.74***	-1.24**	-1.56***	-1.36	-0.38	-1.40**
	(0.50)	(0.43)	(0.45)	(0.60)	(0.50)	(0.50)	(0.90)	(0.65)	(0.60)
4IR utilization × SME	1.09***	0.61***	1.17***	1.61**	0.80	1.66***	1.03**	0.54**	1.09***
	(0.24)	(0.14)	(0.24)	(0.68)	(0.49)	(0.54)	(0.38)	(0.20)	(0.33)
Constant	8.98***	4.40***	7.37***	11.18**	4.74***	9.65***	7.07***	4.34***	5.49***
	(0.48)	(0.40)	(0.41)	(0.75)	(0.51)	(0.76)	(0.81)	(0.73)	(0.72)
Observations	5 567	5 567	5 567	2 988	2 988	2 988	2 369	2 369	2 369
R^2	0.740	0.712	0.734	0.757	0.717	0.750	0.728	0.714	0.721
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Adoption year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Source: Authors' estimation based on Survey of Business Acitvities, Republic of Korea.

Note: All regressions include firm characteristics (yearly turnover, total assets, total number of employees) as explanatory variables. Statistical significance is indicated by *($p < 0.1$), **($p < 0.05$), ***($p < 0.01$). Standard errors are clustered at industry level.

for manufacturing firms (column 1 – column 3) and for firms in the services sector (column 4 – column 6). The results show that manufacturing-specific technologies did not lead manufacturing SMEs to internationalize: the estimated coefficients of Manufacturing 4IR utilization × SME are not significantly positive at the 5 per cent significance level. SMEs' degree of adoption of automation technologies is not advanced enough to allow them to substitute foreign low-cost labour with in-house production.

Table 4. Regression results, manufacturing sector-specific technology

	Manufacturing			Services		
	(1) ln(FDI total)	(2) ln(FDI advanced)	(3) ln(FDI lagging)	(4) ln(FDI total)	(5) ln(FDI advanced)	(6) ln(FDI lagging)
SME	-3.24*** (0.88)	-0.23 (0.56)	-2.77*** (0.93)	-0.51 (0.88)	0.049 (0.91)	-0.35 (0.80)
Manufacturing × 4IR utilization	-1.00* (0.51)	-0.14 (0.51)	-0.48 (0.56)	-2.43* (1.20)	-1.06 (1.38)	-1.69* (0.95)
Manufacturing 4IR utilization × SME	1.41* (0.79)	-0.21 (0.59)	1.05 (0.65)	1.25 (2.26)	-0.05 (2.77)	1.57 (1.38)
Constant	9.52*** (0.58)	3.83*** (0.45)	8.11*** (0.62)	4.83*** (0.53)	3.15*** (0.42)	3.61*** (0.50)
Observations	3 423	3 423	3 423	3 395	3 395	3 395
R^2	0.757	0.717	0.750	0.728	0.714	0.721
Year fixed effects	yes	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes
Adoption year fixed effects	yes	yes	yes	yes	yes	yes
Controls	yes	yes	yes	yes	yes	yes

Source: Authors' estimation based on Survey of Business Acitvities, Republic of Korea.

Note: All regressions include firm characteristics (yearly turnover, total assets, total number of employees) as explanatory variables. Statistical significance is indicated by *($p < 0.1$), **($p < 0.05$), ***($p < 0.01$). Standard errors are clustered at industry level.

Conversely, table 5 shows that services sector-specific technologies helped SMEs in both the manufacturing and the services sectors to internationalize, especially in economies that lag technologically. This is consistent with the theories that digitalization facilitates firms' presence in foreign markets, especially services ones. Companies offering automated services on the cloud can easily penetrate foreign markets with a little investment, probably only as a sales office. Also, manufacturing companies benefit as these technologies reduce information costs and provide SMEs with a tool to deal with local procedures and administration rules.

Table 5. Regression results, services sector-specific technology

	Manufacturing			Services		
	(1) ln(FDI total)	(2) ln(FDI advanced)	(3) ln(FDI lagging)	(4) ln(FDI total)	(5) ln(FDI advanced)	(6) ln(FDI lagging)
SME	-3.43*** (0.84)	-0.47 (0.56)	-2.92*** (0.90)	-0.72 (0.95)	-0.05 (1.03)	-0.56 (0.81)
Services 4IR × utilization	-1.51*** (0.48)	-1.25* (0.66)	-1.18** (0.45)	-0.51 (0.48)	-0.01 (0.33)	-0.80* (0.42)
Services 4IR utilization × SME	2.26** (0.99)	1.33 (0.81)	1.73* (0.88)	0.94* (0.49)	0.37 (0.39)	1.03*** (0.35)
Constant	9.66*** (0.57)	4.00*** (0.43)	8.26*** (0.58)	4.85*** (0.50)	3.11*** (0.42)	3.71*** (0.50)
Observations	3 423	3 423	3 423	3 395	3 395	3 395
R^2	0.757	0.717	0.750	0.728	0.714	0.721
Year fixed effects	yes	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes
Adoption year fixed effects	yes	yes	yes	yes	yes	yes
Controls	yes	yes	yes	yes	yes	yes

Source: Authors' estimation based on Survey of Business Acitvities, Republic of Korea.
Note: All regressions include firm characteristics (yearly turnover, total assets, total number of employees) as explanatory variables. Statistical significance is indicated by *($p < 0.1$), **($p < 0.05$), ***($p < 0.01$). Standard errors are clustered at industry level.

4. Conclusion and policy implications

The Republic of Korea is a leading investor globally and in Asia. Korean firms play an important catalytic role in the Industry 4.0 transformation process as users, technology providers, manufacturers and ecosystem enhancers. They also invest in digitalization of manufacturing, advanced manufacturing solutions, smart factories, and R&D facilities, technology hubs and centres of excellence in the region.

4IR technologies can affect firms' decisions to invest abroad. While automation can push manufacturing companies to reshore production and thus reduce overseas investments, digitalization, in contrast, can facilitate their geographical expansion.

We find empirical evidence supporting this notion for companies based in the Republic of Korea, with an overall negative impact of 4IR technologies on outward FDI by large enterprises. However, SMEs constraints and drivers differ from those of large MNEs (UNCTAD, forthcoming). In general, foreign investment by SMEs is not negatively affected by adoption of 4IR technologies. Lower rates of automation

often do not allow SMEs to substitute low-cost foreign labour with efficient in-house production. In addition, digitalization technologies facilitate internationalization processes in both services and manufacturing SMEs. This is in line with the idea that digital technologies lower the information and transaction costs of overseas operations. Thus, manufacturing SMEs still invest in neighbouring economies, driven by efficiency-seeking motives, whereas services SMEs take full advantage of new digital technologies such as big data and the cloud to penetrate less advanced markets. Both services and manufacturing SMEs have become key actors in regional integration processes.

The empirical findings in this paper have important implications for policy and for future research. In the current global context, with a shrinking pool of productive investment, FDI by SMEs could contribute to boosting investment in sustainable post-pandemic recovery. Small firms could also support resilience-seeking FDI.

The need for multinational enterprises, both large and small, to diversify supply sources and strengthen regional value chains should translate not only to shifting FDI patterns within the region but also to renewed overall growth of international investment in industry. SMEs could help promote investment for development in the context of broader economic integration and cooperation. They can also contribute to closing the investment gap in the least developed countries in the Asia-Pacific region. To unleash the potential of SMEs, policymakers need to refocus their investment promotion and facilitation strategies, paying more attention to smaller players and their specific needs, with support services that facilitate their internationalization.[8]

Finally, regulatory frameworks in both home and host countries of FDI are important factors in enhancing the attractiveness of the investment environment in Industry 4.0. Adequate plans to support the development of digital infrastructure and platforms and a strategic investment policy to support SMEs' digital transition and internationalization are thus key prerequisites for successful SME investment policies.[9]

[8] For further detail on policies, see UNCTAD (forthcoming).

[9] For a policy package and other promotion measures for investment in Industry 4.0 in the ASEAN region, see ASEAN Secretariat and UNCTAD (2021).

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Annex table A.1. Economy classification for regression analysis

	Economy	Score
Economies ranked higher than the Republic of Korea	United States	8.16
	Singapore	7.96
	Switzerland	7.92
	United Kingdom	7.84
	Netherlands	7.75
	Germany	7.56
	Canada	7.54
	Hong Kong, China	7.45
	Sweden	7.40
	Denmark	7.20
	Finland	7.16
	Australia	7.14
	Norway	7.07
	France	6.89
	Ireland	6.85
	Japan	6.82
	Belgium	6.80
	Austria	6.79
	United Arab Emirates	6.76
	New Zealand	6.73
Republic of Korea		**6.51**
Economies ranked equally or lower than the Republic of Korea	Malaysia	6.51
	Israel	6.24
	Spain	6.23
	China	6.14
	Czech Republic	6.01
	Estonia	6.00
	Portugal	5.99
	Qatar	5.96
	Italy	5.90
	Poland	5.83
	Slovenia	5.71
	Cyprus	5.65
	Chile	5.60
	Thailand	5.45
	Saudi Arabia	5.44
	Lithuania	5.42
	Latvia	5.39
	Mauritius	5.37
	Slovak Republic	5.33
	Bahrain	5.31
	Hungary	5.30
	the Russian Federation	5.30
	India	5.24
	Oman	5.13
	Mexico	5.04
	Brazil	5.03
	Bulgaria	5.02

/…

Annex table A.1. Economy classification for regression analysis (Concluded)

	Economy	Score
Economies ranked equally or lower than the Republic of Korea	South Africa	5.02
	Greece	4.96
	Croatia	4.93
	Romania	4.93
	Viet Nam	4.93
	Georgia	4.92
	Jordan	4.91
	Costa Rica	4.90
	Republic of Türkiye	4.90
	Panama	4.89
	Indonesia	4.89
	Uruguay	4.75
	Kazakhstan	4.74
	Azerbaijan	4.69
	Kuwait	4.65
	Serbia	4.59
	Colombia	4.53
	the Philippines	4.51
	Ukraine	4.47
	Egypt	4.46
	Botswana	4.43
	Armenia	4.43
	Lebanon	4.43
	Tunisia	4.41
	Morocco	4.35
	Sri Lanka	4.26
	Argentina	4.25
	Peru	4.18
	Ghana	4.14
	Albania	4.07
	Bosnia and Herzegovina	4.04
	Dominican Republic	4.02
	Republic of Moldova	4.02
	Paraguay	3.84
	Kenya	3.83
	Mongolia	3.82
	Senegal	3.73
	Guatemala	3.71
	Algeria	3.70
	Nigeria	3.68
	Bangladesh	3.67
	Ecuador	3.66
	Cambodia	3.63
	Honduras	3.61
	Pakistan	3.60
	El Salvador	3.55
	Zambia	3.54
	Kyrgyzstan	3.43
	Uganda	3.31
	Ethiopia	3.29
	United Republic of Tanzania	3.28
	Cameroon	3.24

Source: WEF (2018).
Notes: Economies are listed in order of WEF Drivers of Production ranking.

International project finance deals as indicators of productive cross-border investment: UNCTAD's approach*

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Abstract

International project finance (IPF) can channel private cross-border capital toward productive investments in (mostly) infrastructure sectors, especially where government budget constraints are tight. Moreover, it has recently gained importance as a tool to finance the Sustainable Development Goals (SDG) and bridge the large infrastructure gap for climate megaprojects. In such contexts, projects often require international capital along with expertise and credibility; they also require a project-specific risk allocation that IPF accommodates. This research note assesses project finance in the context of international productive investments, its link with other forms of international investment (mergers and acquisitions, and cross-border greenfield investments) in the data used, and its use in UNCTAD's publications. Data is a lynchpin for analysis but is not unproblematic. The note explores incongruences and their impact. It also outlines UNCTAD's conceptual choice to capture *ongoing* productive investments in infrastructure through project finance in the world economy.

Keywords: cross-border direct investment, imputation, international project finance, matching, Refinitiv data

JEL classification codes: F30, F39, O16, O18, Q56

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1. Introduction

The financing gap for the Sustainable Development Goals (SDGs) amounts to a massive $4.3 trillion per year (UNCTAD, 2022). A pre-pandemic analysis estimated that developing countries were missing about $2.5 trillion to keep their SDG ambitions on track (UNCTAD, 2020). Lack of infrastructure hampers sustainable and inclusive growth. Although funding is low, the impetus for investment is high. This financing gap and the positive effect of infrastructure on growth (Ramey, 2020) partially explain the massive infrastructure initiatives developed by China (Belt and Road Initiative – BRI) since 2013 and by the G7 in 2022.[1]

Infrastructure can be economic (e.g. transport facilities such as highways, water supply such as sewage networks, energy supply such as power plants). It can also be social (related to human capital, such as hospitals, elderly housing, schools and prisons). Infrastructure shares some key characteristics: it has low demand elasticity, quasi-monopoly status, public service orientation and/or high regulation, long service life and stability of cash flows (Weber et al., 2016, p. 12). These characteristics lead to larger risks of expropriation and opportunistic behaviour by a monopolistic buyer or a monopsonistic supplier. These characteristics call for specific ways in which to finance infrastructure – if it is not entirely financed by a public entity.[2] Project finance is a well-suited financing structure for such cases. The defining elements of IPF are three:

i. The project sponsors constitute a dedicated entity: a special purpose entity (SPE).

ii. The SPE is the borrower.

iii. The recourse of lenders vis-à-vis the sponsors is limited.

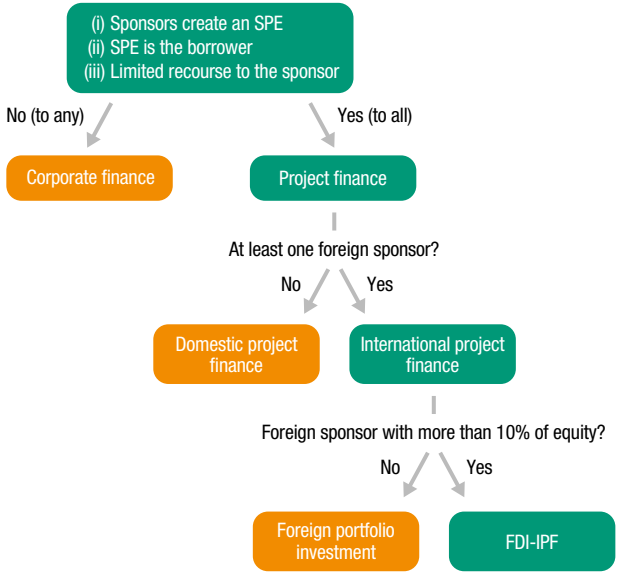
When a project does not satisfy all three criteria, it cannot be considered as project finance: it falls under the umbrella of corporate finance. International project finance (IPF) implies that at least one sponsor in the project finance deal is a foreign resident. When this sponsor owns at least 10 per cent of the project's equity, IPF is FDI-IPF (figure 1). This research note specifically looks at the share of IPF that is FDI-IPF.

From a development perspective, IPF is important because it has a positive impact on economic growth in least developed countries (LDCs) (La Cour and Müller, 2014). This type of finance bankrolls projects in countries that face acute fiscal constraints and supports the building of cornerstone infrastructure in

[1] Since 2013, China has invested between $40 billion to $60 billion every year. The G7 countries have pledged to raise $600 billion dedicated to infrastructure projects in developing countries.

[2] In developing countries, States lack the financial capacity to invest in all of the infrastructure they require.

Figure 1. What is an IPF project ? And what would be FDI-IPF (simplified)?



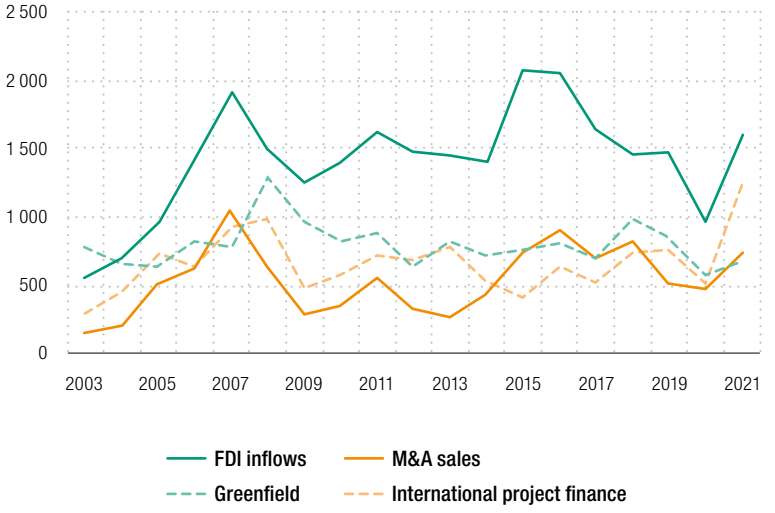
Source: Authors' elaboration, based on UNCTAD (2021).

these countries.[3] Although IPF accounts for approximately one third of all project finance deals, it accounts for 45 per cent of project finance projects in low-income countries and is thus a crucial enabler of development.

IPF is increasingly common in financing infrastructure and across sectors: between 2012 and 2021, the number of projects increased by 68 per cent and the total value of projects increased by 15 per cent.[4] Importantly, IPF has experienced a dramatic shift in the sectors that implement such financing. In 2010, mining, oil and gas, and petrochemicals accounted for 21 per cent of all IPF projects but in 2020 only 12 per cent. Conversely, and on the upside for sustainable development, IPF has contributed to the rise of the renewables sector. IPF renewable projects accounted for 31 per cent of all announced deals in 2010, and for 54 per cent of all deals in 2021. Figure 3 shows the evolution of IPF by sector, over time. The sectoral change also has led to less costly projects being financed through IPF (Steffen, 2018). Figure 4 displays the reduction in average IPF project costs over time.

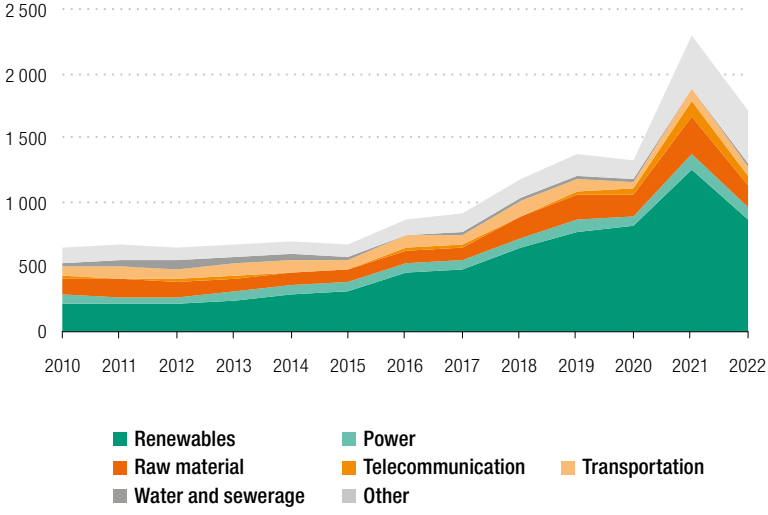
[3] By construction, public-private partnerships (PPPs) are part of project finance.
[4] See UNCTAD (2022), figure 2.

Figure 2. Trends in FDI and types of FDI (Millions of dollars)



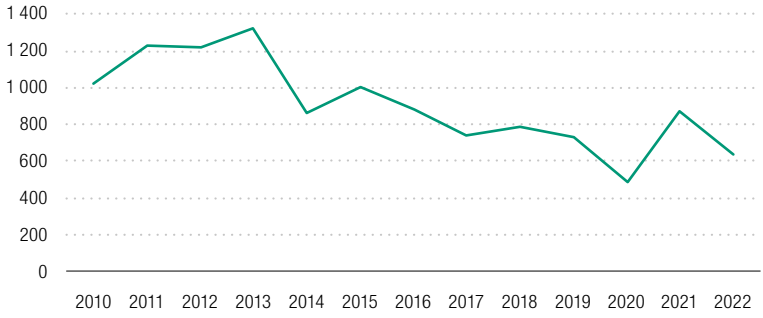
Source: Refinitiv data on project finance deals, UNCTAD.

Figure 3. IPF projects by main sectors, 2010–2022 (Number of deals)



Source: Refinitiv data on project finance deals.

Figure 4. Average IPF project cost, 2010–2022 (Millions of dollars)

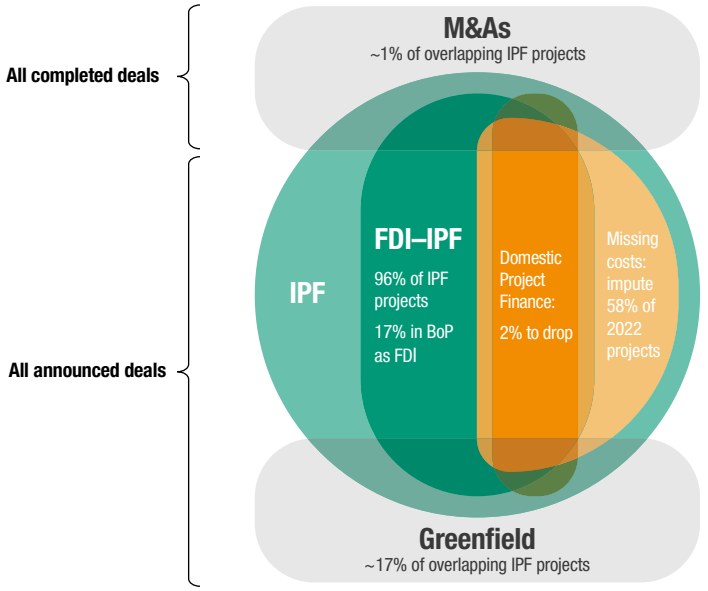


Source: Refinitiv data on project finance deals.
Note: Only projects with cost information are included.

IPF is financing projects that could otherwise be financed using corporate finance. The overlap in terms of projects between cross-border greenfield investments (financed through corporate finance) and IPF can be sizeable. Measuring this overlap is one of the objectives of this research note. Project finance investments can be "gate openers": once some projects have been implemented, investors may feel confident enough to bear the risks inherent in future corporate finance investments. Frequently, infrastructure projects in LDCs do not have precedents against which to anchor decisions. Therefore, project finance is a well-suited financial scheme to pave the way for future infrastructure investments, regardless of their financing structures. LDCs could use this type of investment to create a positive case for future infrastructure investments.

This research note aims to provide the rationale behind the use of IPF data as part of cross-border investments and FDI in UNCTAD's investment research. It highlights the rationale behind the selection of announced IPF deals as indicators of productive cross-border investment intentions. It also explores the possible overlap between IPF and other forms of cross-border investments, namely greenfield investments and mergers and acquisitions (M&As). The research note assesses the quality of IPF data and its suitability for UNCTAD's investment research. Estimating the share of IPF that is FDI is challenging. This note suggests a framework to conceptualize its measurement to inform data-led decision-making. Figure 5 summarizes the layers of difficulties UNCTAD faces when using IPF data, an indicator of both a data challenge and an opportunity. The research note addresses these issues by responding to the following questions: (i) what is IPF and why is it a valuable source of information on FDI? (ii) What are the data limitations, the impacts on reported trends and the possible solutions? (iii) How much of IPF is FDI?

Figure 5. Overall summary of the data challenges covered



Source: Authors' elaboration and calculations, based on Refinitiv data on project finance and merger and acquisition deals and fDi Markets data.

The key issue is that, currently, because of differing definitions and data incongruences, the way IPF is measured conceals the scale of FDI associated with it. Including deals on the basis of announcements provides a forward-looking measure of FDI, and this measure supports the developing-country case for future FDI. Methods to extract this information vary but essentially clean the data by dealing with overlaps, better identifying offshore and onshore companies, and exploring missing information.

2. What is IPF?

When deciding among financing schemes, project finance is traditionally compared with corporate financing. Cross-border greenfield investments are investments funded through corporate financing.[5] A company directly invests in or develops

[5] Here, cross-border greenfield investments are projects in which a company invests abroad through a branch or a subsidiary.

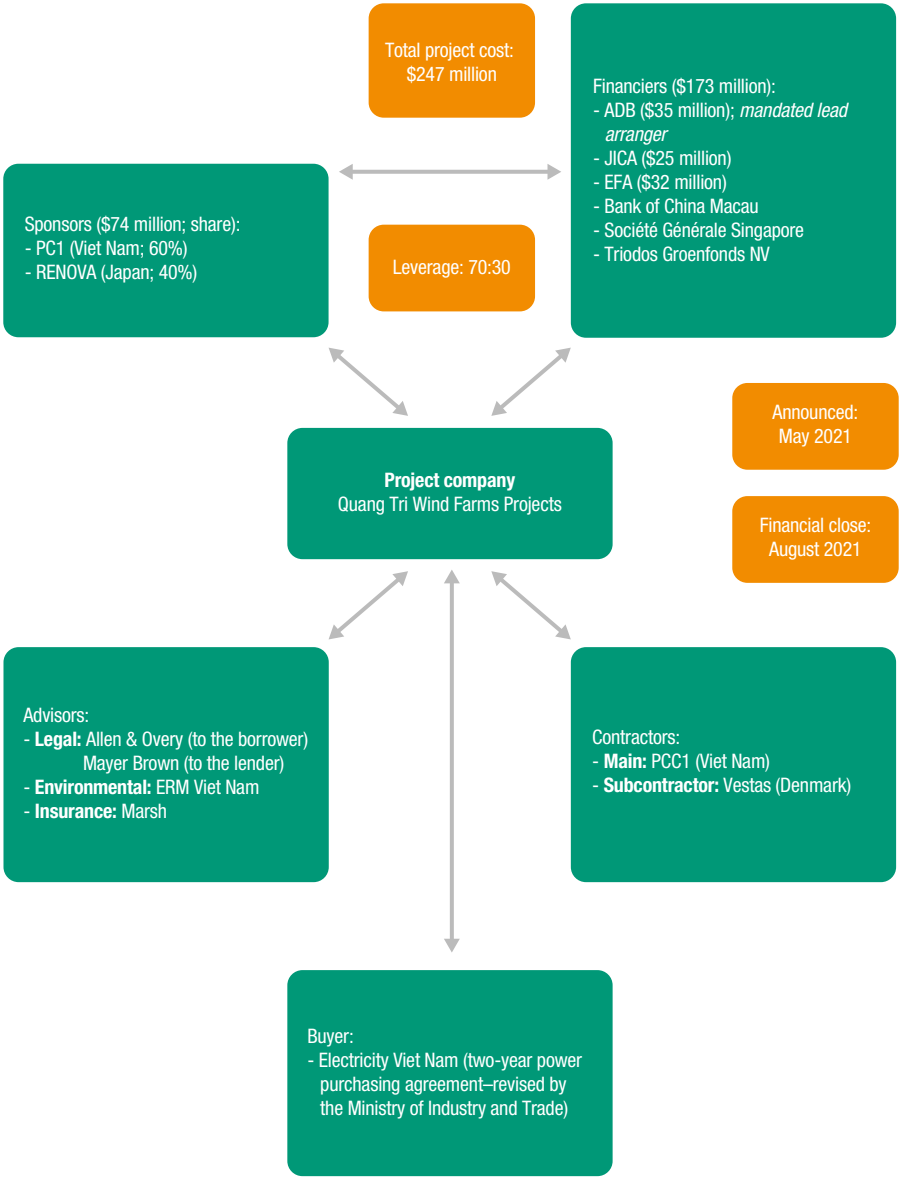
a subsidiary and bears all the risks, particularly on all the company's assets. The link between lenders and equity providers is direct in greenfield investments. In contrast, the link between lenders and sponsors is indirect in IPF investments (the SPE is a buffer that allows limited recourse and thus lower risk for the sponsors). In corporate finance, financing is granted for satisfying several characteristics: customer relations, solidity of the balance sheet and profitability of the project. In contrast, financing in project finance is granted only on the prospect of future cash flows. In corporate finance, leverage is gained through a robust balance sheet, whereas in project finance it comes from cash flows (Gatti, 2013).

An investment becomes a cross-border investment when at least one equity provider is a foreign entity. Cross-border investments add extra layers of complexity and risks; for example, exchange rate variances, jurisdictional differences, risks of expropriation and hold ups by influential buyers or suppliers (Sawant, 2010; Shah and Thakor, 1987). Because of limited recourse, equity providers are more willing to develop an IPF structure than a traditional corporate finance structure, when these perceived risks are high. Project finance is suited for structuring longer-run, evolving projects entailing many stages of negotiations among stakeholders to construct the most suitable financing structure. In this process, negotiations among the main stakeholders are costly. Transaction costs are estimated to account for 5–10 per cent of the total investment but are supposed to save on agency costs in the medium to long run (Gatti, 2013).

A concrete illustration of an IPF infrastructure project in a developing country can draw on the experience of Viet Nam (figure 6). The case in the figure demonstrates what a project looks like when it incorporates the SDGs.[6] Perhaps the most important aspect is the power purchasing agreement with the relevant State-owned enterprise in conjunction with a public agenda that endorses renewable infrastructure in Viet Nam. Public support, whether direct (e.g. equity participation, loans) or indirect (e.g. authorizations, guarantees, feed-in tariffs), is crucial for not only domestic but also international project finance, especially in developing countries (table 1). The case of the Vietnamese wind farm reflects this. Still, even with public support, it is likely that the project would not have occurred without explicit (the power purchasing agreement) or implicit (a long-term State agenda in favor of SDG-oriented investments) guarantees from public entities. It is critical that developing nations consider both State and public support in securing IPF.

[6] Private capital from expert enterprises as sponsors, credible loan providers led by a multilateral development bank and credible contractors.

Figure 6. Quang Tri Farm IPF project in Viet Nam, illustration



Source: Authors' elaboration, based on Refinitiv data on project finance deals, PC1 (https://pc1epc.vn/en/phong-nguyen-wind-power-plant-project), Renova (https://www.renovainc.com/en/development/quangtri_wind/202204_3438/), *PFI 2022 Yearbook* (https://www.pfie.com/story/3180690/foreword-sdgzm8mxvs).

Table 1. Public support in equity in project finance, share of projects by category (Percentage)

Sample	Variables	Values	All projects	Domestic projects	International projects	Domestic projects in developing countries	International projects in developing countries
All projects	Using Refinitiv variable	Some government support	50.4	60.1	27.5	75.3	35.6
Top 100 projects (per category)			47	67	43	78	51
	Checking sponsor's name	No support	56	34	79	24	66
		State-owned enterprise	12	44	4	27	17
		Government	32	21	17	49	17

Source: Refinitiv data project finance deals.

Note: "All projects" refers to all international project finance projects from 2011 until May 2022. "Top 100 projects" is by total cost. Developing countries include both least developed countries and middle-income countries. To read the table, 50.4 per cent of all projects have some government support, and 47 of the 100 biggest projects have some government support.

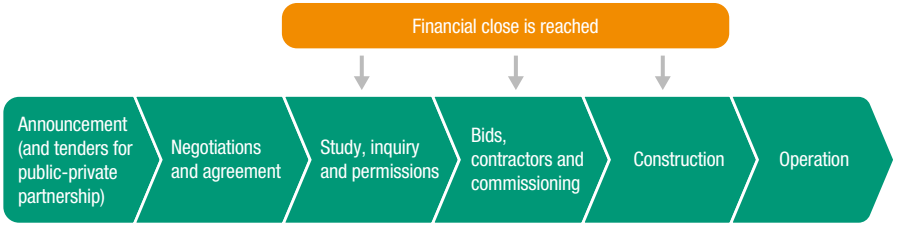
3. Why use announced deals?

A project financing journey is complex and varies according to the context. Nevertheless, it includes milestone events such as project announcement, financial close, construction, completion and inauguration, and transfer. The two most important events from the perspective of data collection are the initial announcement and the financial close announcement. Some institutions use financial close announcements (e.g. the European Investment Bank, the Global Infrastructure Hub and the World Bank), UNCTAD includes initial announcements (referred to as "announced projects").[7]

It is clear that using announcement data will tend to overestimate the numbers and values of projects, because some projects never reach the stage of construction or completion. In contrast, using financial close data will lead to underestimation, because many projects have open-ended financing arrangements or financial close data is not reported, despite the fact that construction has started or the project is completed. Looking at all project finance (including domestic deals) shows that the degree of underestimation from the use of financial close data is actually larger than the degree of overestimation from the use of announcement data. This is not the case for international projects, where relatively more projects reach financial close, but the degree of underestimation remains substantial.

Ultimately, both data strategies are more complementary than conflicting. Restricting data collection analysis to deals that reach financial close gives a post-event view of the state of play rather than of intent. Figure 7 indicates that financial close comes at various stages of the project; and it is clear that often financial close is reached only after the start of the construction (in 56 per cent of IPF projects).

Figure 7. Simplified IPF timeline



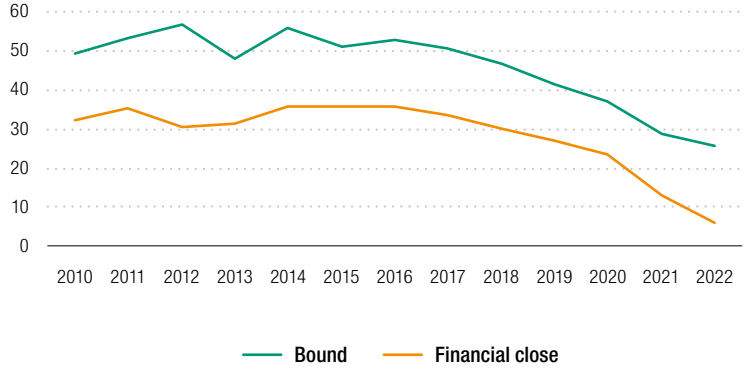
Source: Authors' elaboration, based on Gatti (2013) and Weber et al. (2016).

[7] Canceled and suspended deals are excluded, and data updating makes the set of excluded projects vary over time.

In contrast, using announced deals to reveal data trends provides an indication of the investment intentions of stakeholders before the financial deal closes, and is an indicator of policy commitment with financial intent and opportunity. In a real-world analysis, this enables a wider picture of the current state of play and the future dynamics. In this regard, UNCTAD's World Investment Reports assess the *current* state of the economy and provide insights into what is to come. Keeping announced IPF projects in the data has two key justifications: it is consistent with cross-border greenfield investments, and it captures the *willingness* to invest.

Announcing investment is already a strong signal to the market. It can drive a more positive investment sentiment, in a virtuous circle. This is visible in the current trend of public and private entities building an agenda that is more climate change-oriented, using infrastructure as a lever. For example, Egypt's integration of solar energy into the policy mix enabled the Benban solar complex to be financed largely by project finance. Today it is the fifth largest photovoltaic power station in the world.[8] Concisely, announced projects, even if not completed, play a vital role for sponsors and lenders. Announcements are a decisive signal for international investors about where, when and how to invest.[9]

Figure 8. Share of bound IPF projects, 2010–2022 (Percentage)



Source: Refinitiv data on project finance deals.
Note: A project is deemed bound if it (i) reaches financial close, (ii) is under construction, (iii) is in commissioning or (iv) has a sale agreement signed or completed, in the case of acquisitions.

[8] Louise Sarant, "The rise of solar energy in Egypt", 18 February 2015, Middle East Institute, www.mei.edu.

[9] About half of announced projects in 2010 have not reached the construction stage and thus are likely to never reach the construction stage. On the other hand, beyond one third of all binding projects have not reached financial close. For details, see figure 8.

Importantly, both decisions to announce a deal and to announce financial close are strategic.[10] These decisions play a role in the market value of the project and/or in the return for stakeholders (Blose and Shieh, 1997; Kammoun and Power, 2022).

4. What are the data limitations and the possibilities to overcome them?

4.1 How much do IPF and other cross-border investments overlap?

Data comparability and consistency across different types of FDI is challenged whenever overlaps exist with other FDI types used in the World Investment Reports (M&As and greenfield investment).

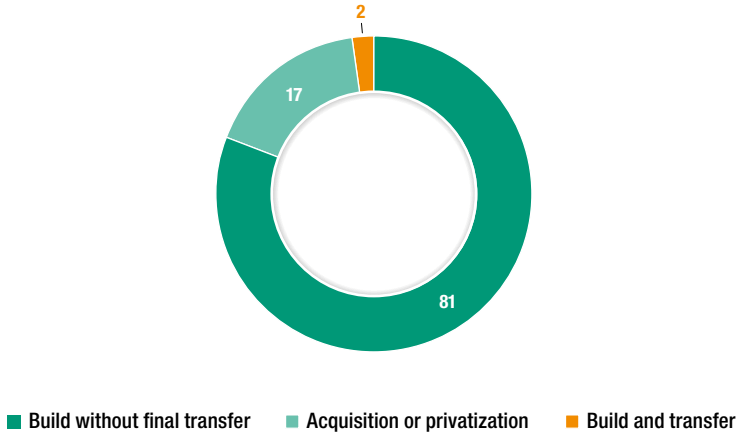
4.1.1 How do IPF deals and M&A deals overlap?

FDI taxonomy, as it is reported in the World Investment Reports,[11] separates projects funded by corporate finance and by project finance, which are both considered productive investments, and M&As, including privatizations, which are less so because the production facility already exists. Although in various cases the situation is intricate, as in the case of acquisition with capital extension, this taxonomy allows the tracking of trends in different types of FDI. Figure 9 shows that 17 per cent of all IPF projects are in fact acquisitions or privatizations and may therefore be relatively less productive. For the sake of consistency, M&A and privatizations might be excluded from productive IPF investments but this exclusion prevents the inclusion of potential capital extensions. Understanding this implication is vital in the data analysis.

Regarding the risk of overlap with M&A data, not all IPF deals that lead only to an acquisition appear in M&A data. Matching IPF and M&A databases, the number of overlapping projects corresponds to 1.3 per cent of all IPF projects (using 2022 data).[12] This accounts for a small proportion of all projects, so the overlap is limited and thus not worrying.

[10] Indeed, 40.30 per cent of IPF deals have identical announcement and financial close dates (when any) and 23.32 per cent of IPF deals have identical announcement and construction start dates.
[11] For example, see UNCTAD (2022), p. 18 and pp. 22–32.
[12] This amounts to 1.45 per cent of all project values.

Figure 9. Announced IPF projects by type, 2022 (Percentage)



Source: Refinitiv data on project finance deals.

4.1.2 How much of IPF might be cross-border greenfield investments?

In World Investment Reports and other UNCTAD publications, greenfield cross-border investments are predominantly projects funded by international corporate finance. In theory, corporate finance and project finance do not overlap; however, it appears that projects can overlap in the databases used. This is both unsurprising because the data sources differ and worrying because data harmonization is poor. Refinitiv and fDi Markets, which UNCTAD uses to extract IPF deals and cross-border greenfield investments, respectively, have different methods for collecting data. The former collects from a broad range of sources (e.g. banking, financial, public), whereas the latter is restricted to public announcements. The result is little common ground for matching both databases and sets. Companies' names differ, capital expenditure values vary and the years of the project can change. Data congruence is paramount for the full picture, yet difficult to achieve.

A simple and imperfect matching procedure is attempted. It is based on the direct investment country and direct investor country, the year of the deal and the first word of the investor's name.[13] Although the procedure is not definitive, it helps map the magnitude of the issue. Matching suffers from two major flaws.

[13] More elaborate matching methods, for example constituting a matching score based on bigram algorithms, lead to less satisfactory matching than this simple method.

First, the process overestimates the number of overlaps when the same firm invested in several projects in the same foreign economy in the same year. The matching process is based on the first word only, so when firms (or investing entities) have the same first word projects might be counted as overlapping although they are not (a typical example arises when the investing entity is a country name starts with "Republic").[14] As displayed in table 2, the case of Uzbekistan from 2020 to May 2022 shows that two project pairs were wrongly included because of the issue of the same company investing in multiple projects. Second, there are several data discrepancies, such as the fact that years are not identical across data sets. In the case of Uzbekistan, three projects cannot be matched for these reasons. It is extremely tedious (if even possible) to decipher the balance between these two opposite effects. Accurate conclusions based on the precision of the overlap identifications cannot be derived.

Table 2. Summary of manual screening in Uzbekistan

Item	Refinitiv (IPF)	fDi Markets (FDI)
Number of projects	26	48
Number of overlapping projects	7	8
Number of projects with missing costs	13	0
Share of overlapping projects	23.1%	14.9%
Share of overlapping project costs	12.3%	41.5%

Source: Refinitiv data for project finance deals, fDi Markets (2020 to May 2022) for FDI.

Note: Numbers of overlapping projects differ because one overlapping project is not considered to be international project finance in the Refinitiv data. fDi Markets imputes costs, hence no costs are missing. Overlapping projects differ because some domestic projects in Refinitiv can overlap with projects in fDi Markets.

Data from 2020 to May 2022 demonstrates that about 17 per cent of all IPF project numbers and 20 per cent of all IPF projects' value could overlap with cross-border greenfield investments extracted from fDi Markets. Table 3 provides details on the different matchings and their outcomes. This overlap is large and raises serious concerns, as the matching method cannot be exact. It is probably better to keep the overlapping projects to IPF data only, as these projects are larger than traditional cross-border greenfield investments and therefore not representative of greenfield FDI. Again, the issue of data congruence is telling and affects deeper analysis of the genesis of funding.

[14] For the 2020–2022 (May) period, only 0.2 per cent of all projects include a foreign State named "Republic ..." as a sponsor.

Table 3. Approximate overlap per database

Number of unique paired projects	Refinitiv (IPF)	fDi Markets (FDI)
Match score > 0.2	2 166	4 976
First word in company name	731	810
Total number of international projects	4 325	29 721
Share of overlapping projects (using the most conservative number: 731 for Refinitiv and 810 for fDi Markets)	16.9%	2.7%
Share of total costs (and imputed costs)	19.8% (18.7%)	13.2%

Source: Refinitiv data for project finance deals, fDi Markets (2020 to May 2022) for FDI.

Note: The matching score uses the Jaccard similarity score, using the matchit command on Stata built by Julio Raffo (see Raffo and Lhuillery, 2009, pp. 1619–1627). Both data sources have two name variables for the investing company(ies). A score is constructed for the four pairs. Restricting matching pairs that have at least one of these scores above 0.2 reduces the matched pairs to 13 with only 7 different projects in fDi Markets and 13 in Refinitiv. Given that two of the six projects cannot be merged because of year discrepancies across the data and that one does not have a common investing country, the five recovered pairs are a rather good result: the five overlapping pairs that could be retrieved are retrieved. Given the lack of accuracy of the matching, the minimum number of each database is used for the subsequent computed statistics. Projects are deemed international in Refinitiv project finance data as soon as at least one sponsor is foreign. The second matching is more realistic, using the fact that one of the company name pairs has an identical first word. This has two drawbacks leading to overestimation of pairs: one when the first word is identical but not the company, the other when the same company is differently named (even the first word can be different).

4.2 Is there domestic project finance in IPF?

What is implicit in the data limitations is that some IPF projects actually might be domestic project finance investments. Knowing where the direct investor's headquarters are and the location of the ultimate investor's headquarters is useful for tracking this issue.

Projects occurring in a country whose sponsor's headquarters is in the same country and whose ultimate sponsor's headquarters is a tax haven can be questioned as being an FDI on two grounds.[15] First, the international component of the investment is doubtful, as the sponsor's headquarters is in the same locale. Second, sponsors located in tax havens might be more interested in the rate of return and the profitability of projects than the impact on the management of projects; hence, the financing is more likely to be portfolio finance, rather than FDI. This second scenario calls for a more cautious analysis, in line with the work of Coppola et al. (2021).[16] Only the first one is addressed in this research note.

The concept of cross-border transactions incorporates investments of international actors that seek to be involved in another economy for reasons such as diversifying,

[15] From UNCTAD's listing.

[16] About 16 per cent of all IPF projects have an ultimate sponsor in an offshore centre.

extending market access and global value chains, and developing new partnerships. Yet, cross-border transactions also include investments from local actors whose ultimate headquarters are based in a tax haven. A typical example is a project implemented in the Russian Federation by a Russian company whose sponsor is based in Cyprus. In such a case, the underlying motive for this investment differs from that of other international investors. About 3 per cent of IPF projects have a different headquarters and ultimate headquarters, with the ultimate one being a tax haven. Profit shifting and round-tripping are likely reasons underlying this phenomenon. However, among these IPF projects, some headquarters are already not located in the country where the project is being built (i.e. some projects have country A not equal to country B in figure 10). The FDI aspect of the investment remains for these projects. In 2 per cent of IPF deals there are headquarters in-country but an ultimate headquarters in a tax haven in another country.[17] When this is the case, the project is still a domestic project finance project. The estimate here accounts only for projects whose foreignness is questioned. Only a lower bound is provided here. These projects do not belong to IPF and should not be included in further analyses.

Figure 10. Headquarters and ultimate headquarters, from FDI to other investments

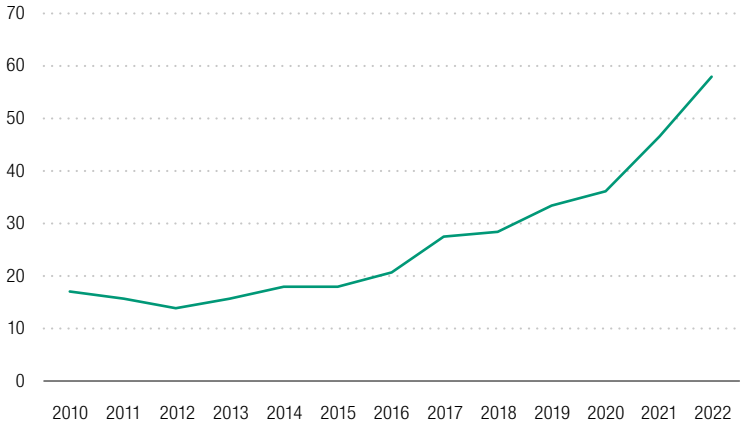
Source: Authors' elaboration, based on UNCTAD (2009).
Note: A project is deemed bound if it (i) reaches financial close, (ii) is under construction, (iii) is in commissioning or (iv) has a sale agreement signed or completed, in the case of acquisitions.

4.3 How important is missing information?

Project costs are necessary to evaluate the total value of IPF and equity information is required to decipher what is true FDI among IPF investments. These elements are often missing. The more recent the financing or investment, the greater the lack of data on missing costs. This is caused by data gaps associated with pending project updates. Figure 11 shows the share of missing costs over time.[18]

[17] When country A in the figure is identical to country B (figure 10).
[18] Equity is non-missing when there is only one sponsor, as one can infer that the unique sponsor owns all the equity. The issue of missing equity information is covered in a subsequent section.

Figure 11. Share of IPF projects with missing costs (Percentage)



Source: Refinitiv data on project finance deals.

The initial multiple imputation used so far has drawbacks; however, these can be reduced when using a non-subjective choice of variables to include in the imputation. To include the most relevant variables in the multiple imputation procedure, a backward selection on a simple robust regression model is implemented. The explained variable is the project cost and only the subset with information on project cost can be used to select the appropriate set of variables. The variables that are statistically significant (at the 10 per cent level of significance in the regression model) are used in the multiple imputations. This produces more satisfactory results than the initial imputation used, which includes subjectively selected variables.

Nevertheless, imputation still is not satisfactory. Total costs for the current year (here using the first nine months of 2022) are missing for 58 per cent of projects. Imputations are conservative, as megaprojects are less likely to be implemented or successful than other projects (Denicol, 2020, p. 2). They systematically underestimate total costs, leading to a likely 20 per cent underestimation of the grand total of project costs in IPF. Indeed, the imputed missing costs represent 58 per cent of the projects but only 37 per cent of all costs (using the backward-selected variables for the multiple imputations).[19] As table 4 shows, cross-

[19] Using the original subjective imputation, the total costs of imputed projects amount to 28.03 per cent of all costs, so the underestimation is even larger: close to a 30 per cent overall underestimation of project costs (for the current year).

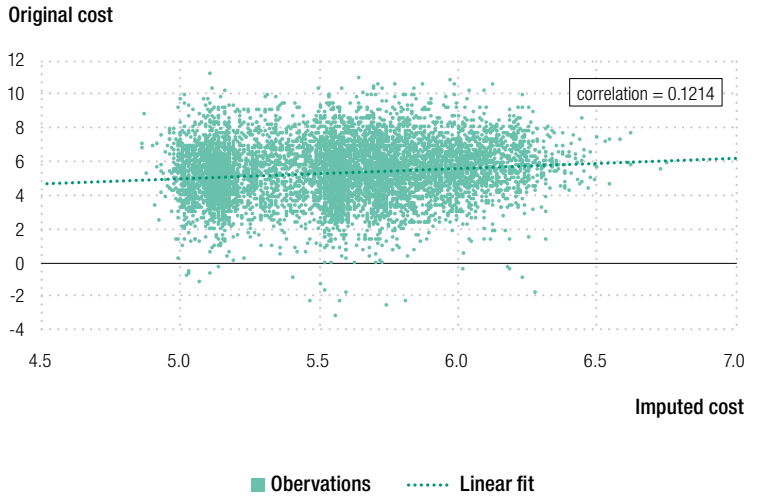
validation exercises are not fully satisfactory either. The means of imputed costs are between two and three times smaller than the actual costs. The linear correlation between the actual costs and the imputed costs when variables are backward selected is +0.275, whereas it would be equal to +1 if imputation were perfect (figures 12 and 13).

Table 4. Cross-validation summary statistics (Millions of dollars)

	Original data	Base multiple imputation	Enriched multiple imputation
Mean	806	281	391
Median	217	266	284
Total costs	6 155 088	2 148 432	2 989 444

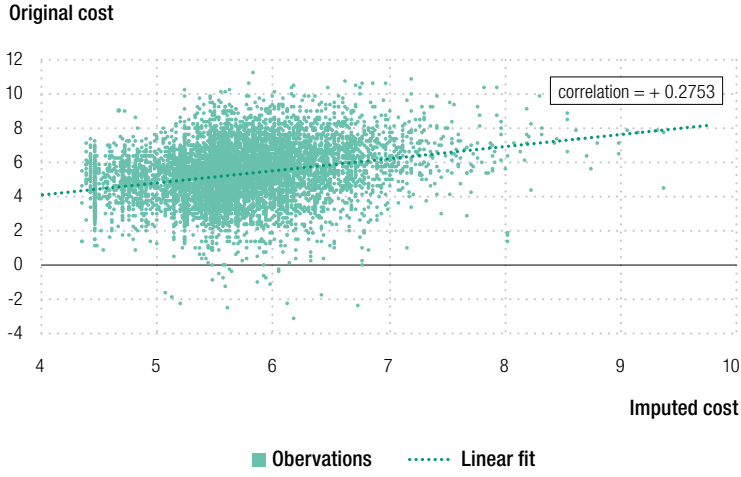
Source: Refinitiv data for project finance deals.
Note: All international projects from 1990 to 2022 (30 September) are included.

Figure 12. Cross-validation of costs using the initial imputation method
(Millions of dollars)



Source: Refinitiv data on project finance deals.
Note: Basic multiple imputations used in UNCTAD's investment research include the level of development of the project host country, year of announcement, sector, type of project, whether the project crosses borders and project home country.

Figure 13. Cross-validation of costsusing enriched imputation, backward selection (Millions of dollars)



Source: Refinitiv data on project finance deals.
Note: Proceeding to a simple backward selection, imputation uses the following variables: year and quarter of announcement, project host country, number of sponsors, project status, whether the project is (i) in financial close, (ii) BRI, (iii) under construction or operational or (iv) providing information on equity.

Although state-of-the-art methods are tested,[20] and although backward-selection multiple imputation is implemented, the imputations cannot be deemed fully satisfactory. Great care is required when interpreting the total values of projects where imputed costs are included. It calls for a use of project numbers rather than projects' values anytime possible, as is done in UNCTAD publications.

5. How much of IPF is FDI?

A big question remains. How much of international project finance qualifies as FDI? There is a discrepancy between a generic criterion of 10 per cent of non-resident equity for all the capital in the project to be FDI and what is included in a balance of payments (BoP). A BoP includes only the non-resident equity-based capital and not debt. Data limitations prevent accurate conclusions. It is only possible to compute shares of equity across projects, for projects with available equity information,

[20] Multiple Imputation with Denoising Autoencoders – MIDAS – is tested but does not deliver better cross-validation results than traditional multiple imputation methods (Lall and Robinson, 2022).

and infer global shares. For this a stepwise procedure is implemented. Thus it is critical to problematize this issue by considering three key questions. First, what is the share of projects with at least one non-resident equity provider with more than 10 per cent of equity? Second, what is the average share of equity owned by non-residents? Third, what is the debt-to-equity ratio?

5.1 What is the share of IPF projects that fulfils the 10 per cent equity criterion?

An investment is deemed to be FDI when an entity is registered outside the economy where the project is implemented and possesses at least 10 per cent of the voting rights (or 10 per cent of the equity). The underlying reason for this definition is the medium- to long-term involvement of the investors in the project. IPF and FDI are almost identical: almost 96 per cent of IPF projects are FDI projects. This magnitude is taken from the deals where information on equity shares among sponsors is available or can be retrieved.[21] The underlying assumption is that the ratio FDI/IPF of deals with information on equity is similar to the set of all deals.

Computing this share by year, by sector or by project region is a natural extension of this exercise. The idea is simply to compute the shares of IPF and of FDI-IPF among projects with equity information in the subset of interest (for example, renewable projects, projects in Sub-Saharan Africa).[22] Beyond the number of projects, the issue is also about the value of IPF that is FDI.

5.2 What is FDI-IPF in BoP accounting?

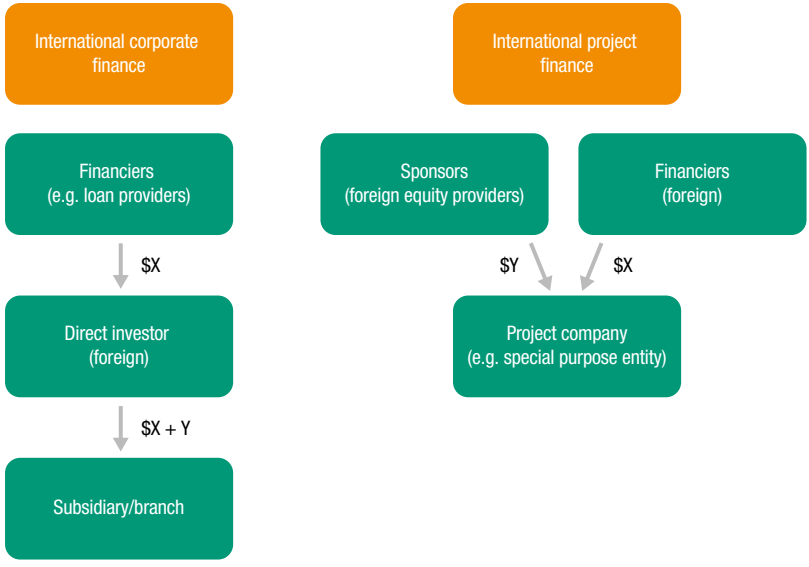
Although the FDI definition is clear, it might be particularly restrictive for project finance because sponsors are not borrowers. The SPE structure of IPF makes it difficult for such financing to feature in FDI statistics. Indeed, the benchmark definition of the Organisation for Economic Co-operation and Development (OECD) recommends "the statistics be compiled excluding resident Special Purpose Entities" (OECD, 2015, p. 6). Not all IPF investment would be included as FDI. Unlike projects funded by corporate finance in which financiers provide loans to equity owners, in projects funded by project finance the borrowing entity is the dedicated entity. Amounts that accrue from financiers are included in the BoP in the case of corporate finance insofar as they translate into intrafirm loans, whereas in the case of project finance they are mostly not included.

[21] The longer the panel, the larger the share of deals with retrievable information. This is a reason why using the long time series 1990-2022.

[22] The subset should not be too restrictive to provide realistic approximations that are not relying on a handful of projects.

Figure 14 sketches corporate finance and project finance projects involving international direct investors in their simplest form.[23] There is only one direct investor in either type of financing and one foreign loan provider. The former invests $Y in equity and the latter lends $X. The key difference is that corporate finance implies that the direct investor is the borrower while project finance implies that the SPE is the borrower. This difference has a tremendous impact on what a BoP would include as FDI. Indeed, in the case of corporate financing, FDI on this project amounts to $(X + Y) whereas in the case of project finance it amounts to $Y only.

Figure 14. International corporate finance and IPF processes



Source: Authors' elaboration, based on UNCTAD (2009).

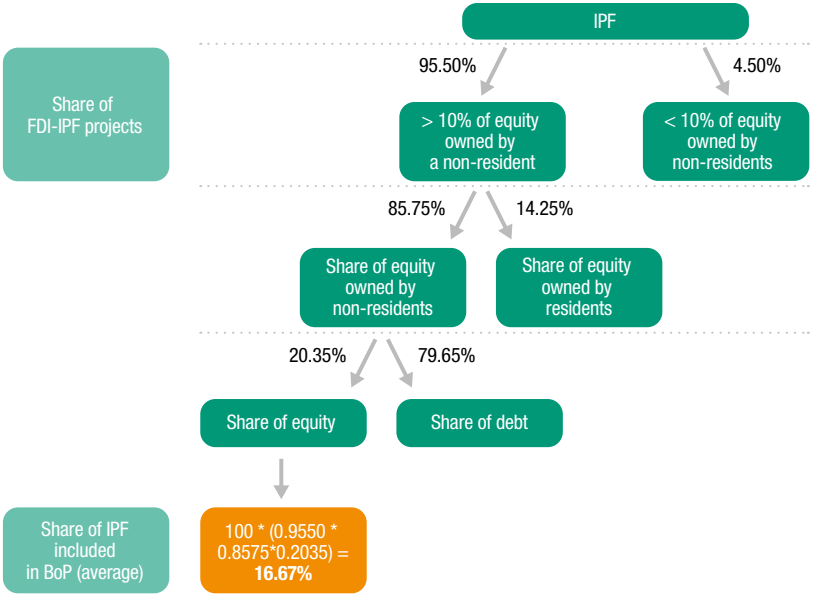
Furthermore, BoP compilation includes only FDI direct investors from entities not residing in the economy of the project. Therefore, among sponsors, only the non-resident sponsors are considered foreign direct investors. In the Vietnamese project illustrated in figure 6, this would imply that the FDI of the project is $29.6 million (= 0.4 * 74), out of the total project costs of $247 million. The remainder belongs to

[23] The most common corporate finance FDI consists of wholly or majority-owned subsidiaries or branches (UNCTAD, 2009). The majority (52.73 per cent) of IPF has only one sponsor.

the "other investment" category of the BoP, whereas $247 million would have been included as FDI if the non-resident sponsor performed a corporate investment.

Moreover, a larger leverage ratio in project finance (a debt-to-equity ratio about twice as large) further reduces the part of the total capital invested that accrues to FDI. As compared with corporate finance, Y is relatively smaller than X in project finance.[24] For all IPF projects, equity accounts on average for 20.35 per cent of capital invested in projects. Among projects that are considered FDI-IPF, the share of equity owned by non-residents amounts to 85.78 per cent. This implies that only 16.67 per cent (= 0.9550 * 0.8578 * 0.2035 * 100) of IPF total project value would be accounted for in the BoP (figure 15).[25]

Figure 15. From IPF to BoP FDI by magnitude



Source: Authors' elaboration, based on Refinitiv data on project finance deals.

[24] Using IJGlobal data that tracks infrastructure investments for corporate and project finance investments, leverage ratios (debt-to-equity ratios) are 2.13 in corporate finance and 4.88 in project finance (data from 2011 until May 2022).

[25] However, the 85.78 per cent of foreign-owned equity might not be fully converted to FDI. If one used the FDI/IPF ratio of 0.9550, assuming that about the same proportion of nonresident equity owners would own beyond 10 per cent of all equity, then the share of IPF that is FDI in value would be closer to 15.92 percent (= 0.9550 * (0.8578 * 0.9550) * 0.2035 * 100).

5.3 What is best to capture productive cross-border investment?

Often financiers do not invest only for profitability motives but are involved in the structuring of projects and investing in the long run (a loan maturity beyond 10 years is frequent if not the norm in IPF). Therefore, all measures arising solely on equity-specific information underestimate the real commitments in terms of international investments. Nevertheless, financiers and sponsors tend to be vastly different actors. Financiers, as loan providers, are mostly banks with financial expertise. Sponsors, as equity providers, have sectoral or local expertise. A new taxonomy introducing financiers might be a promising development, but it would require a rationale separating financiers by their degree of involvement, which would be highly challenging (if even possible).

Going back to the Vietnamese project. it can be advocated that the entire project cost should be included as a cross-border productive investment. Indeed, international lenders offer a syndicated loan; one contractor and one sponsor are non-residents. Because the project is unprecedented in the country, IPF is well-suited and local stakeholders are required. It paves the way for future cross-border productive investments (IPF or greenfield). Overall, the intricate construction of FDI-IPF should not hide that most of the time, cross-border productive IPF investment might simply be measured using the whole project cost. This is what has been done so far in UNCTAD's investment research.

6. Conclusion

The SDG financing gap requires all possible forms of financing, in particular where public fiscal expenditures are tight. Project finance is a structured financing well suited for large projects, such as most infrastructure projects. International capital is needed to best address capital shortages in developing countries.

Capturing *investment intentions* and *locational decisions* in the reporting of investment trends – as is done in UNCTAD publications through the use of announcement-based IPF and greenfield investment data – is important for informed investment policymaking. It also helps policymakers anticipate emerging trends. This is the rationale behind the decision to incorporate announced deals for cross-border greenfield investments as well as IPF deals. UNCTAD's use of IPF departs from other institutions that tend to use financial close deals only. Announcements in this regard are strategic. The best time to announce a project largely differs across deals. Therefore, data would only imperfectly capture the pipeline of a project, even when it is frequently updated, as is the case for Refinitiv data.

Data limitations prevent exact and accurate statistics. Imputing missing costs helps partly to overcome this issue, but it also calls for caution in using total deal values.

Using deal numbers is advised to limit approximation due to imperfect imputation. Furthermore, some IPF projects are domestic project finance and should be dropped from the IPF set (beyond 2 per cent of deals).

Recent World Investment Reports report three types of investment projects to complement FDI data: M&As, greenfield and IPF. Although in theory these are distinct forms of FDI, the data does overlap. The IPF-M&A overlap is minor (about 1 per cent of projects) and can be circumvented rather well. Cross-border greenfield investments and IPF have larger overlaps (more than 15 per cent of IPF projects overlap with greenfield deals) and require caution. A simple matching method is suggested, but it cannot provide an exact identification of the overlapping projects.

Almost all IPF projects are FDI projects: 96 per cent of IPF projects have at least one nonresident sponsor with more than 10 per cent of the equity. But because the SPE is the direct borrower, loans are not part of FDI (in contrast to cross-border greenfield investments, where the direct investor is the borrower). This leads to a less straightforward measure of FDI-IPF than for cross-border greenfield investments. The approximation constructed in the present note concludes that about 17 per cent of IPF would be considered as FDI in the BoP.

Overall, this situation calls for a separation of cross-border productive investments from FDI as understood by BoP compilers. Unless significant changes are made in the compilation of the BoP, they would capture only a small fraction of IPF. Given the rising role IPF plays in financing SDG-oriented infrastructure, it is important to measure all IPF and perhaps depart somehow from the FDI categorization.

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[1] India, Ministry of New and Renewable Energy, "India achieves 100 GW milestone of installed renewable energy capacity", 12 August 2021, https://pib.gov.in.

[2] European Commission, "What category do I fit into?", EU Immigration Portal, https://ec.europa.eu/immigration (accessed 13 December 2021).

[3] Based on UNCTAD, "International investment agreements navigator", Investment Policy Hub, https://investmentpolicy.unctad.org/international-investment-agreements (accessed 15 April 2018).

[4] *The Financial Times*, "Gig workers should get pension rights now, says regulator", 19 May 2021.

[5] Bloomberg News, "Tracking tax runaways", Bloomberg Special Reports: Corporate Tax Inversions, 1 March 2017, www.bloomberg.com/graphics/tax-inversion-tracker.

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