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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 a global reach, a strong development policy imprint, and high potential for impact beyond the scholarly community.

Objectives and central terrain

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 to make international investment and multinational enterprises contribute to sustainable development. It 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. Only contributions that draw clear policy conclusions from the research findings will be considered.

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Inclusive: multiple contributors, types of contributions and angles

Transnational Corporations aims to provide a bridge between academia and the policymaking community. It publishes academically rigorous, research-underpinned

[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).

and impactful contributions for evidence-based policy-making, including lessons learned from experiences in different societies and economies, both in developed and developing-country contexts. It welcomes contributions from the academic community, policymakers, research institutes, international organisations, and others. Contributions to the advancement and revision of theories, frameworks and methods are welcomed as long as they are relevant for shedding new light on the investigation of investment for development, such as advancing UNCTAD's *Investment Policy Framework for Sustainable Development*.

The journal publishes original research articles, perspective papers, state-of-the art review articles, point-counterpoint essays, research notes and book reviews. All papers are double blind reviewed and, in line with the aims and mission of the journal, each paper is reviewed by academic experts and experts from the policymaking community to ensure high-quality impactful publications that are both academically rigorous and policy relevant. In addition, the journal features synopses of major UN reports on investment, and periodic reviews of upcoming investment-related issues of interest to the policy and research community.

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UNCTAD INSIGHTS

Diverse paths of upgrading in high-tech manufacturing: Costa Rica in the electronics and medical devices global value chains

Gary Gereffi, Stacey Frederick and Penny Bamber*

Costa Rica has sought to improve its position in the global economy by prioritizing export growth in two high-tech manufacturing industries led by foreign direct investment (FDI): electronics and medical devices. We use a global value chain (GVC) perspective to identify key commonalities and contrasts in Costa Rica's performance in upgrading these two sectors. Because the electronics and medical devices GVCs have very different structures in Costa Rica (electronics is dominated by a single large firm, Intel, whereas medical devices has a highly diversified set of foreign manufacturers), multiple forms of upgrading, downgrading and knowledge spillovers are possible. Although the experience of these two industries illustrates different paths to upgrading, developing backward linkages in Costa Rica was not the preferred nor the only way of moving up the value chain. The medical devices sector exhibited more traditional knowledge spillovers and labor market features of local industrial agglomerations, whereas the electronics sector demonstrated significant wage and skill-level gains because of the incorporation of high-value service activities due to the evolving global strategy of its GVC lead firm, Intel. By combining a GVC perspective with a focus on knowledge flows and value creation at the local level, we seek to promote more explicit integration of international business and economic geography concepts and methods.

Keywords: global value chains; electronics; medical devices; upgrading; downgrading; knowledge spillovers; local linkages; servicification; industrial agglomerations.

1. Introduction

Developing nations have sought to improve their positions in the global economy through various upgrading strategies, including the use of foreign direct investment (FDI) to help them catch up with advanced country competitors in high-tech manufacturing and service industries. This emphasis on entering high-tech export-

* The authors are affiliated with the Global Value Chains Center at Duke University, Durham, North Carolina, USA, where Gary Gereffi is the founding director, Stacey Frederick is the managing director and Penny Bamber is senior researcher. The corresponding author is Gary Gereffi (ggere@soc.duke.edu).

oriented sectors is particularly attractive for relatively small economies, which often do not have the natural resource base or large domestic markets needed for inward-oriented development strategies.

Evidence is mixed on the potential for FDI-led development to support high-tech upgrading in developing economies. Early studies of Costa Rica's high-tech development strategy agreed that FDI has been very successful in boosting the country's export competitiveness, but achievements were far less in terms of the transfer of technology, local linkages and knowledge spillovers needed for a more sustainable pattern of industrial upgrading (Giuliani, 2008; Paus and Gallagher, 2008). For example, Ciravegna and Giuliani (2007) concluded that Costa Rica has successfully created FDI-dominated clusters in both the electronics sector and the medical devices sector, although backward linkages to local suppliers are weak and of low technological content.

For medical devices in Galway, Ireland, Giblin and Ryan (2012) demonstrated that inward FDI was initially attracted to the region through "top-down" public policy rather than through a pre-existing cluster or a large domestic market. However, the success of two world-class multinational enterprises (MNEs), Boston Scientific and Medtronic, resulted in positive reputational effects for the Galway region, which made it easier for local firms to establish their own linkages abroad and participate in global networks. This finding challenges earlier studies that suggested external economies or knowledge spillovers of MNEs could be captured only if FDI entered existing clusters driven by indigenous firms (Phelps, 2008; De Propris and Driffield, 2006).

This debate sets up our main research questions in this paper: Under what conditions can FDI-led, export-oriented industries in Costa Rica, such as electronics and medical devices, generate significant and sustainable patterns of upgrading in the local economy, and what types of policies can help create such conditions? We address these questions by using the global value chains (GVC) framework to integrate global, national and local levels of analysis (Gereffi and Fernandez-Stark, 2016). At the global level, we examine the governance structure of the electronics and medical devices GVCs and the strategies of the lead firms that located in Costa Rica. At the national level, we highlight Costa Rica's development strategy of export-oriented industrialization with a particular focus on high-tech manufactured exports. Also relevant are key institutional features that shape the role played by FDI in the country, such as Costa Rica's free trade zones (FTZs) and its foreign investment promotion agency (CINDE), which markets the country's location-specific assets to potential foreign investors. At the local level, we focus on specific activities that MNEs carried out in each sector and how these activities changed over time. In addition, we analyze the local labor market impact of MNEs in terms of jobs, skills and wages in these two industries, along with backward and forward linkages involving suppliers of goods and services across the value chains.

Our GVC focus highlights the interplay between global and local factors, and does not assign causal priority ex ante to host-country absorption capacity, domestic institutions or local linkages as determinants of upgrading (or downgrading) outcomes. Our empirical research uses value chain mapping to document which activities are carried out locally in each industry, and how and why these activities evolve over time. The contrasting structures and FDI dynamics of the electronics and medical devices sectors in Costa Rica generate different patterns of upgrading, linkages and knowledge spillovers, and both domestic and external factors will affect their future trajectories.

Costa Rica is a very interesting case for exploring these questions. Although it is a small country of fewer than 5 million people, Costa Rica has been the most successful Latin American economy, after Mexico, in attracting FDI into high-tech manufacturing (Paus and Gallagher, 2008: 54-55). Costa Rica's traditional exports were bananas, coffee and clothing, but in the 1990s the country shifted to a high-tech industrialization strategy emphasizing FDI and manufactured exports.[1] Intel's decision in 1996 to invest US$300 million in an assembly-and-testing (A&T) semiconductor factory proved that Costa Rica was able to attract high-tech FDI, and the country subsequently expanded its efforts to target other high-tech sectors such as medical devices and information technology (IT)-enabled services (Monge-González, 2017). Although electronics and medical devices both involve high-tech products and processes, the two sectors vary considerably in their global production structures and in the relevance of local linkages for industry growth and sustainability.

Our paper is structured as follows: Section 2 provides an overview of the literature on GVCs and upgrading, and several propositions that link the GVC perspective to the local and institutional contexts of upgrading in Costa Rica. Section 3 discusses the data and methodology used in our study. Section 4 analyzes our empirical findings for the electronics and medical devices GVCs in Costa Rica, showing how the contrasting structures and lead-firm strategies of these sectors produce varied results in terms of local upgrading trajectories. Section 5 discusses the key lessons from our findings for the sustainability of high-tech upgrading efforts in Costa Rica, and Section 6 examines the policy implications of our analysis for other countries.

[1] By 1994, apparel products represented 36 per cent of the total exports of Costa Rica's FTZs; the low value-added of this assembly industry led to a rapid decline in the 1990s (Giuliani, 2008: 388).

2. Global value chains and the upgrading challenge

The GVC perspective looks at global industries from two contrasting vantage points: top down and bottom up (Gereffi and Fernandez-Stark, 2016). The key concept for the top-down view is the "governance" of GVCs, which examines the organization of global industries by linking GVC lead firms and their varied networks of suppliers, while the central concept for the bottom-up view is "upgrading", which highlights the strategies used by countries, regions and firms to maintain or improve their positions in the global economy (Gereffi, 2014). Global lead firms are a defining feature of the governance structure of GVCs, including the initial distinction between producer-driven and buyer-driven chains (Gereffi, 1994) as well as the more comprehensive typology involving captive, relational and modular GVC governance structures along a continuum whose end points are markets and hierarchies (Gereffi et al., 2005).

Economic upgrading can be defined as "the process by which economic actors – nations, firms and workers – move from low-value to relatively high-value activities in global production networks" (Gereffi, 2005: 171). Various typologies have been used to analyze how this upgrading process takes place. One of the best-known formulations of firm-level strategies to improve their competitive position in GVCs (Humphrey and Schmitz, 2002) involves four types of upgrading:

- *Product upgrading*: moving into more sophisticated product lines with higher unit values.
- *Process upgrading*: transforming inputs into outputs more efficiently by reorganizing production systems or by using superior technology.
- *Functional upgrading*: acquiring new, superior functions in the chain (or abandoning low value-added functions) to raise the skill content of activities.
- *Intersectoral or chain upgrading*: using the competence acquired in a particular chain to move into new sectors.

Early GVC studies suggested that local upgrading trajectories were associated with moving away from assembly production into original equipment manufacturing (OEM) or full-package production, and eventually into original design manufacturing (ODM) and original brand manufacturing (OBM), all of which utilize more extensively the higher-value activities associated with pre- and post-production services (Gereffi, 1999; Bair and Gereffi, 2001; Schmitz and Knorringa, 2000). However, newer GVC studies have shown that this "linear" upgrading scheme is just one among a much larger range of possible upgrading trajectories, many of which involve more extensive linkages between manufacturing and services activities within local clusters as well as along GVCs (Sturgeon et al., 2008; Gereffi, 2015; Low and Pasadilla, 2016).

A new World Bank study highlights that the development impact of manufacturing comes not only from production per se, but also increasingly from the services involved in a product's broader value chain (Hallward-Driemeier and Nayyar, 2018). The boundaries between the manufacturing and services sectors are blurring. The so-called "servicification" of manufacturing refers both to services *embodied* in goods (as part of the manufacturing process) and to services *embedded* in goods during the post-production process (including after-sales support and other add-on services such as manufacturing-related engineering services). The key theme is that upgrading in high-tech industries is about making and adding value at every stage of the production process – from raw materials to design and production, and all the way to sales and follow-on services.

This review of both the GVC and upgrading literatures provides us with the necessary foundation to employ these frameworks in our analysis of the electronics and medical devices GVCs in Costa Rica. The GVC perspective is used to better understand the governance structures of these two industries at the global level, as well as the role played by lead-firm strategies in both sectors as they have been established within Costa Rica. The upgrading concept is applied not to analyze the atomistic position of single firms, but rather as a relational concept to assess the role of market players, inter-firm networks and public policy across the entire value chain. Our emphasis is dynamic because we need to evaluate the evolution of value chain structures, strategies and upgrading outcomes over time.

2.1 Propositions

To clarify our perspective, we briefly outline three theoretical propositions that guided our research on the Costa Rica case.

Proposition 1: *The strategies of GVC lead firms in the electronics and medical devices sectors determine how Costa Rica is inserted in export-oriented production networks and the potential gains from trade in these sectors.*

GVC lead firms are the key drivers of upgrading, and public policy plays a facilitating role. Neither the electronics nor the medical devices industries in Costa Rica had previous clusters of export-oriented firms, so MNE lead firms entered Costa Rica to respond to top-down public policy initiatives by the national government rather than to exploit pre-existing sectoral capabilities or a large local market. Upgrading dynamics are largely determined by local industrial agglomerations established by inward FDI.

Proposition 2: *The contrasting roles played by MNE lead firms in the electronics and the medical devices GVCs in Costa Rica create different kinds of industrial agglomeration in the host economy: Intel has a quasi-monopoly in electronics production and exports, whereas medical devices has a much greater diversity of foreign investors that instigate cluster-like patterns and competitive dynamics.*

These differences have implications for FDI-related knowledge spillovers in Costa Rica. With only one firm participating in the production segment of the electronics value chain, there are limited possibilities for intra-sector spillovers. By contrast, medical devices MNEs have instigated cluster-like properties in the local industrial agglomeration they generated in Costa Rica, resulting in much higher levels of technological upgrading through exports, a more diversified group of local suppliers, and some forward linkages into manufacturing-related services.

Proposition 3: *Different GVC characteristics and lead firm strategies in electronics and in medical devices led to diverse upgrading and downgrading patterns in Costa Rica.*

We expect the patterns in Costa Rica to be mixed. On the upgrading side, we anticipate the strongest performance in terms of exports over time because this was an explicit objective of Costa Rica's policy of FDI-led export-oriented growth. We also look closely at local labor market effects through employment, skill training and wage performance. The role of local linkages is likely to be weakest in backward linkages to suppliers as there is a very limited industrial base on which to build. However, GVCs have incentives to create needed linkages of goods and services if export growth is rapid and diversified. On the downgrading side, we assess the impact of the closure of Intel's plant in 2014, and the associated drops in exports and employment. This is a byproduct of Costa Rica's dependence on a single GVC lead firm in the electronics sector. However, the story of Intel's expansion of relatively high-value services in Costa Rica is also very intriguing, as that expansion may offset some of the employment and manufacturing export losses.

Several factors condition sustainable upgrading in these two GVCs in Costa Rica:

- *GVC lead-firm strategies* – Will Intel continue to promote Costa Rica as a hub in its regional and global service activities? Will Costa Rica be able to diversify the number of GVC lead firms that operate in high-tech sectors so as to create more sustained demand for high-value manufacturing-related and professional services?
- *Endogenous variables* – Public policy is a core issue, especially Costa Rica's policies related to its local innovation system. Although the innovation system literature tends not to emphasize the role of GVC linkages in knowledge flows (Pietrobelli and Rabellotti, 2011), there are clear roles for specialized training programs and industry-university linkages in expanding pools of skilled labor and promoting local start-ups.
- *Exogenous variables* – Given Costa Rica's export-oriented strategy, the policies of its major trade partners are a key factor, especially protectionist policies that could limit Costa Rica's access to its primary export market, the United States. Costa Rica's extensive set of free trade agreements with a variety of countries in Europe

and elsewhere provides a hedge against protectionism from the public policy side. GVC lead-firm strategies can also play a role here by connecting Costa Rica to a more diversified set of global production networks and end-markets.

In our broader assessment of knowledge flows related to high-tech upgrading in Costa Rica's electronics and medical devices GVCs, we discuss the role of five potential determinants of FDI-generated spillovers: (1) the characteristics of the manufacturing GVCs being analyzed; (2) the transnational strategies of MNE lead firms within these GVCs; (3) Costa Rica's industrial policies, including those related to the establishment of the FTZ regime; (4) the position of Costa Rica within these GVCs; and (5) the absorptive capacity of Costa Rican institutions to manage FDI flows and convert them into value-adding activities at the local level.

3. Data and methodology

The research was undertaken in two stages. The objective of the first stage was to understand the evolution of the two industries in Costa Rica and establish comparable metrics for both sectors. A longitudinal data set of electronics and medical devices firms operating in Costa Rica was created. This data set covered annual trade data, investment year, employment, key product categories and activities. It was created using information from the Costa Rican Central Bank together with annual surveys for the Costa Rican FTZs. The data set covered firm-level exports, employment and wages for 2000–2015, and imports for 2009–2014. Import-export data included the Harmonized System (HS) product code, value, weight and destination or origin. These data were supplemented with information from CINDE about the year of investment. Company annual reports, industry reports and news articles were used to identify the health care subsectors in which medical devices firms were engaged.

In total, 14 firms were identified as participating in the electronics sector and 35 firms in the medical devices sector. All firms engaging in GVC exports in either sector were located in the country's FTZs. In both sectors the firms listed in the data set accounted for 96 per cent of the country's exports, as reported by UN Comtrade over the 15-year period analyzed. Firm exports were categorized as either intermediate or final products. The final products were grouped together by technological sophistication in the case of medical devices (i.e. disposables, instruments, therapeutic devices or capital equipment; see table A-1) and by end-market in the electronics sector (e.g. consumer electronics, medical; see table A-2). Firm activities were also coded into four groups: R&D Services; Component Manufacturing; Final Products Assembly; and Distribution. This information was used to map Costa Rica's participation in the two GVCs by examining a series of empirical indicators: the activities performed by different firms in the sectors;

backward linkages with both local and foreign suppliers; employment and salary information; primary end-markets; and type of products exported.

In the second stage, we analyzed how these firms had altered their participation or increased their value addition in their respective chains, including through expansion or change of activities undertaken, products made, and subsectors and markets served. This research combined year-on-year analysis of the data set with information derived from 23 semi-structured interviews with senior executives of firms from both industries (12 medical devices firms, 10 electronics firms and one firm operating in both sectors). The interviews covered topics such as company background, detailed history of firm investments in Costa Rica, evolution of processes undertaken at plants, changes in employment number and profiles, industry linkages (with both foreign and domestic firms), and engagement with local educational institutions and public agencies. The information from these interviews was supplemented with interviews from several public and private stakeholders including the Ministry of Foreign Trade, CINDE, the Ministry of Education, the National Training Institute and other academic institutions. Based on this information, comparative analysis was undertaken to evaluate the upgrading trajectories.

Table 1. Methodological approach

Research Stage	Research Method	Data Sources
GVC Mapping	Compilation of firm-level data set (including firm name, origin, exports and imports, local sourcing, employment, activities and products exported) Segmentation of exports and activities by value chain stage 7 personal multi-stakeholder interviews	• Costa Rica Central Bank, Annual Survey for Costa Rican Free Trade Zones • Costa Rican Investment Promotion Agency (CINDE) • Ministry of Foreign Trade (*Ministerio de Comercio Exterior, COMEX*) • Costa Rican Export Promotion Agency (PROCOMER) • United Nations Statistics Division
Upgrading Analysis	Analysis of evolution of product exports, evolution of activities, backward linkages Personal interviews with 23 firms	• Analysis of GVC mapping data set • Foreign-owned medical devices firms • Foreign-owned electronics firms

Source: Authors.

4. A GVC analysis of high-tech upgrading in Costa Rica

In the mid-1990s, Costa Rica sought to diversify its economy by focusing on an FDI strategy to promote high-technology manufacturing exports. The opening in 1998 of Intel's factory in Costa Rica was the first major step in realizing this strategy, but Intel's decision to close this plant in 2014 and lay off 1,500 workers highlighted the vulnerabilities of depending on just one high-profile MNE. The medical devices sector represented a very different approach to Costa Rica's economic diversification efforts. Instead of targeting a single dominant MNE such as Intel, in the medical devices sector Costa Rica recruited a more diverse set of MNEs. This enabled the country to follow a trajectory of upgrading based on successive waves of FDI, embodying different categories of medical devices with higher levels of technological content. As a result, medical devices emerged as the most successful cluster developed in Costa Rica under its FDI-driven, high-tech export strategy. Investment, trade and upgrading patterns of the two sectors are discussed in the following sections.

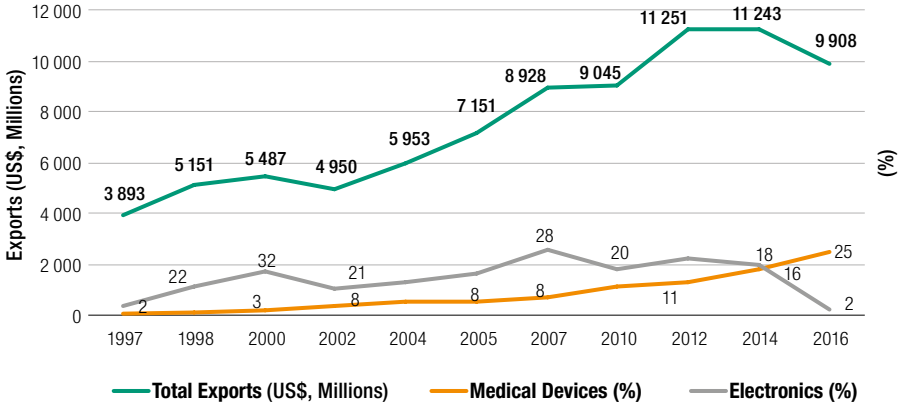
4.1 Costa Rica in the electronics GVC

Costa Rica's initial foray into a high-tech manufacturing export sector was in electronics. The first foreign firms in the electronics GVC started investing in Costa Rica in the 1960s and 1970s, when import-substitution policies were being implemented. These "market-seeking" subsidiaries were mainly European, and they made simple electrical components (batteries, switches and connectors) and consumer appliances (washing machines and hair dryers) for the domestic and regional markets. During the 1980s and 1990s, Costa Rica shifted its strategy to the attraction of high-tech FDI geared to export-oriented industrialization. Instead of local markets, the new "efficiency-seeking" MNE subsidiaries thus attracted were typically American-owned firms that exported their entire output to the United States.

When Intel opened its A&T factory in Costa Rica in 1998, it became the star performer in terms of the country's manufactured exports, but with a focus on intermediate inputs rather than final consumer goods. Thus, Costa Rica was positioned in the upstream (components) side of the electronics GVC, rather than in the final products side. By 2000, electronics represented 32 per cent of Costa Rica's total exports. Between 2000 and 2014, electronics was Costa Rica's leading manufactured export item, and Intel represented over 80 per cent of Costa Rica's electronics exports (figure 1).[2]

[2] For an in-depth analysis of the GVC in Costa Rica, see Frederick & Gereffi (2013).

Figure 1. Costa Rica's exports: total, medical devices and electronics, 1997–2016 (Millions of dollars and per cent)



Source: UN Comtrade (2017).

a. Governance and global firm strategy in the electronics sector

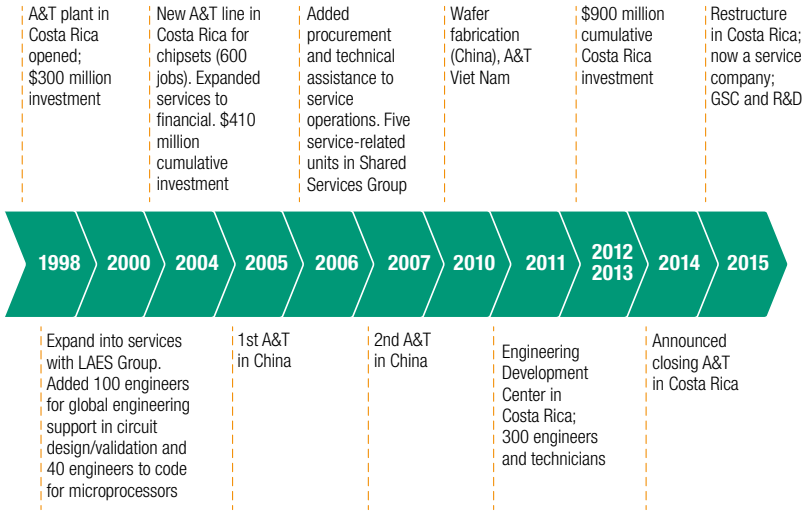
Global: The ecosystem of the electronics GVC has three principal actors: lead firms with global brands (such as Apple, Samsung and Lenovo); large contract manufacturers that make products and sometimes provide design services for lead firms (such as Foxconn and Flex); and platform leaders, which are companies (such as Intel and Microsoft) that have successfully implanted their propriety technology (hardware, software or a combination) in the products of other companies in industries such as personal computers, mobile phones, and a few industries unrelated to electronics such as bicycles (Sturgeon and Kawakami, 2011: 124-129). Platform leaders often capture a large share of industry profits and influence the innovative trajectory of global lead firms by unilaterally determining the "pinch points" in modular GVCs such as the personal computer industry.

Consumer electronics are price sensitive, and the center of gravity for manufacturing in this industry has been in Asia since the rise of offshore manufacturing. Asia's share of 3C (computers, consumer electronics and communication device) final products, subassemblies and electronic components exports increased from 51 per cent to 73 per cent between 2000 and 2015. In all three segments, the increase was driven by East Asian countries, particularly China. This has been at the expense of exports from Europe across all three segments, and from North America in intermediates (subassemblies and components) (Frederick & Lee, 2017).

Costa Rica: Given that one firm dominates investment in Costa Rica's electronics sector, the country's development is highly dependent on that firm's strategy. Intel invested in Costa Rica in 1998 to assemble and test integrated circuits. In 2000, the company began to add services to the activities it conducted in Costa Rica. It started with manufacturing-related engineering services for Latin American clients[3] and expanded into back-office services such as finance and purchasing. In 2006, Intel added procurement and technical assistance service operations, followed by more R&D service jobs (300 engineers) for global operations in 2011. In 2015, Intel restructured its service activities in Costa Rica to establish two "centers of excellence": a Global Services Center and an R&D Center.

In manufacturing, Intel continued to expand its base in Costa Rica throughout the 2000s, adding a second A&T line in 2004. However, the company began investing in manufacturing facilities in Asia in 2005. Between 2005 and 2010, Intel opened three plants in China and one in Viet Nam, while manufacturing employment in Costa Rica declined. In 2014, Intel announced it was closing electronics manufacturing in Costa Rica (ICS News, 2014) and moving to Viet Nam (figure 2). The 1,500 workers employed in Intel's assembly plant were laid off, and new workers were hired as engineers and technicians.

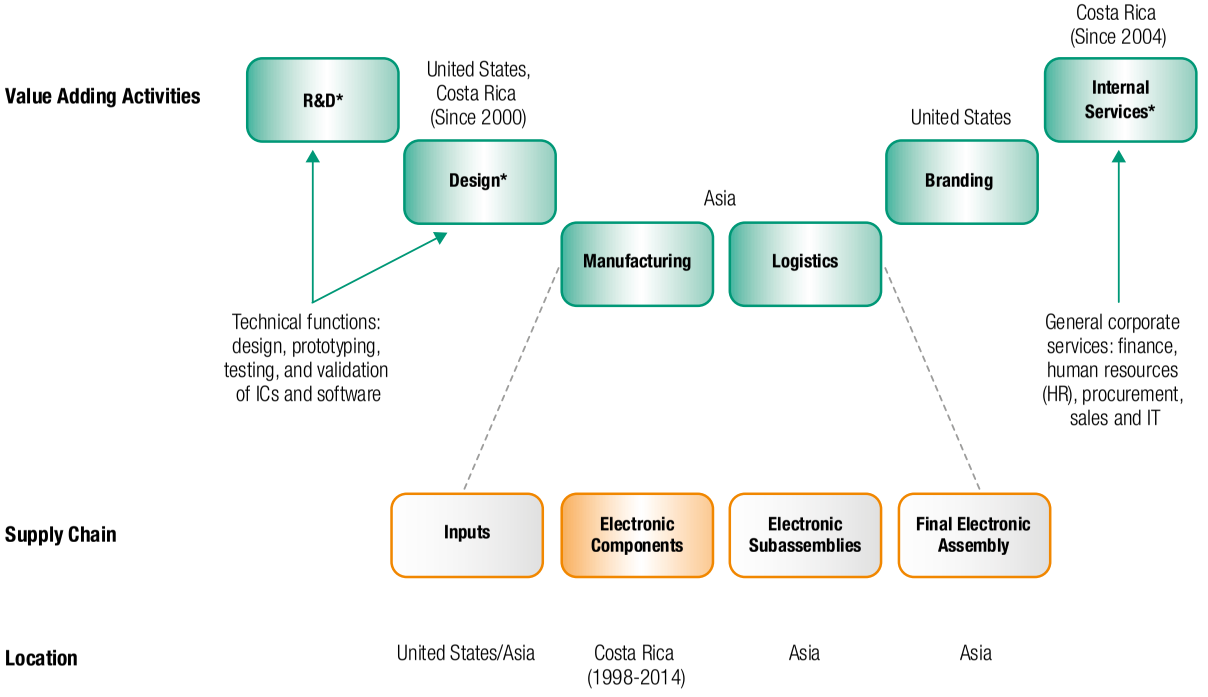
Figure 2. Intel timeline (Primarily in Costa Rica but also key events in Asia)



Source: Authors.

[3] Intel's Latin America Engineering Services (LAES) Group provided jobs for 100 engineers for global engineering support in circuit design and validation, and for 40 engineers to design enabling code for microprocessors.

Figure 3. Activities in the electronics global value chain and Costa Rica's shift from manufacturing to services (1998–2015)



Source: Authors.
* Higher wages and education levels than manufacturing.

b. Local agglomeration effects

Over the course of its investment in Costa Rica, Intel made few direct local linkages. Because of their large scale and demanding technological requirements, platform leaders such as Intel typically work with well-established global contract manufacturers on a "follow-sourcing" basis, rather than seeking inputs from local suppliers. Furthermore, Intel's upstream location in the electronics GVC severely constrains the potential for backward linkages, since the natural resources and silicon wafers used in semiconductors are available from only a few locations in the world. Thus, Intel's primary contribution to Costa Rica's economy from the outset was going to be its high volume of exports, which indeed had an immediate and sustained impact on Costa Rica's total exports, as shown in figure 1. However, Costa Rica was unable to maintain its cost competitiveness relative to Asia in the cost- and scale-driven electronics components sector, and electronic exports in Costa Rica collapsed after Intel closed its A&T plant.

c. Upgrading, knowledge transfer and local institutions

Overall employment by Intel in Costa Rica declined after the plant closure in 2014, but wages increased significantly owing to a shift in the composition of the company's workforce. Manufacturing workers (entry-level technicians) were replaced by an increase in IT-related positions (programmers, developers and engineers). After the closure of the A&T facility, the IT-related share of the company's workforce rose from 13 to 28 per cent, while production operations fell from 37 to 5 per cent.[4] Intel's new workers typically have a three- to four-year college degree. Approximately 80 per cent are recent graduates, with the remaining 20 per cent hired from other companies with experience. In 2014, the average salary of electronics[5] FTZ workers in Costa Rica was US$27,800 per year; this was significantly higher than the average wage of all FTZ workers (US$19,000) and the average for the overall economy (US$9,200). Although there has been no formal study of where the laid-off workers went, it is believed most were easily absorbed by other companies in Costa Rica's FTZs, specifically life sciences.

Intel's operations in Costa Rica generated better sources of employment over time, evidenced by the increase in domestic value-added as the company shifted from manufacturing to services. In 2013, when Intel was still engaged in manufacturing, for each dollar Intel produced and sold outside the country, only 18 cents stayed in the country in the form of payments for the factors of production and inputs produced by Costa Rican companies. By 2016, when the company was solely focused on services, this increased to 44 cents (Monge-González, 2017).

[4] Estimated from firm-level interviews.
[5] This is a proxy for Intel's wages. Monge-González (2017: 18) provides similar findings.

Costa Rica's entry into R&D services was through Intel's original investment in electronics manufacturing (figure 3). As such, this single MNE has had a significant impact on Costa Rica's development. Intel trained some workers for higher-wage service-level positions, while others employed in the A&T assembly plant acquired skills that were easily transferable to other formal work environments. Intel's transition from manufacturing to services in Costa Rica has made the company a leader in bringing higher-skill and better-wage service jobs into the country. As Costa Rica's wage levels are too high to be competitive in the manufacturing segment of price-sensitive consumer goods markets such as those for electronics or apparel, the Intel case is instructive. It shows that a developing economy such as Costa Rica can transition from high-tech manufacturing into high-value services *in the same industry* if GVC lead firms involved in manufacturing can supplement their production activities with relatively high-value service jobs that increase both skills and wages in the local workforce. Indeed, because of the dramatic change in the composition of Intel's operations in Costa Rica in 2014, the company is no longer considered an electronics manufacturer, but an R&D services firm.[6]

While exports of electronics declined, R&D service exports increased. In 2015, Costa Rica's R&D service exports amounted to US$124.8 million, of which Intel accounted for 60 per cent (Monge-González, 2017: 22). Intel's new operations demonstrate to other MNEs that the country is a good location for R&D operations in the same way it showed efficiency-seeking MNEs that the country was a suitable location for manufacturing. Intel's decision to invest in services put Costa Rica on the map as a potential destination for firms across multiple industries; thus, it had an important demonstration effect that led to increased FDI. IBM and HP established service divisions in Costa Rica in 2004, and Amazon did the same in 2008; each has more than 1,000 employees in Costa Rica, with HP employing over 6,000 (CINDE, 2012).

4.2 Costa Rica in the medical devices GVC

The medical devices industry has become Costa Rica's largest and most dynamic high-tech export cluster. It has succeeded in improving the quality and increasing the quantity of its exports over time, with different strengths and limitations in upgrading than those in the electronics industry. The sector has demonstrated more

[6] The case of Intel and electronics in Costa Rica illustrates the deficiencies of national industrial statistics in distinguishing industry-specific services from "service industries" and thus measuring industry-specific upgrading without tracing firm-level data over time. When a firm engages in functional upgrading by moving from manufacturing to services, its activities are reclassified from electronics to a generic service industry that is not affiliated with the manufacturing industry (Frederick, 2014).

traditional upgrading patterns, with participation diversified across a large number of MNEs focused on multiple end-markets. This diverse base has facilitated the establishment of forward linkages in supplier operations with economies of scope.

a. Governance and global firm strategy in the medical devices sector

The medical devices GVC until recently has been characterized by vertical integration with relatively low degrees of outsourcing and offshoring. The majority of lead firms in the GVC operate as OBM firms (Bamber & Gereffi, 2013), due to the substantial investment required in developing new products and thus the need to protect intellectual property, together with the very strict regulatory environment in the sector. Given heightened awareness of product safety and quality concerns globally, these factors have led to increased concentration in the industry, with few firms able to sustain the significant investment costs while simultaneously maintaining strong global production and marketing. As a result, lead firms in the GVC are large, diverse and from developed-country markets, such as Koninklijke Philips (Netherlands), Becton Dickinson (United States), Baxter (United States), Boston Scientific (United States) and Medtronic (Ireland). These dynamics make it very difficult for new firms to emerge in the sector and increase the scale requirements for the industry's global suppliers.

The medical devices sector has been slower than the electronics sector to offshore operations in order to take advantage of lower-cost locations. Where it has done so, offshoring has been concentrated in a limited number of countries where firms can ensure quality, regulatory compliance and intellectual property protection. These include Costa Rica, the Dominican Republic, Ireland, Mexico, and Singapore. In many of these locations, special export-processing zones provide an additional layer of security for firms.

Medical devices products vary in their technological complexity and their capital and labor intensity in manufacturing. They differ in the degree of oversight and protection required by brands, and their offshoring has been uneven. Medical devices can be placed in four key product categories:

- *Disposables*: single use-products, such as catheters, tubing and syringes, which are cost-driven and subject to less stringent regulatory requirements. Their production was the first to be offshored.
- *Medical instruments*: multi-use products, such as forceps and surgical scissors, that are sterilized between uses with different patients.
- *Therapeutic devices*: highly diverse products that may be inserted in the human body (e.g., orthopedic implants, pacemakers and hearing aids), which are subject to very high levels of international health and safety regulation and quality standards.

- *Capital equipment*: large, long-term investments for complex, single-purchase machines that can be used repeatedly over the years, such as magnetic resonance imaging (MRI) equipment. Comparatively little offshoring of final production has occurred in these industries.

Offshoring of products to specific locations tends to be a long-term investment. Because of regulatory compliance requirements and technological complexity, and the importance of supply continuity in the life-sustaining industry, product transfers and production site shifts can be lengthy (up to 18 months). Training for some complex products can take up to six months before line operators reach full productivity. As a result of these factors, relocations have consisted primarily of movements in initial outsourcing to new offshore locations; once investments are made, they are stable over time. These characteristics indicate greater sustainability for including sector-based investment as part of an economic development strategy. Costa Rica, which offers a stable economy close to the headquarters of many of these lead firms, has benefited from these characteristics.

b. Local industrial agglomeration effects

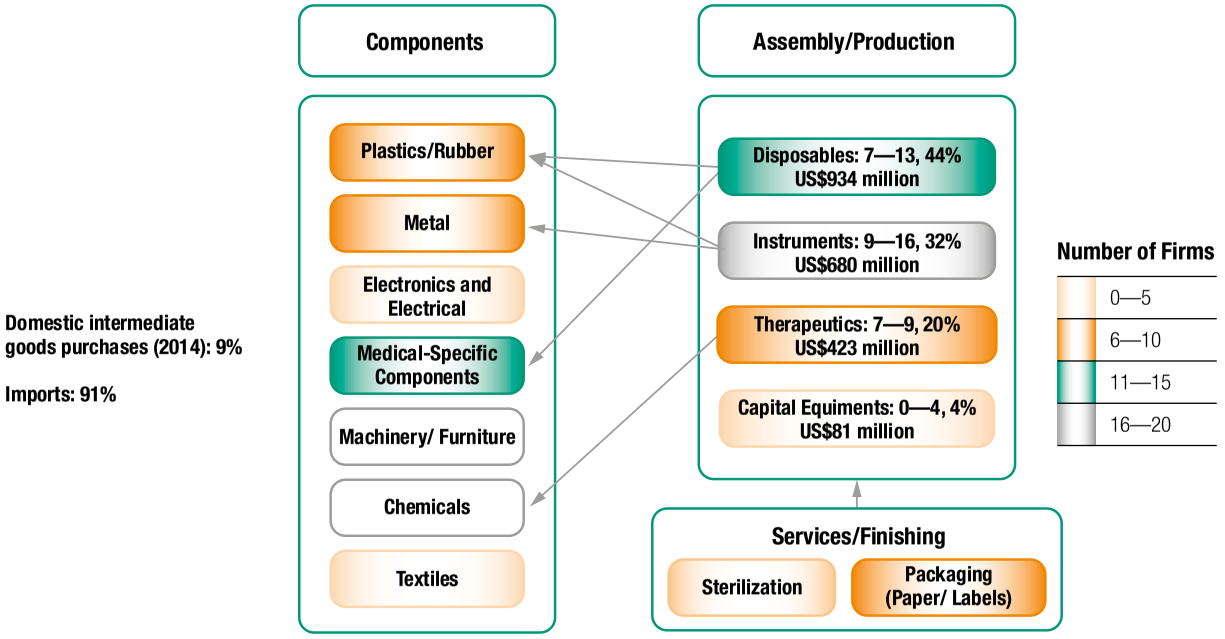
The Costa Rican medical devices sector consists of a consolidating base of foreign manufacturers that offer increasingly sophisticated products. The local industry dates to 1985, when the first device companies – Baxter Healthcare and Abbott – established operations in the country. By 2015, medical devices exports had reached US$2.1 billion (22 per cent of total exports), the largest export sector in Costa Rica (UN Comtrade, 2017).[7] In 2012, about 50 firms participated directly in the value chain, with an additional 16 companies providing packaging and support services. Over half (60 per cent) of these firms were from the United States and less than 30 per cent were Costa Rican[8] (Bamber and Gereffi, 2013: 33).

By coding the activities of these firms and categorizing their output as intermediate and final products, we found that these companies are concentrated in the production segments of the value chain, with 70 per cent of them manufacturing components or assembling final goods. Product exports are concentrated in two categories: disposables (44 per cent) and instruments (32 per cent) (as of 2015). Figure 4 uses these details to illustrate Costa Rica's participation in the medical devices GVC with the degree of shading illustrating the number of firms in the sector at each stage of the chain in 2015.

The earliest investors arrived in the late 1980s, but rapid growth did not occur in the sector until the 2000s. Between 2000 and 2015, export performance

[7] This is due to sector growth, as well as to the closure of Intel's plant in 2014.
[8] The remaining firms came from five economies: Colombia, Germany, Ireland, Japan and Puerto Rico.

Figure 4. Costa Rica in the medical devices global value chain



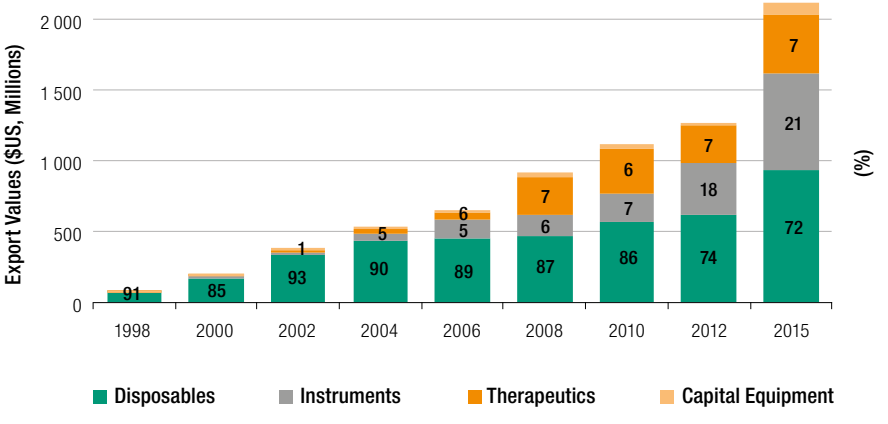
Sources: Imports and exports (2014) of medical devices (AE080) companies (28 establishments). UN Comtrade export data. Costa Rica SUT 2014. Firm interviews, 2012. For the HS product codes used for the four main export categories, see Table A-1. For more detail on the methodology, see Frederick (2017).

Note: Components data: From top to bottom based on share of purchases for medical devices overall; shading based on capabilities. Arrows show top inputs by product category.
Assembly/Production data: Numbers of exporters with >50% of exports in category and number of firms with capabilities, but not a majority (<50% of exports); category shares of exports; export value as of 2015.

underwent very steady and significant expansion in overall value, from just under US$400 million in 2002 to over US$2 billion in 2015. This increase derived from product and functional upgrading, as well as market diversification, as global firms gained confidence in the ability of their Costa Rican subsidiaries to meet the quality and regulatory requirements of multiple markets. There was both an expansion of exports of early products and a shift in export composition in terms of technological content (figure 5). In 2002, about 90 per cent of medical device exports were in the low-tech disposables category, but by 2015, the other three higher-tech categories accounted for 56 per cent of exports. This changing composition shows that Costa Rica was moving toward product categories of higher technological content (*product upgrading*). At the same time, the value-added content of exports continued to rise, increasing by 32 per cent between 2012 and 2015 alone, illustrating that a broader set of activities was being undertaken in-country (*functional upgrading*). Simultaneously, Costa Rica diversified its export destinations. In 2005, 93 per cent of exports were to the United States, while in 2015 this had dropped to 72 per cent as exports to Europe and Japan increased.

With few pre-existing local firms, this growth and upgrading was the result of FDI, supported by considerable efforts on the part of CINDE as well as by Costa Rican investment incentives. Between 2000 and 2014, a series of large GVC lead firms,

Figure 5. Costa Rica's medical exports by product category: 1998–2015
(Millions of dollars and per cent)



Source: UN Comtrade (2017).

including Boston Scientific, St. Jude Medical and Covidien (Medtronic), established "efficiency-seeking" export-oriented manufacturing plants in the country. Figure 6 disaggregates these investors into four waves: pre-2000, 2001–2004, 2005–2008, and 2009–2014. A very clear pattern of FDI succession emerges that underpins the technological upgrading of Costa Rica's exports: the companies that invested pre-2000 were predominantly in the low-tech, cost-driven disposables category. In each successive period, companies with higher-level technology entered Costa Rica. In addition, several established firms continued to expand their capabilities through reinvestments. Each wave of investment appeared to build on the last. During interviews, when asked why companies came to Costa Rica, managers repeatedly emphasized that they were encouraged by the positive experiences of the earlier investors. This mirrors the demonstration effects of Intel's investments in the electronics sector.

Local sourcing is low but growing; in 2014, approximately 9 per cent of intermediate goods inputs were purchased within Costa Rica, up from only 6 per cent in 2012.[9] The relatively low amount is due primarily to global supply chain limitations caused by scale and regulations; local MNE plants have little flexibility to source locally and as of 2012, there was only one Costa Rican OEM supplier. Any local sourcing is predominantly from foreign suppliers, and the presence of domestic Costa Rican firms in the industry remains limited. Domestic sourcing is concentrated in activities with economies of scope, which has allowed foreign suppliers to address the demands of the diverse range of medical device manufacturers in the country. In particular, these suppliers were concentrated in forward linkages in packaging and sterilization activities, supporting the distribution-based activities for final assembled products.

[9] Based on the Supply and Use Table (SUT) for 2014, intermediate purchases of medical device companies were worth US$1.3 billion, of which 64 per cent were goods and 36 per cent were services. Services are primarily royalties (20 per cent) followed by administrative office services (4.5 per cent). Top material purchases were plastic and/or rubber products (42 per cent), metal (22 per cent), electronics and electrical inputs (14 per cent), and medical-specific inputs (13 per cent). The United States accounts for approximately three-quarters of imports.

Figure 6. Firms in Costa Rica's medical devices sector, pre-2000 to 2014

Entry Year	Firm Characteristics	Main Product Category	Core Market Segments	Product Examples (FDA Class)	Select OEMs
Up to 2000 24 firms: 9 US 14 CR 1 German	6 OEMs 8 Components 1 Input distributor 7 Packaging 1 Finishing 3 Support services	Disposables	Drug delivery Women's health	Intravenous tubing (I) Mastectomy bras (I)	Baxter Hospira Amoena
2001–2004 13 firms: 9 US 3 CR 1 Colombia	4 OEMs 5 Components 1 Finishing 1 Logistics 2 Support services	Instruments	Endoscopic surgery	Biopsy forceps (II)	Arthrocare (Smith & Nephew) Boston Scientific
2005–2008 8 firms: 7 US 1 Puerto Rico	2 OEMs 4 Components 1 Packaging 1 Finishing	Therapeutics	Cosmetic surgery Women's health	Breast implants (III) Minimally invasive surgical devices (II)	Allergan Horizon
2009–2014 24 firms: 18 US 1 CR 2 Ireland 1 Japan 2 JVs (US-CR)	12 OEMs 7 Components 1 Input distributor 2 Sterilization 2 Packaging	Disposables Instruments Therapeutics	Cardiovascular drug delivery	Heart valves (III) Dialysis catheters (III) Guide wires (III) Compression socks (I)	Abbott Vascular St. Jude Moog Covidien Volcano Corp.

Source: Authors; updated from Bamber and Gereffi (2013).

c. Upgrading, knowledge transfer and local institutions

The upgrading patterns described earlier indicate that strong growth combined with increased capability development was the result of agglomerations of FDI leveraging Costa Rica as one of a few offshore production platforms. Costa Rica's ability to harness this FDI reflects (1) the country's human capital base, in particular, the capabilities of Costa Rican managers, as well as skills upgrading by Costa Rican employees; and (2) considerable efforts by CINDE, COMEX (Ministry of Trade) and other institutional actors to facilitate export-oriented investor operations. These two factors were continuously ranked by interviewees as very important to investment decisions.

The medical devices industry relies on a relatively small but highly skilled workforce. In Costa Rica, growth created some 17,500 manufacturing jobs between 2000 and 2015. By 2012, 10–20 per cent of the workforce was comprised of engineers and 10-15 per cent of technicians. The remaining 60–80 per cent of direct production workers initially drew from the unskilled labor pool that had served the apparel sector. However, even these positions have begun to require a minimum of technical high school education, i.e., nine years primary and secondary education followed by three years of technical education. Management draws heavily from former Intel employees, and by 2012, the majority of foreign-owned plants were managed by Costa Ricans. Several interviewees suggested that this factor further contributed to the willingness among MNE subsidiaries to work with local authorities to overcome challenges. Overall, based on analysis of the interviews, there were very few foreign workers on staff in any MNEs located in Costa Rica.

The shift to a more diversified and sophisticated product portfolio was accompanied by a shift to more highly skilled and better paid jobs. The higher qualifications in the labor pool helped to raise average wages. In 2015, the average annual salary in firms that were primarily exporting disposables was US$12,448, compared with US$13,986 in those primarily exporting medical instruments, and US$14,687 in those primarily exporting therapeutic devices. Average salaries in all categories of firms exporting medical devices were higher than those for the total economy, at approximately US$9,748 (Central Bank of Costa Rica, 2016). According to interviewees, finding qualified human capital is the biggest challenge for firms aiming to continue to increase output and expand to new markets; consequently, local educational institutions have been receptive to providing industry-specific training. Examples include the development of an introductory course for medical devices regulation for operators by the National Technical Institute; a six-month international training program for packaging technicians; and a postgraduate degree in regulatory affairs at the Costa Rica Institute of Technology.

The second key dynamic that facilitated firm upgrading in the sector was the identification by lead firms themselves of critical "GVC gaps" in Costa Rica's

technical capabilities, which was followed by targeted FDI recruitment efforts by national development institutions (CINDE and COMEX). One example is the co-location in 2009 and 2012 of two sterilization plants in Costa Rica, which allowed for market diversification through direct exports. This occurred after a critical mass of MNEs pointed out the value-adding advantages for the medical devices sector of creating this forward-linkage capability. CINDE's post-arrival services for investors created an environment that contributed to inter-firm collaboration. Finally, spatial clustering of the firms in a small number of industrial parks created an additional layer of institutional support for the industry. These parks facilitated collaboration among park members to overcome constraints.

5. Discussion

Costa Rica has demonstrated substantial progress on various metrics of upgrading in the electronics and medical devices GVCs, but the results remain uneven (see table 2). In terms of export competitiveness, the quantity (volume) of Costa Rica's exports increased significantly in both sectors, but the quality (technological content) rose most visibly in medical devices. In terms of local linkages, the backward linkages for medical devices have increased only modestly (from 6 per cent to 9 per cent between 2012 and 2014), and in electronics they remain negligible. Changes in the skills and wages in the workforce are relatively high in both sectors, but electronics, led by Intel, was clearly the pacesetter, with an average annual compensation of nearly US$40,000 in 2014 (compared with US$18,300 in medical devices).

We summarize our findings by highlighting the impact of the five main determinants of FDI-generated spillovers mentioned earlier.

Industrial Policy: Costa Rica's decision to attract high-tech FDI in the 1990s and 2000s was successful due to a combination of factors: political and macroeconomic stability; legacy investments in education and infrastructure from past development policies; proximity to the U.S. market; Costa Rica's FTZ regime, which offers very beneficial conditions to MNE investors; and supportive institutions such as CINDE and COMEX that have proven very effective in targeting FDI promotion. Nonetheless, the success of this investment strategy in the electronics and the medical device GVCs differs: electronics was dominated by a single company, Intel, involving neither local suppliers nor other major MNE investors, whereas the medical devices GVC has a large number of MNE subsidiaries in diverse product categories.

GVC Characteristics: Electronic components is a very scale-intensive and cost-driven sector, which is concentrated in a few Asian countries (e.g., China and Viet Nam). Thus, as a small country with comparatively high minimum-wage levels that is located far from the Asian production network, Costa Rica has virtually no

Table 2. Upgrading metrics in the electronics and medical devices sectors

Type of Upgrading		Medical Devices			Electronics		
		2012	2014	2015	2012	2014	2015
Overall GVC Performance	Gross Output (US$, Millions)	1,397	1,798	2,066	697	456	134
	Value Added (US$, Millions)	537	666	711	475	344	60
	Exports (US$, Billions)	1.3	1.7	2.1	2.3	2.0	0.3
	Contribution to Total GDP (All)	1.30%	1.50%	1.40%	1.10%	0.70%	0.10%
	Number of Firms	23	28	35	14	14	12
Product Upgrading	Share of Exports by Product Category	D: 49% I: 29% T: 21% CE: 1%	--	D: 44% I: 32% T: 20% CE: 4%	--	--	--
Backward Linkages (Products)	Share of Goods Sourced Domestically	6%	9%	--	1%	2%	--
Social (1)	Total Employment	11,882	13,940	16,290	4,475	4,329	1,758
Social (2)	Avg. Total Compensation/ Emp. (US$)	17,488	18,324	18,891	34,389	39,603	17,098
Definitions		AE080			AE074-75		

Sources: Imports and exports (2014) of medical device and electronics companies. UN Comtrade export data. Costa Rica SUT 2014.
Note: In 2015, the average total compensation per employee for all firms was US$11,365 (the average salary per employee was US$9,748). Values in table are for special regime and free zone companies.
D: Disposables, I: Instruments, T: Therapeutics, CE: Capital Equipment

chance to remain competitive in the A&T stage of this industry. Medical devices, by contrast, is a much more diversified sector driven by quality and regulatory compliance, in which proximity to the leading global market (the United States), economic and political stability, and intellectual property protection are prized. This allows Costa Rica to leverage capability development and institutional strengths, rather than scale, in specific segments to drive growth.

Strategies of GVC Lead Firms: A critical contribution of our study is its exploration of how the strategies of GVC lead firms created upgrading opportunities within Costa Rica. This topic was largely ignored by the previous studies of Costa Rica's high-tech upgrading, which instead focused on collecting social network data within clusters to identify knowledge linkages with domestic and foreign firms (Giuliani, 2008; Ciravegna and Giuliani, 2007). Intel's decision to set up an A&T plant was critical to the country's early success, but its decision to close this plant in 2014 eliminated this exporting option. More important for the long term, however, may have been Intel's strategy since the early 2000s of setting up and expanding engineering and R&D service centers in Costa Rica, which contributed to the growth of service exports and employment in the country. As in medical devices, competitiveness in this services niche is based on skill rather than scale.

Similarly, the strategies of GVC lead firms appear to be key for explaining the upgrading trajectory in the medical devices GVC. The technology-upgrading pattern shown in figures 5 and 6 came about in large measure because GVC lead firms were talking to one another and their headquarters about why Costa Rica was a good place to invest and expand their operations over time.

Position in GVCs: Costa Rica occupied different structural positions in these two GVCs that shaped its upgrading outcomes in both goods and services. In electronics, the possibilities for backward linkages were quite limited because the inputs to semiconductors are few and upstream segments are typically capital- and technology-intensive. However, the flourishing of service-sector employment in electronics showed great potential for knowledge-intensive linkages with Intel. In medical devices, exports from Costa Rica were finished products rather than intermediate goods. The diversity of medical device market segments that Costa Rica operates in opened more possibilities for technology transfers and knowledge spillovers. In addition, the number and diversity of MNE investors created more opportunities within Costa Rica to upgrade and move up the technology ladder across market segments, and to fill value chain gaps with relatively high-value manufacturing-related services, such as product sterilization.

Absorptive Capacity of Host Country: The country's political stability, rule of law, bureaucratic probity and highly skilled workforce are all advantages in attracting FDI. Equally important for the electronics and medical devices GVCs are the institutional coordination between CINDE and COMEX in implementing the country's industrial

policy and attracting the right kind of FDI to support export-oriented growth. This inter-agency cooperation is a selling point across industries, and it can facilitate more extensive forms of public-private sector coordination in the future.

6. Conclusions: considerations for policy development

Promoting economic development through transnational knowledge networks is a challenge for all countries, but it is particularly important for small economies in high-tech, exported-oriented sectors. Our comparison of the electronics and medical devices GVCs in Costa Rica reveals important differences in terms of technology spillovers, even though both sectors are part of Costa Rica's high-tech upgrading strategy. The gains in electronics were very significant in one area – volume of manufactured exports; however, they were limited because the inputs from local suppliers were restricted to low-value activities associated with the operations of the plant. The disruption caused by the closure of the Intel plant in 2014 led to a large-scale layoff, although the skills of the electronics workforce were relatively high and could be readily absorbed by other export-oriented sectors of the economy. These findings have broader implications for policy development beyond the specific case of Costa Rica and these industries.

Targeted industrial policy can be used to attract investments in particular GVC segments without having in place all of the key elements that are often considered prerequisites. These include a local supplier base, local absorptive capacities and strong linkages with the educational sector. Industry and activity selection, however, have an important effect on the sustainability of investments. Industrial policy oriented towards GVC participation must be based on a thorough understanding of the offshoring drivers of lead firms.

Investment policies supporting functional upgrading and diversification can mitigate shocks caused by changes in lead-firm strategy or by exogenous variables. One of the most striking findings of this study is the key role played by high-value service activities as a complement to high-tech manufacturing in both of Costa Rica's high-tech GVCs. In the electronics sector, the addition of manufacturing-related and other professional services began in the early 2000s, relatively soon after the opening of Intel's assembly plant, but Costa Rica's centrality in Intel's global services strategy expanded considerably after 2014. In the medical devices sector, forward linkages from production into high value-addition services such as product sterilization drove market diversification and opened the door to functional upgrading into sales and distribution channels.

Human capital development policies are key to supporting upgrading; these can be closely linked to the firm. Experienced local management and skilled human capital can increase location attractiveness and drive embeddedness in lieu

of (or in addition to) local supplier development. The waves of FDI in the medical devices sector established pipelines to MNE headquarters and other knowledge centers outside of Costa Rica that facilitated the rapid diffusion of new technologies that entered the country during this period (see figure 6). A key conduit between these two worlds were the Costa Rican managers of the MNE subsidiaries in the medical devices GVC, who used their local contacts and knowledge to identify potential suppliers and to reduce institutional barriers.

Finally, services-related upgrading can often be obscured by firm-level statistics. The benefits of FDI in a country can transcend the boundary of what standard statistical categories label as "manufacturing" or "services" activities, as illustrated by the case of Intel. By examining both firm-level and industry-specific dynamics, GVC analysis provides a lens to identify potential outcomes that would go unnoticed if one focused solely on product-specific trade data or industrial statistics. Intel's entry into the R&D services "industry" and the subsequent increase in the services share of Costa Rica's GDP was due to functional upgrading by an electronics manufacturing firm. Thus, the future of manufacturing-led development (Hallward-Driemeier and Nayyar, 2018) increasingly may rely on the growth of complementary, but hard to measure, high-value services.

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Appendix

Table A-1. Medical devices product categories by HS codes

Productw Category	Product Examples	HS Codes
Disposables	Needles, syringes, catheters, tubing, IV sets	901831, 901832, 901839
Instruments	Dental instruments, forceps, medical scissors, dialysis devices, defibrillators	901841, 901849 901850 901890
Therapeutics	Artificial body parts, hearing aids, pacemakers, crutches, implants, prosthetics	9021
Capital Equipment	MRI, ultrasound machine, x-rays, patient monitoring systems, blood pressure monitors	901811, 901812, 901813, 901814, 901819, 901820, 9022

Source: Authors.

Table A-2. Electronics GVC definition by HS Codes

Segment	Product Examples	HS Codes
3C Final Products	Consumer Electronics Cell Phones Computers	8469, 8470, 8471, 8472, 8519, 8520, 8521, 8525, 8527, 8528 85181, 85182, 85183, 85184, 85185 85171, 85172, 85173, 85174, 85175, 85176, 85178 90061, 90062, 90063, 90064, 90065 90091, 90092, 90093 844312, 844351, 84433 950410, 950450
Medical Final Products	Capital Equipment	901811, 901812, 901813, 901814, 901819, 901820, 9022, 902140, 902150
Industrial Final Products	Analytical Instruments	8526, 901210, 901410, 901420, 901480, 901600, 902410, 902480, 90271-5, 902780, 90281-3, 90291-2, 90301-4, 90308, 90321-2, 90328
Industrial Subassemblies	Parts of above	901290, 901490, 902490, 902790, 902890, 902990, 903090, 903290
3C Subassemblies	Parts of above	8473, 8522, 8529, 851770, 851790, 85189, 90069, 90099, 844399
Components	ICs	8532, 8533, 8534, 8540, 8541, 8542, 8523, 8524

Source: Frederick (2017). Background reports on the global electronics GVC prepared for the UN Statistics Division and UNIDO.
Note: If only four or five digits are listed, implies all six-digit codes are included.

Global value chains and the fragmentation of trade policy coalitions

Ari Van Assche, and Byron Gangnes*

Recent decades have seen the emergence of global value chain (GVC) production arrangements in which firms fine-slice production processes and disperse activities over multiple countries. This paper analyses how the rise of GVCs affects trade politics in developed countries. Our theoretical model shows that GVCs drive a wedge between the interests of workers and of managers in unskilled-labour-intensive industries, upsetting a traditional coalition that has favoured protectionism against competing imports. Managers of GVC firms switch towards favouring trade promotion since they can substitute foreign for local unskilled workers. The loss of their management ally further weakens the position of low-skilled workers, whose jobs and income are threatened by foreign competition. This new trend may help to explain the recent surge in anti-trade sentiment, while indicating the importance of an active policy response to deal with the economic challenges for affected workers.

Keywords: global value chains, trade policy, coalition, trade politics

1. Introduction

Economists have long recognized that the benefits from international trade are unequally distributed across workers and time. International commerce creates both winners and losers, and there are currently no institutions in place to ensure that the winners sufficiently compensate the losers so that everyone gains (Autor et al., 2016). Key research questions for political economists are thus whose welfare is enhanced or worsened by trade, how this affects political interests and coalitions, and what the resulting implications are for policymaking.

In this paper, we contribute to this line of inquiry by exploring how recent changes in the way that firms conduct international trade – the emergence of global value chains (GVCs) – alters the types of firms and workers that win and lose from trade liberalization in developed countries. In recent decades, firms have globalized

* Ari van Assche is at the Department of International Business, HEC Montréal in Canada and Byron Gangnes is at the Department of Economics, University of Hawaii at Manoa, United States of America. The corresponding author is Ari van Assche (ari.van-assche@hec.ca).

their production processes as they have separated value chain tasks and moved them to different countries. Most international trade no longer involves exchanging finished goods but rather intermediate inputs, which firms increasingly use to produce their own exports. We show that this trend alters trade policy coalitions in ways that further disadvantage low-skilled workers and explain how this may have exacerbated populist anti-trade sentiment.

Our study is particularly pertinent in the current context where questions about the distributional effects of international trade have moved to the forefront of political discourse in many developed countries (Rodrik, 2018). In the United States, the 2016 presidential election saw renewed resistance to trade. Both major party candidates pointed to job losses associated with foreign competition. Hillary Clinton backed away from her earlier support for the Trans-Pacific Partnership (TPP), and Donald Trump called for sweeping punitive tariffs on imports by U.S. companies who offshore production. In the two years since his inauguration, President Trump has formally abandoned the TPP, forced a renegotiation of the North American Free Trade Agreement (NAFTA) and begun to take punitive actions against foreign competitors in specific industries. He continues to rail against allegedly unfair foreign trade practices.

The anti-trade populist movement has been more muted in Canada, yet the discussion of the effect of trade on workers has entered the political scene with the same vigour in the form of the Canadian Government's "progressive trade agenda." In a speech at the Conference of Montréal in May 2016, International Trade Minister Chrystia Freeland proposed that "the middle class in western industrial societies […] has begun to fear very profoundly that the two great economic transformations of our time — globalization and the technology revolution — may have been good for a narrow elite […] but that they haven't been good for most people." The progressive trade agenda attempts to respond to these concerns by ensuring that trade contributes to broad-based prosperity through the inclusion of provisions related to gender, indigenous issues, labor, and the environment in Canada's three priority free trade negotiations: the launch of bilateral talks with China, the signing of a Comprehensive and Progressive Trans-Pacific Partnership (renamed at Canada's behest) and the renegotiation of NAFTA.

The recent surge in political focus on trade and workers is to a large extent about jobs and the suspicion that firms' decisions to offshore production are to blame for manufacturing job losses. And, in fact, there has been a substantial decline in manufacturing jobs in the United States over the past two decades (Pierce and Schott, 2016). The shift away from manufacturing to services activities is not new, of course. Since 1950, the share of manufacturing in total U.S. non-farm payroll employment has fallen from about 30 per cent to roughly 8.5 per cent. But recent losses have been pronounced and concentrated in a number of states that were decisive in the 2016 election. More than six U.S. states have each seen the loss

of at least 300,000 manufacturing jobs since 2000, with declines in percentage terms of 30 per cent to nearly 40 per cent. Although trade may only account for a limited part of these losses, it certainly has played a role. Autor et al. (2014) found that import shocks from China imposed substantial labor adjustment costs on U.S. workers, which disproportionately hurt blue-collar workers.[1] Because of this, it is not surprising that organized labor in import-competing industries has come out strongly against liberal trade policies.

What is new, we argue, is a divergence that has developed between the trade policy demands of labor and those of management in these same import-competing industries. In many cases, managers now favour freer trade, rather than barriers to imports in their sector. This divergence between worker and manager interests is starkly different from the unified resistance to trade liberalization by import-competing firms and workers that typified much of the post-war period.

As we will show in our theoretical framework, this fragmentation of the trade policy coalition between managers and workers in import-competing industries is exactly what one would expect in a world where production is increasingly conducted by networks of firms operating within GVCs. A key reason for managers to offshore labor-intensive production activities is to substitute cheap foreign labor for expensive domestic workers, but that substitution comes at the price of tariffs and other barriers to imports. Many managers who traditionally lobbied for protection to keep their local factories open now fight for trade liberalization in order to allow the goods that they produce in their offshore factories to come in at a lower cost.

This fragmentation of traditional trade policy coalitions may have helped stir the recent anti-trade populist movement. Autor et al. (2017) find that exposure of local labor markets to heightened competition from China has contributed to rising political polarization in the United States. They suggest that this trend is consistent with political economy theories that connect economic adversity to in-group/out-group identification, as motivated by group-based resource competition. We argue that the loss of a key political ally in blue-collar workers' quest for trade protection may only have intensified their political attachment to their in-group, exacerbating the process of political polarization.

Our paper contributes to two streams of research which use distinct approaches to study GVCs. Researchers in economic sociology and development studies have primarily focused on the social and territorial consequences of GVCs. For this purpose, they have developed frameworks that analyse the various actors involved in global supply chains, the governance of these activities, and the possibilities or

[1] It is important to note that Feenstra et al. (2017) attribute similarly large job gains in the United States to export expansion.

barriers that GVCs present for upgrading and regional development (Gereffi, 1999; Gereffi et al., 2005; Humphrey & Schmitz, 2002). More recent research has used these models to study how trade liberalization shapes new GVC relationships, but also to show that this is a contested process marked by asymmetric gains (Curran & Nadvi, 2015; Gereffi, 2014; Horner & Nadvi, 2018).

Economists, not surprisingly, have focused on the economic causes and consequences of GVCs. A vast literature has analysed GVCs by investigating the drivers of firms' decisions to fragment their production internationally (Grossman and Rossi-Hansberg, 2008; Van Assche, 2008), the type of firms that are more likely to offshore production activities (Defever and Toubal, 2013; Farinas and Martin-Marcos, 2010; Tomiura, 2007) and the effects of offshoring on a firm's productivity, employment and wages in both the home and host countries (Amiti and Konings, 2007; Goldberg et al., 2010; Hummels et al., 2014; Kasahara and Rodrigue, 2008). Our paper fits in the economics tradition of GVC research but highlights distributional effects that would in some ways be familiar territory for researchers in economic sociology and development studies.

Our paper also relates to a growing political economy literature which studies the effect of global supply chains on firms' trade preferences. Jensen et al. (2015) provide evidence that GVC firms are less likely than others to support anti-dumping actions against foreign countries, especially those in which they have investments or with which they trade. Eckhardt (2013) and Eckhardt and Poletti (2016) find that European companies whose operations depend on imported components are more likely to favour trade liberalization. There is also evidence that these new trade preferences affect trade policy. Blanchard and Matschke (2015) find that the United States is more likely to offer preferential market access to countries that host U.S. multinational affiliates than to other countries. Blanchard et al. (2016) show that a country's discretionary final goods tariffs are decreasing in the domestic content share of foreign-produced final goods. We add to this literature by digging deeper into how the emergence of GVCs affects the trade policy preferences of various stakeholders.

Finally, our research relates to studies that apply trade models with firm heterogeneity to analyse trade policy coalitions. Madeira (2016) sets up a framework with horizontal intra-industry trade and shows that high-productivity and low-productivity firms have opposing preferences concerning trade liberalization. High-productivity firms favour trade liberalization because it improves their access to foreign markets, but low-productivity firms oppose it because they are unlikely to export and they face intensified pressure from imports. Using data on lobbying expenditures in the United States, Madeira found that industry-based associations are indeed less active relative to individual firms in industries with higher horizontal intra-industry trade. Using Japanese data, Plouffe (2017) finds that highly productive manufacturers are more likely to support trade liberalization than low-productivity firms. Our research

complements these studies by showing that the emergence of GVCs induces a similar division in trade preferences between high-productivity and low-productivity firms in import-competing industries.

Our paper consists of six parts. In section 2, we describe the evolution that is occurring in global production arrangements. In section 3, we consider the various ways that these changes would be expected to affect the trade policy positions of firms that take different approaches to production and of their workers, and we review the evidence to date on shifting trade policy stances. In section 4, we offer a theoretical model that, by incorporating key aspects of GVC production, can be used to understand these changes in constituent interests and policy pursuits. In section 5, we look at two high-profile cases where these issues have been playing out: the different trade policy positions taken by New Balance and Nike in the U.S. shoe industry and the shifting policies of Canada's export finance agency, Export Development Canada. Section 6 discusses the political implications of our analysis and concludes.

2. GVCs and international trade

In recent decades, many firms have undertaken rapid transformations that are changing the way products and services are produced. Thanks to reduced communication and transportation costs, they have abandoned the practice of producing goods and services themselves in a single country. Through offshoring and outsourcing, they have sliced up their value chains and dispersed production activities across the globe, creating GVCs.

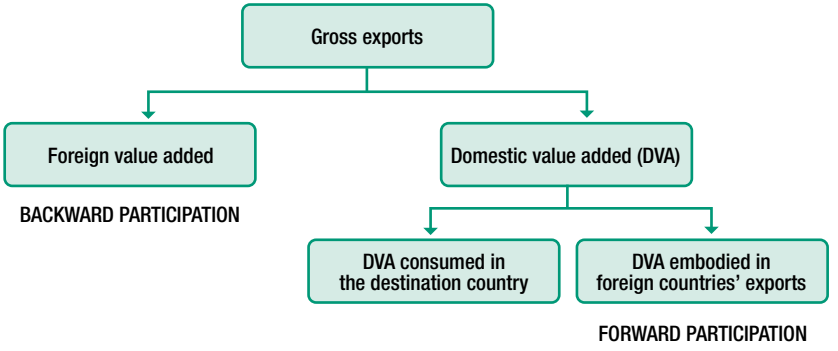
The introduction of GVCs has fundamentally altered the nature and determinants of trade patterns between countries. It has been widely documented that production chains for goods and services are not concentrated within single countries but are now increasingly fragmented, with corporations dispersing activities across multiple countries and companies (Feenstra, 1998; Johnson and Noguera, 2012). Many firms only concentrate a sliver of the value chain in their home country, not the production of entire goods. Furthermore, they connect more and more with foreign value chain partners to make final goods and services. As a result, trade in intermediate inputs – those goods and services which are used in the production process to produce other goods or services rather than for final consumption – now accounts for roughly two-thirds of all international trade (Johnson and Noguera, 2012).

Firms can connect with foreign value chain partners in two directions to produce goods and services: upstream and downstream. Upstream, they can import intermediate inputs from their foreign value chain partners which they then use for the production and export of their own goods. This is called *backward participation* in GVCs. Downstream, firms can export intermediate goods to their foreign value

chain partners which in turn use them to make their own exports, known as *forward participation* in GVCs.

The Trade in Value Added (TiVA) data set compiled by the Organization for Economic Co-operation and Development (OECD) and the World Trade Organization (WTO) provides aggregate insights into the extent of a *country*'s backward and forward participation in GVCs (De Backer and Miroudot, 2014). By combining input-output data for multiple countries with trade statistics, the data set allows a country's gross exports to be decomposed into two parts: (1) *domestic value added*, which is generated in the exporting country, and (2) *foreign value added*, which comes from outside the exporting country. Foreign value added depicts a country's backward participation in GVCs. Domestic value added can be further decomposed into two subparts: *domestic value added consumed in the destination country* and *domestic value added embodied in a foreign country's exports*. The latter term captures a country's forward participation in GVCs. In the remainder of this section, we will use the TiVA data set to document the growing importance of GVCs in North American trade. These relationships are outlined in figure 1.

Figure 1. Decomposition of gross exports



2.1 Backward participation

Starting with Hummels et al. (2001), scholars have used the foreign value added share embodied in gross exports as an indicator of a country's backward participation in GVCs, since it indicates how heavily a country relies on imported inputs to produce its exports (see also Johnson and Noguera, 2012). As table 1 shows, foreign value added is responsible for a significant portion of North American countries' gross exports. In 2011, it accounted for 15 per cent of U.S. exports, 24 per cent of Canadian exports and 32 per cent of Mexican exports. In other words, for the three

Table 1. Integration in global value chains, NAFTA countries, 1995 and 2011

	Share of foreign value added in gross exports		Domestic value added embodied in foreign exports as share of gross exports		GVC trade as share of gross exports	
	1995	2011	1995	2011	1995	2011
United States	11.5	15.0	19.4	24.9	30.9	39.9
Canada	24.2	23.5	11.1	19.0	35.3	42.5
Mexico	27.3	31.7	11.1	15.1	38.4	46.8

Source: Authors' calculations using the OECD-WTO TiVA database.

North American countries, foreign inputs account for one-sixth to nearly a third of their gross export value.

Note that the significantly smaller foreign value added share for the United States should not come as a surprise. The large size of the U.S. economy implies that firms have a substantially bigger pool of local intermediate input providers in their proximity to draw on than do countries with smaller economies such as Mexico and Canada. Consequently, there is less need to partner with foreign suppliers to produce goods or services.

Canada is the only North American country that has seen a decrease in its share of foreign value added in gross exports between 1995 and 2011. This is due primarily to the rise in oil prices, which has made the composition of Canada's exports more oil-intensive. Since the foreign value added share of oil exports is relatively lower than that of other industries, the foreign value added share of aggregate gross exports has therefore also declined.

2.2 Forward participation

North American countries also export intermediate inputs to foreign value chain partners who use them to produce their own exports. For example, a Canadian aerospace company may export an intermediate good to Seattle, which Boeing then uses to produce and sell planes around the world. As we noted above, to capture a country's *forward participation* in GVCs, the TiVA data set allows a further decomposition of a country's domestic value added into two subcategories: (1) domestic value added consumed in the destination country and (2) domestic value added embodied in foreign countries' exports. The latter term captures a country's forward participation in GVCs.

Table 1 shows that a significant portion of exports from North American countries are intermediate goods that are used in the exports of other countries. In 2011, forward participation accounted for 15 per cent of Mexico's gross exports, 19 per cent of

Canada's gross exports and 25 per cent of U.S. gross exports. Furthermore, for all three countries the forward participation rate increased between 1995 and 2011.

A country's forward participation in GVCs means that its exports are not necessarily determined by demand conditions in the destination country, but rather in the country where they are ultimately consumed. Table 2 demonstrates the importance of taking this distinction into account. If one country exports a larger share of its value added to another country than what is ultimately consumed there, it suggests that the latter country serves as a downstream partner in GVCs. It is clear from the table that North American countries do tend to use GVC partners in this way. Canada and Mexico (but also China) are important downstream partners for the United States. For Canada, the United States and China are leading downstream partners. For Mexico, Canada and the United States are important downstream partners.

Table 2a. Share of the United States' exports by destination country, 2011

	Domestic value added content in gross exports	Domestic value added in foreign final demand
EU 28	24.5	25.2
Canada	13.7	12.5
Mexico	9.3	7.2
China	7.3	6.8
Japan	6.6	7.7

Table 2b. Share of Canada's exports by destination country, 2011

	Domestic value added content in gross exports	Domestic value added in foreign final demand
United States	65.9	59.9
EU 28	9.5	11.1
China	5.1	4.6
Japan	3.3	4.1
Mexico	2.3	2.6

Table 2c. Share of Mexico's exports by destination country, 2011

	Domestic value added content in gross exports	Domestic value added in foreign final demand
United States	69.3	63.5
Canada	6.7	6.6
EU 28	5.4	7.1
China	3.4	3.4
Japan	1.1	1.8

Source: Authors' calculation using the OECD-WTO TiVA database.

3. Implications for trade politics

The fact that companies connect with foreign value chain partners to produce goods and services (which they own or do not own) has important implications for firm managers' trade policy preferences. In this section, we outline a theoretical framework that allows us to look formally at these implications, but it is possible to make some general observations first.

To understand the implications of GVCs for trade policy preferences, it is useful to revisit the way we have traditionally viewed trade politics. For decades, our thinking about trade has been based on the notion that the production processes for goods and services are concentrated within the geographical boundaries of a country. A Canadian export product or service was considered entirely "Made in Canada"; a product or service imported from China was considered "Made in China."

This national production paradigm has helped shape the main tenets of trade politics. To illustrate this, consider the Heckscher-Ohlin model. Firms' trade preferences are shaped by the industry in which they operate. Companies in import-competing sectors gain from import restrictions because the restrictions protect them from foreign competition. In skill-abundant countries such as the United States, it is firms in labor-intensive sectors that prefer import restrictions. In labor-abundant countries such as Mexico, it is companies in skill-intensive industries that lobby for import tariffs.

Such firm-level trade preferences influence trade politics because governments not only care about national welfare but also about political support. Indeed, a government that cares about political contributions has the incentive to unilaterally impose import tariffs as long as the financial support that it obtains from companies in import-competing industries outweighs the welfare losses that consumers face due to higher prices (Grossman & Helpman, 1994).

Firms in exporting industries have opposing trade preferences. They benefit from improved foreign market access since it increases their export opportunities and strengthens their competitiveness in foreign markets. As a result, they want foreign countries to reduce tariffs on their goods. In skill-abundant countries, for example, firms in skill-intensive industries benefit from a tariff reduction on foreign imports. In labor-abundant countries it is the firms in labor-intensive industries that care about reductions in foreign countries' import tariffs.

Governments do not have the power to unilaterally reduce the import tariffs of foreign countries, but they can enter trade agreements with foreign countries that lead to reciprocal tariff reductions. In such trade liberalization scenarios, the government inevitably loses political support from its firms in import-competing industries, but it gains political support from its firms in exporting industries

(Regan, 2015). Government may thus decide to enter trade agreements if the political support gained from exporting industries (as well as from consumers) exceeds the loss in political support from import-competing industries.

Traditional models of trade and trade politics, which are built on the assumption that production processes are concentrated locally, generally predict that firms and workers will form narrow industry-based or broad class-based coalitions (Madeira, 2016). If factor mobility is low (as in the Ricardo-Viner framework), all firms and workers in an import-competing industry benefit from trade protection, while workers in exporting industries are hurt. If factor mobility is high (as in the Stolper-Samuelson model), firms share the same trade preferences as the production factor that they use intensively. Skill-abundant countries such as the United States and Canada import unskilled-labor-intensive goods (e.g. textiles, shoes), and so unskilled-labor-intensive firms and their unskilled workers benefit from trade protection. Skill-intensive firms and skilled workers in those economies, in contrast, favour trade liberalization.

The departure we are seeing from these predictions stems from the failure of traditional trade models to capture the fundamental restructuring that has occurred in the way that goods and services are produced. Counter to the models, production no longer takes place in factories located within the geographical boundaries of a single country. Instead, as we have seen, today's value chains are now spread across multiple countries. The emergence of these firms generates conflicting trade preferences between the managers of GVC firms and those of firms with local value chains (LVCs) producing primarily within the home country. The latter continue to support trade restrictions because they strengthen their market share compared with both foreign and GVC firms. GVC firms, however, prefer certain types of trade liberalization that facilitate their ability to connect cheaply and effectively with their foreign value chain partners. In some sense, they no longer view trade policy through a national lens, but rather through an internationalist lens necessitated by their international production structures.

GVC firms want policymakers to focus not only on greasing the wheels on the export side, but also on eliminating barriers on the import side. Indeed, the productivity of GVC firms depends critically on their ability to connect to the most competitive foreign suppliers. Through backward participation, companies can reduce input costs and increase their overall productivity (Grossman and Rossi-Hansberg, 2008). There is ample evidence to back this up. Amiti and Konings (2007), for example, show that a 10-percentage point drop in tariffs on inputs leads to a 12 per cent productivity gain for Indonesian firms that import their inputs. Goldberg et al. (2010) and Topalova and Khandelwal (2011) have found similar results for Indian firms.

Recent studies provide evidence that GVC firms are more likely to support trade liberalization than firms with LVCs. Jensen et al. (2015) show that firms with

global supply chains are less likely than others to support anti-dumping actions against foreign countries, especially those in which they have investments or with which they trade. Studies of trade policymaking in the European Union (EU) have traced the emergence of a new category of actor: companies whose operations are dependent on imported components and which, consequently, favour trade liberalization (Eckhardt, 2013; Eckhardt and Poletti, 2016).

4. Theoretical framework

In this section, we develop a theoretical framework based on Melitz (2003) that articulates the ways in which the emergence of GVC arrangements alter the structure of preferences over trade policy in skill-intensive countries like the United States and Canada. In the model, firms with different productivities choose whether to manufacture at home (LVC) or abroad (GVC). Manufacturing offshore entails extra coordination costs, and so only the most productive firms in an industry set up GVCs, while less productive firms manufacture locally. We show that offshoring generates conflicting trade preferences among firms in the same industry. The less productive LVC firms support import tariffs because this strengthens their market share compared with GVC firms. The more productive GVC firms, in contrast, oppose import tariffs because they increase their costs and weaken their competitiveness.

Second, we illustrate that – counter to the Stolper-Samuelson theorem – GVC production arrangements drive a wedge between the trade preferences of unskilled workers and the owners of unskilled-labor-intensive GVC firms. The elimination of import tariffs makes offshoring more attractive, inducing some firms to substitute foreign for domestic unskilled labor. This shrinks the demand for local unskilled workers, which pushes down their real wages. Unskilled workers therefore oppose the elimination of import tariffs, while the GVC firms favour it. In a sense, a firm's ability to offshore unskilled-labor-intensive activities overseas flips its trade preferences towards those of skilled workers, even in an industry that is a heavy user of unskilled labor.

In this section we present the model and its predictions verbally. The model in mathematical form is included in the appendix.

Consider a world of two small countries, "North" and "South." Consumers in North spend a fixed amount of money on a differentiated good – say, footwear. Northern consumers' welfare increases when they buy more of a shoe type and when they buy different shoes (they love variety). In the model, consumers' demand for each shoe variety depends in the same way on changes in shoe prices, and we assume this relationship to be independent of the overall level of their consumption.

In North, there are many footwear companies, each of which have the knowledge to produce a single shoe type.[2] An entrepreneur who wants to enter the footwear sector must hire workers to develop a production technology, which in turn determines his productivity. The precise productivity that he will obtain is unclear, but the distribution of possible productivities is known. Once he learns his productivity, the entrepreneur determines whether to start producing. If it is profitable to start producing, the entrepreneur turns into a firm. The skilled-labor cost to develop a technology equals the fixed cost of entry and is identical for all entrepreneurs.

Producing a shoe variety requires two consecutive value chain stages: headquarters services and manufacturing. In the first stage, the firm needs to use skilled workers to produce headquarters services such as product design and marketing. We assume that headquarters services can be produced only in North (where the skill base is more sophisticated). In the second stage, the firm uses unskilled workers to manufacture the shoes. Manufacturing is footloose in that it can be performed either in North (at a high unit labor cost) or in South (at a low unit labor cost). South's cost advantage in unskilled labor provides firms the incentive to offshore manufacturing and create GVCs.

Offshoring comes at a cost: firms are subject to a tariff when they import their manufactured shoes from South. We assume that the tariff does not entirely wipe out the Southern labor cost advantage so that firms still have the incentive to offshore production to South. But firms also have to pay a fixed cost to coordinate activities across borders, which provides a counter-incentive to keep manufacturing in North.

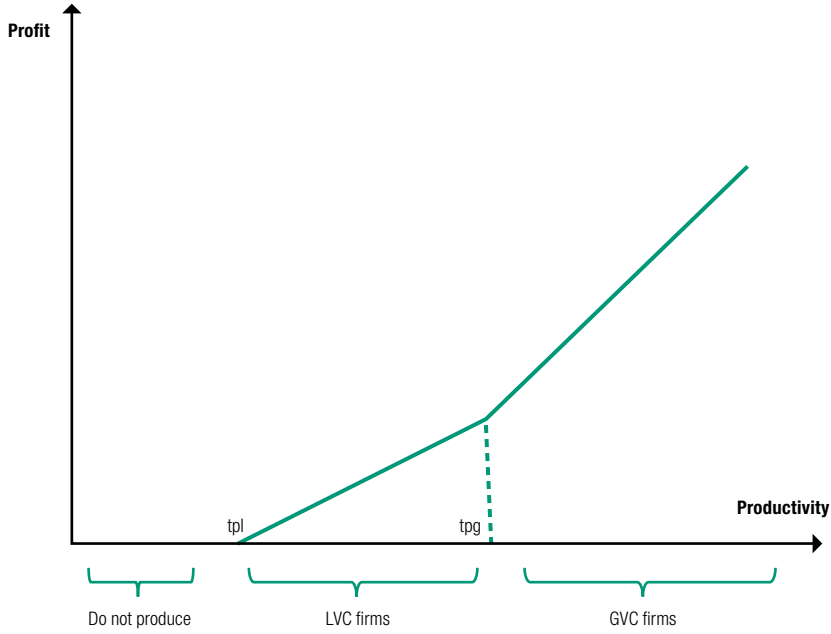
Because firms vary in their productivity, the marginal cost of production differs across shoe companies. A firm's average cost falls if it produces more (due to the fixed cost of production), and the average cost varies across firms (due to differences in their production level and differences in their marginal cost of producing). We call firms that require a relatively high amount of unskilled labor to manufacture shoes low-productivity firms; firms that can produce a shoe with less labor input are called high-productivity firms.

For simplicity, we assume that firms sell all their output in the Northern market, although that is not crucial for our results. They each sell a unique type of shoes but face competition with closely substitutable shoes. Each firm is too small to influence overall market prices (i.e. the market structure is monopolistically competitive.)

As long as the fixed cost of coordinating across borders is not too high, two types of Northern firms will coexist in the industry (figure 2): less productive LVC firms that

[2] Our model does not have foreign firms. Adding them would not alter the main results.

Figure 2. Co-existence of LVC and GVC firms



manufacture in North, and more productive GVC firms that manufacture in South. We develop the intuition behind this conclusion in the following paragraphs.

In this model there are two key productivity thresholds. The first threshold productivity level, *tpl*, determines the productivity at which it becomes profitable for firms to start producing using LVCs. Entrepreneurs with a productivity below the threshold simply do not set up a firm. Entrepreneurs with productivity above this threshold set up firms with manufacturing plants in North. The second threshold, *tpg*, determines the productivity at which it becomes profitable for firms to manufacture in South. One way to think of this is that only the more productive firms have sufficient profits to cover the fixed cost of coordinating across borders. Therefore, the less productive firms (those with a productivity between *tpl* and *tpg*) choose to operate as LVC firms, with production remaining within the home country. The most productive firms, with a productivity above *tpg*, become GVC firms.

4.1 Trade liberalization

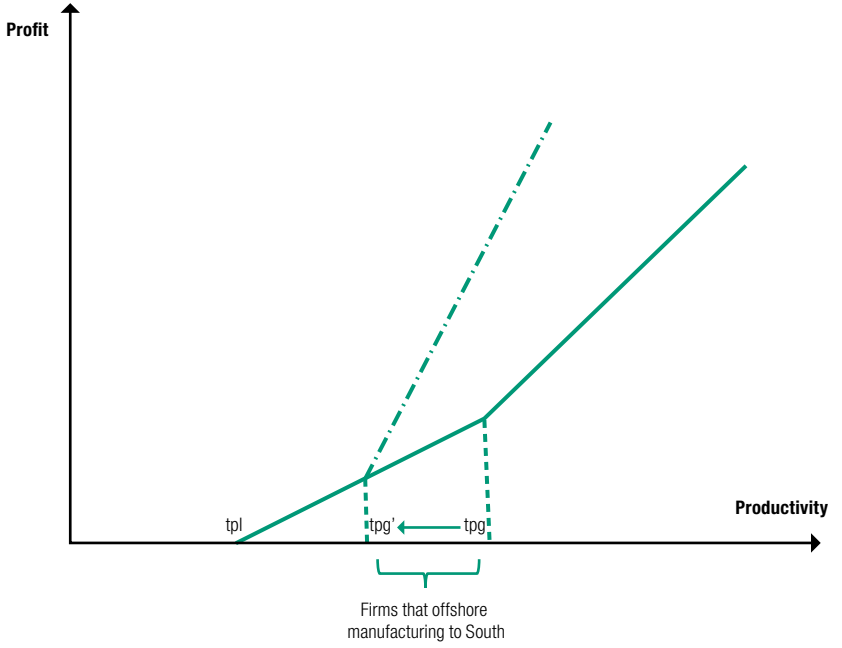
The impact of trade liberalization can now be analysed by looking at the effect of a decrease in tariffs on shoe imports from South. A reduction in tariffs into North

generates two changes. First, it lowers the marginal cost of production for incumbent GVC firms, since they can now bring in their manufactured shoes without a large tariff. Because in this framework firms always apply the same markup over costs, the marginal cost reduction lowers GVC incumbents' prices and increases their sales and profits. (This is known as an increase at the *intensive margin*). In figure 3, this is depicted as an increase in the slope of the curve that depicts profits as a function of firm productivity. Second, the tariff reduction reduces the threshold productivity *tpg* at which firms decide to offshore manufacturing to South and become GVC firms. This shift in the threshold productivity suggests that numerous firms switch from LVC to GVC (known as an increase at the *extensive margin*).

Trade liberalization affects the economic fortunes and political positions of various stakeholders differently.

Managers. The tariff reduction affects managers of GVC and LVC firms differently. Not surprisingly, managers of GVC firms favour trade liberalization. Due to the intensive and extensive margin effects, a tariff reduction reduces the costs and improves the profits of both GVC incumbents and entrants. They thus favour import tariff reductions. In contrast, the position of LVC firms is generally disadvantaged by

Figure 3. The effect of trade liberalization on profits of LVC and GVC firms



trade liberalization. In our model the profits of LVC incumbents are not negatively affected (no intensive margin effect). However, the reduction in the market share of LVC firms compared with that of GVC firms (due to the extensive margin effect) plausibly reduces the political clout of LVC firms in the industry.

Consumers. The fall in tariffs benefits consumers in the model, because it induces lower prices and increased overall consumption opportunities.

Workers. The effect of trade liberalization on workers is mixed. The skilled workers employed in headquarters services are unambiguously better off. Since GVC firms expand their production more than LVC firms contract theirs, demand for skilled workers increases, putting upward pressure on their real wages. Unskilled workers may be worse off, however. As the output of LVC firms contracts, demand for unskilled workers shrinks, pushing their wages downward. Therefore, trade liberalization has distributional effects across skill levels within the same industry.

The country as a whole. At the national level, trade liberalization brings aggregate welfare gains. The total gains to individuals who are better off after the liberalization (skilled workers) exceed the total losses to individuals who suffer reduced real income (unskilled workers). Although the government could in principle design taxes and transfers to ensure that no individual is worse off after trade liberalization, in the real world there are significant political impediments to doing so.

We summarize the results in table 3.

The model illustrates how the fortunes and political interests of various stakeholders depend on characteristics of the economic environment and the roles they play. It is easy to see how the most productive multinational firms may tend to be big supporters of free trade in a world where there are large cost advantages to producing abroad and the costs of coordinating such activities have come down

Table 3. Impact of trade liberalization on various stakeholders

Stakeholder	Gain	Lose
Consumers	X	
Workers		
Skilled workers	X	
Unskilled workers		X
Firms		
GVC firms	X	
LVC firms		X

over time. Firms that cannot thrive in this environment will have incentives to press for more restrictions on trade. While all consumers benefit from lower prices of imports, less-skilled workers will lose out in skill-abundant North, consistent with the backlash against trade that we saw reach a head in the United States during the 2016 presidential campaign. Skilled workers, in contrast, gain as North's production pattern falls in line with its comparative advantage.

In the following section, we look at several case studies that highlight these forces at work and how firms in the same industry have taken divergent positions on trade policy.

5. Case studies

5.1 Nike, New Balance, and Viet Nam footwear tariffs[3]

During the TPP negotiations in 2012, a heated topic of discussion was whether the United States should accept a reduction of tariffs on imported footwear products. On the one hand, TPP negotiating partner Viet Nam was the second largest foreign supplier of footwear to the United States and was lobbying strongly for the elimination of tariffs as part of the TPP agreement. Obtaining concessions for other industries might therefore have depended on the willingness of the United States to reduce footwear tariffs. On the other hand, opponents including U.S. labor unions argued that Viet Nam's strength in the footwear industry was based on unfair subsidies and labor practices, and that the elimination of tariffs would sound the death knell for a key U.S. manufacturing industry.

The discussions came at a sensitive time for the footwear manufacturing sector in the United States. As in other unskilled-labor-intensive industries in the United States, manufacturing jobs were down. According to the Bureau of Labor Statistics, between 2003 and 2012, employment in the footwear manufacturing industry dropped from 19,440 to 13,290 workers. This decrease was due largely to a 41 per cent decline in the number of unskilled production workers. In comparison, white-collar office and administrative support occupations in the footwear industry had dropped by just 25 per cent, and management occupations had almost returned to 2003 levels.

The main reason for the decline in footwear industry employment was growing import competition from low-wage countries. In 2012, nearly 99 per cent of the footwear sold in the United States was imported from low-cost manufacturing locations, especially in East and Southeast Asia. China alone accounted for 72 per cent of U.S. footwear

[3] A lengthier version of this case was presented in Brodeur and Van Assche (2014).

imports in 2012, while TPP negotiating partner Viet Nam accounted for 10 per cent of those imports (see table 4). The pace of Viet Nam's growth in the footwear market was particularly rapid: exports to the United States jumped an astounding 24 per cent annually between 1997 and 2012, albeit from a very low base.

In line with the predictions of our model, however, there was widespread disagreement among U.S. footwear companies on the trade policy stance the United States should adopt. New Balance, the only U.S. athletic footwear company still producing shoes in the United States, was vehemently opposed to the elimination of tariffs. According to a spokesperson of New Balance, it was already 25 per cent to 35 per cent more expensive to produce in the United States than in Viet Nam and so a tariff reduction would only chip away at the tariff buffer that allows New Balance to produce in America (Aeppel, 2013). In line with the extensive margin story in our model, New Balance pointed out that a tariff reduction on footwear imports from Viet Nam would force New Balance to close its U.S. factories and move all of its production facilities overseas.

In contrast to New Balance, U.S. footwear giant Nike was a strong supporter of reducing import tariffs. None of Nike's employees in the United States are factory workers (Nike, 2013). Rather, they are mostly involved in providing headquarters services, designing and engineering new equipment, promoting products, and selling them in Nike stores. As with most U.S. footwear companies (with the notable exception of New Balance), Nike has completely outsourced its footwear manufacturing to foreign contractors. In December 2016, it was estimated that Nike's external contractors employed more than 600,000 workers in 133 factories around the world to produce their footwear products. More than 90 per cent of these workers were in Viet Nam, Indonesia and China.

Table 4. Growth of U.S. Footwear Imports, by Country of Origin, 1997-2012

	U.S. footwear imports			Share of U.S. footwear imports	
	(US$ millions)		Compound annual growth (%)	(%)	
Country	**1997**	**2012**	**1997-2012**	**1997**	**2012**
China	7,737	17,876	5.74	53.03	71.90
Viet Nam	102	2,512	23.83	0.70	10.11
Italy	1,244	1,230	-0.07	8.53	4.95
Indonesia	1,139	982	-0.99	7.81	3.95
Mexico	393	497	1.57	2.69	2.00
Rest of the world	3,560	1,233	3.62	27.24	7.09

Source: United Nations Comtrade Database: http://comtrade.un.org/

The arguments of Nike were much in line with the predictions of our model. First, consumers would benefit from the tariff reduction, because being able to import footwear products without being penalized by tariffs would make footwear more affordable. As argued by Oregon's U.S. Representative Earl Blumenauer, whose constituency is home to Nike employees as well as the U.S. headquarters of Adidas, keeping the tariffs would tax millions of Americans on their footwear purchases to protect only a few thousand manufacturing jobs (Martin, 2012). This argument is especially compelling when one considers that 99 per cent of the footwear purchased in the United States is produced in other countries.

Nike further suggested that the tariff reduction would benefit many (high-skilled) workers. U.S. footwear manufacturers would be able to save on production costs and reinvest their savings in modern, high value added jobs in headquarters services in the United States. As Erin Dobson, a Nike spokesperson, said, "[t]he question comes down to, is one kind of job more important than another? What are the jobs for the 21st century? They're not necessarily jobs that existed 30 years ago" (Martin, 2012).

The case of New Balance and Nike demonstrates how the evolving nature of production arrangements is altering the trade preferences of developed-country firms (table 5). Companies that, like Nike, have fully embraced GVC production are more likely to favour liberalization of imports in order to access low-cost foreign component imports as they increasingly specialize domestic employment in higher-skilled headquarters services. Companies that retain a significant local production presence, such as New Balance, continue to resist import liberalization, as of course do their lower-skilled domestic production workers. And these changing business interests are influencing policymakers, as seen in the stance taken by the Oregon Congressman.

Table 5. Impact of tariff reduction on footwear imports for various U.S. stakeholders

Stakeholder	Gain	Lose
Consumers	X	
Footwear workers		
Skilled workers	X	
Unskilled workers		X
Firms		
Nike	X	
New Balance		X

5.2 EDC's Volkswagen loan

The increasing importance of GVC production is also affecting the practice of public institutions tasked with carrying out trade policy. Export Development Canada, or EDC in short, is Canada's official export credit agency. Created in 1944, its primary mandate is to help Canadian firms expand their international business abroad by offering innovative commercial financing and insurance solutions, often at below-market rates.

As a Crown corporation, EDC needs to balance its public policy goals with the need to operate the programme at no cost to the taxpayer. All transactions that EDC facilitates must be shown to benefit the Canadian economy. In the past, when value chains were largely local, this came down to supporting export sales of Canadian-based companies and ensuring that the goods and services being exported were primarily produced with Canadian inputs. This would help to grow Canadian businesses, which in turn would create Canadian jobs and contribute to Canada's economic growth, all with the goal of improving Canadians' standard of living.

EDC has gradually modernized its interpretation of Canadian benefits to reflect the growing role of GVCs. As we have shown, for GVC firms the competitiveness equation has moved from one of local efficiency and productivity to one that also encompasses the ability to link with strong foreign suppliers, logistics providers, financial intermediaries and foreign affiliates. In line with this shift, EDC has started giving loans and export credits to foreign companies if the case can be made that this will help facilitate the integration of Canadian firms into GVCs.

In April 2015, EDC announced that it would lend roughly C$526 million to Volkswagen, a German company that has no manufacturing presence in Canada, to help it consider doing business with Canadian parts makers. The loan came at a sensitive time. The performance of Canada's automotive exports had been lacklustre over the previous 15 years. In 2013, Canada's automotive exports were only slightly larger in nominal terms than they had been in 2000. Like the global automotive industry overall, Canada's motor vehicle export sector contracted significantly during the Great Recession, with its export value shrinking 34 per cent in 2009. Since then, Canada's motor vehicle exports have seen a strong rebound and have nearly returned to pre-crisis highs.

Automotive imports, in contrast, have risen sharply in the past decade and a half. Between 1998 and 2013, they grew at an annualized rate of 7.5 per cent, tripling in value. Consequently, Canada's traditional trade surplus in the automotive sector has been wiped out: in 2013 the sector had a trade deficit of US$7 billion.

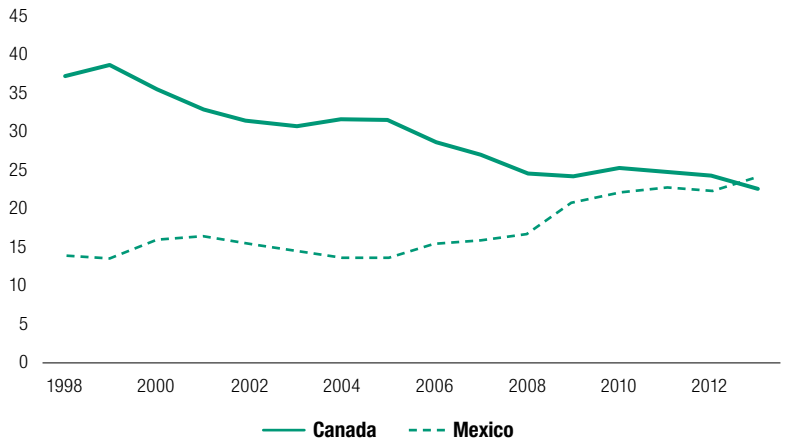
One of the key reasons for the growing trade deficit is heightened competition from Mexico. Powered by cheap labor and a growing supply base, the country has scooped up tens of billions of dollars in new greenfield auto investment by BMW,

Volkswagen, Toyota, Honda, Kia, Daimler and the Detroit Three (General Motors, Ford and Fiat Chrysler). With many automakers choosing Mexico over Canada as the site for new assembly plants, the share of U.S. automotive imports from Mexico recently surpassed that from Canada (see figure 4).

According to Carl Burlock, senior vice-president of finance and investment at EDC, the agency is providing financial support for Volkswagen to facilitate participation by Canadian suppliers in developing GVCs. "[T]his financing is really about relationship building, both for EDC and for Canadian [small and medium-size enterprises (SMEs)] in the tooling and automotive supply industries. The value here is that qualified Canadian SMEs get a real chance to be considered by a major industry player, where they might not have an opportunity to gain that kind of access on their own," Burlock said (EDC, 2015). "With the Southern [United States] and Mexico increasingly becoming prime production locations for global automakers, EDC has a role to play in making sure that Canadian companies have the opportunity and financial wherewithal to compete for that business," he added.

According to Flavio Volpe, president of the Automotive Parts Manufacturers' Association, representing Canadian companies that employ over 40,000 Canadians, "this is great news for our companies and their employees, and we're confident that the stronger connection with Volkswagen, created through this loan, will help

Figure 4. Share of U.S. automotive imports, 1998–2013 (per cent)



Source: Authors' calculations using BACI trade data. Motor vehicles exports are defined as HS 8700-8708.

Canadian toolers and parts manufacturers win new business with VW" (Burlock, 2015). Volpe added, "Volkswagen has already purchased $85 million worth of parts from Canadian-based suppliers over the past year, and they appear ready to buy more."

The decision by EDC to provide financing to Volkswagen was received with much scepticism, however, by manufacturing workers in Canada. Canada's largest private sector union, Unifor, was swift to denounce the move. Its president, Jerry Dias, stated that the financing deal did not guarantee that a Canadian company will benefit or that Canadian jobs will be created, and that the deal will probably lead to deals with part plants in Mexico, where Volkswagen has an assembly plant. He followed by saying, "it is absolutely incredible that a Canadian Government agency is helping to facilitate and accelerate the migration of the continental auto industry to Mexico" (Keenan and McKenna, 2015).

Like the New Balance and Nike case, EDC support for Volkswagen demonstrates how corporate interests are changing in the GVC era, how policy is changing in response, and how new sets of winners and losers are being created (see table 6). It is particularly interesting in the way it highlights how the interests of domestic supplier firms and their workers are also evolving in an environment where production arrangements increasingly extend across international borders. Many of these companies produce sophisticated parts that are well tuned to the capital and skills of Canada, and that can therefore benefit from integration with lower-skilled assembly operations in Mexico.

Table 6. Impact of EDC loan to Volkswagen on various Canadian stakeholders

Stakeholder	Gain	Lose
Consumers	?	?
Automobile workers		
Parts manufacturing	X	
Assembly		X
Firms		
Parts manufacturers	X	
Assembly		X

6. Concluding remarks and policy implications

We have argued that the emergence of GVCs can at least partially explain the growing dissatisfaction about trade in developed countries. Traditional theories tell us that unskilled workers have always benefited least from trade liberalization in skill-abundant countries. We show, however, that they have now lost a big ally in their quest for protectionism: big business. In many import-competing sectors, large companies have offshored their manufacturing plants to developing countries such as Mexico and China, effectively substituting unskilled foreign labor for unskilled domestic labor. For these firms, import tariffs are no longer a boon that acts as a protective buffer against foreign competitors, but rather a hindrance that negatively affects their own competitiveness. To meet corporate objectives, they thus have an incentive to lobby for import liberalization even if this disproportionately helps foreign workers to the detriment of American or Canadian blue-collar workers.

The diverging policy interests of workers and firms under GVCs may help to explain why the debate over trade and jobs has become so prominent in recent years. A number of policy pundits have jumped to the support of blue-collar workers by suggesting that policymakers should consider disregarding the trade policy preferences of GVC firms. Robert Reich (1990), for example, famously questioned whether firms headquartered in the United States that employ most of their workers in other countries should really be considered "American." As we noted, both major-party U.S. presidential candidates were critical of foreign outsourcing. And following the election, former Democratic presidential candidate Bernie Sanders (2017) said that he would be "delighted" at least in principle to work with the Trump administration to "develop a trade policy that finally works for American workers and not the CEOs of large multinational corporations."

This type of trade policy comes with important downsides, however. Penalizing GVC firms will likely damage the local economy. While import tariff liberalization hurts unskilled workers, our model shows that it positively affects multiple other stakeholders. It increases the real wages for skilled workers and reduces the prices for consumers. In addition, what our model does not capture is that, in a GVC world, even many blue-collar workers will suffer from trade restrictions. Citing Brookings Institution analysis, Porter and Gates (2018) report that far more communities stand to lose from steel and aluminium tariffs than will gain because of the widespread use of these materials as intermediate inputs. This is true for manufacturers who serve the domestic market, not just exporters who are hurt by foreign retaliation. In these industries, the interests of workers and owners are well-aligned. Still, while American businesses as whole—and many conservative politicians—have come out strongly against unilateral U.S. tariffs, many workers and unions have applauded the restrictions. Whether that will change as the adverse impacts begin to hit remains to be seen.

Despite the likely preponderance of losses and the potential for popular backlash, the Trump administration continues to ratchet up the scope of restrictions, particularly against China. Why? The formal U.S. argument against China alleges unfair trade practices, particularly excessive subsidies and the forced expropriation of U.S. intellectual property (USTR, 2018). Tariffs are unlikely to be an effective response to such concerns and will hit successful GVC-oriented U.S. high-tech firms particularly hard (Lovely and Liang, 2018). At the end of the day, targeting the GVC structure itself may be the main goal, with the belief that if punitive tariffs are maintained long enough, they will force U.S. companies to dismantle GVCs and reassemble them as LVCs within the United States (Hornby, 2018). Other pundits consider this unlikely, given lower foreign costs, the ability to shift overseas production to countries not targeted by unilateral measures and the high level of competence that has been built up by foreign value chain partners (Baldwin, 2016). One thing is clear: more academic research is needed to investigate how trade policy uncertainty (e.g. Brexit) and trade wars affect the structure of GVCs, to what extent they induce reshoring of low-skilled jobs to the United States, and whether they realign the trade policy preferences of low-skilled workers and firms.

At the end of the day, economics tells us that, with few exceptions, trade restrictions reduce welfare at the aggregate level in all trading countries. The gains from trade are large enough that they more than offset losses at the national level. Trade liberalization should be an overall boon. The problem, of course, is not new. Trade liberalization creates winners and losers. When the winners are large corporations and the most visible losers are blue-collar workers, liberalization is a recipe for social discord, particularly in an era of diminished expectations about future job and income security. Although our economics tells us winners could compensate losers and still come out ahead, that does not happen in practice. Public programmes to compensate workers displaced by trade, such as the U.S. Trade Adjustment Assistance Act, do not have a good track record in getting workers back into well-paying employment (see, for example, Schochet et al., 2012). Unless we do a better job at that, we risk imposing ongoing costs on precisely those workers who are least able to bear them. We also risk inviting knee-jerk trade policy reactions that do more harm than good, as well as a continuation of the social and political discord that is hampering the ability of government to address other important policy objectives.

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Appendix

This section presents a simple model in the spirit of Melitz (2003), but allows firms to manufacture their final goods either in a Northern country (local value chain, or LVC) or in a Southern country (global value chain, or GVC).

Consider a world that includes a small Northern country and a small Southern country, eponymously called North and South. In North, households spend the fixed amount $Y > 0$ on a specific differentiated goods sector. The demand function for a variety v in this sector manufactured in country $i \in \{N, S\}$ and sold in N equals

$$y^i(v) = Ap^i(v)^{-\varepsilon}, \quad (1)$$

where $\varepsilon = \frac{1}{1-\alpha} > 1$ is the elasticity of substitution between any pair of differentiated goods and the demand level A is exogenous from the point of view of the individual firm.[4]

In North, a continuum of firms has the know-how to each produce a single variety. Southern firms do not have this know-how. We assume that each firm draws a productivity φ from a cumulative Pareto distribution $G(\varphi)$ with shape parameter $z > \varepsilon - 1$ (Helpman, Melitz and Yeaple, 2004):

$$G(\varphi) = 1 - \varphi^{-z}. \quad (2)$$

An inverse measure of the heterogeneity in a sector is given by z. If z is high, firms are more homogeneous, in the sense that more output is concentrated among the smallest and least productive firms.

The value chain of a product consists of three stages: *headquarters service*, *manufacturing* and *sales*. A firm can only produce its headquarters services in North. Manufacturing, in contrast, is footloose in that it can be conducted either in North at a unit labor cost of 1 or in South at a unit labor cost of $\omega < 1$. If manufacturing is not co-located with headquarters services, the firm faces a fixed cost g of coordinating its GVC activities across borders. Finally, to sell its product variety to consumers in the destination country j, a firm faces a fixed cost f.

Exports from South to North are subject to an ad valorem tariff t where $\tau = 1 + t$. The tariff implies that for those firms which manufacture in South, the consumer price that they charge in North is higher than the price charged in South. We assume that the following condition holds:[5]

[4] As is well known from previous studies, $A^i = Y^i / \left[\int_0^{n_i} p^i(v)^{1-\varepsilon} dv\right]$, where n_i is the measure of varieties available in country i and $p^i(v)$ is the price of variety v in country i. Firms treat A^i as fixed since they are too small to individually affect A^i.

[5] Under this condition, the marginal profit of manufacturing an extra unit in South compared with that in North. One can obtain this condition by using equation (6).

$$\omega^{1-\varepsilon}\tau^{-\varepsilon} > 1. \quad (3)$$

Under this condition, any firm has a marginal cost advantage of manufacturing its products in South compared with North. In other words, the wage advantage of manufacturing in South is sufficiently large to outweigh the cost advantage of avoiding tariffs by producing in North.

Consider the scenario where the fixed coordination costs g exceeds $f[\tau^{-\varepsilon}\omega^{1-\varepsilon} - 1]$. In that case, two organizational forms coexist in the industry: (1) firms with LVCs, and (3) Northern firms with GVCs.[6]

As illustrated in figure A1, two types of Northern firms sell their products to the destination country: less productive firms ($\varphi^L < \varphi < \varphi^G$), which manufacture in North, and more productive firms ($\varphi > \varphi^G$), which manufacture in South. We consider their optimization problems in turn.

[Insert figure A1 about here]

Firms with GVCs ($\varphi > \varphi^G$) perform their manufacturing in South and choose y to maximize $\pi^G = \left(p^G\tau - \frac{\omega}{\varphi}\right)y^G - f - g$. For these firms, their optimal price equals $p^G = \frac{\omega}{\alpha\varphi}$, their firm-specific sales equal

$$x^G = \frac{B}{1-\alpha}\left(\frac{\varphi}{\omega}\right)^{\varepsilon-1}\tau^{-\varepsilon}, \quad (4)$$

and their firm-specific profits equal

$$\pi^G = \left(\frac{\varphi}{\omega}\right)^{\varepsilon-1}\tau^{-\varepsilon}B - f - g. \quad (5)$$

Using equation (4), the aggregate sales from firms with GVCs equal the integral of firm-level sales (firms with a productivity ($\varphi > \varphi^G$)):

$$X^G = \int_{\varphi^G}^{\infty} x(\varphi)dG(\varphi). \quad (6)$$

Firms with LVCs (L)

Firms with LVCs ($\varphi^L < \varphi < \varphi^G$) choose y to maximize $\pi = \left(p^L - \frac{1}{\varphi}\right)y^L - f$. It is straightforward to check that this profit maximization problem yields the optimal price $p^L = \frac{1}{\alpha\varphi}$, the optimal firm-specific sales

$$x^L = \frac{B}{1-\alpha}\varphi^{\varepsilon-1} \quad (7)$$

and the optimal firm-specific profit

[6] If $f\left[\left(\frac{1}{\omega\tau}\right)^{\varepsilon-1} - 1\right] > g$, it is optimal for all Northern firms to manufacture in South. In this unrealistic case, there will be no extra extensive margin effect and the elasticity of bilateral exports with respect to a country-specific tariff change reverts to that of the case of no vertical specialization.

$$\pi^{L} = \varphi^{\varepsilon-1} B - f, \tag{8}$$

where $B = (1-\alpha)A\alpha^{\varepsilon-1}$

Not all firms are able to generate enough profits to cover the fixed cost f of selling their output in the domestic market. Define φ^{L} as the threshold productivity at which $\pi^{L} = 0$. Using equation (8), the cut-off productivity coefficient for firms to start selling on the market equals

$$\varphi^{L} = \left(\frac{f}{B}\right)^{\frac{1}{\varepsilon-1}} \tag{9}$$

The second threshold productivity φ^{G} occurs when the profits for firms with local and GVCs are equal. In other words, it solves $\pi^{L}(\varphi^{G}) = \pi^{G}(\varphi^{G})$. By using equations (5), (8) and (9), and solving for $\pi^{L}(\varphi^{G}) = \pi^{G}(\varphi^{G})$, the threshold equals

$$\varphi^{G} = \left(\frac{g}{B(\omega^{1-\varepsilon}\tau^{-\varepsilon}-1)}\right)^{\frac{1}{\varepsilon-1}} \tag{10}$$

Firms with a productivity $\varphi > \varphi^{G}$ manufacture in South, while firms with a productivity $\varphi^{L} < \varphi < \varphi^{G}$ perform manufacturing at home in North.

The sales of firms in the local value chain equal the sum of sales by firms with productivities $\varphi \in [\varphi^{L}, \varphi^{G}]$. Using the firm-level sales equation (7), aggregate sales equal

$$X^{L} = \int_{\varphi^{L}}^{\varphi^{G}} x^{L}(\varphi) dG(\varphi). \tag{11}$$

Tariff reduction and GVC sales

We can use equation (6) to investigate the elasticity of aggregate sales with respect to a decrease in tariffs on South . As illustrated by Chaney (2008), the effect can be decomposed into two margins:

$$-\frac{dX^{G}/d\tau}{X^{G}/\tau} = -\frac{\tau}{X^{G}}\left(\int_{\varphi^{G}}^{\infty}\frac{\partial x(\varphi)}{\partial \tau} dG(\varphi)\right) + \frac{\tau}{X^{G}}\left(x(\varphi)G'(\varphi)\frac{\partial \varphi}{\partial \tau}\right). \tag{12}$$

The first term is the intensive margin and the second is the extensive margin. The intensive margin determines by which amount incumbents change the size of their sales. The extensive margin defines the amount that aggregate sales change due to the decision of firms to switch from LVCs to GVCs.

We can solve equation (12) to obtain the elasticity of a country's exports to a tariff change. We show that the intensive margin effect equals ε. That is, we demonstrate that a 1 per cent decrease in the tariff rate induces incumbent GVC firms to increase their sales in North by the elasticity of substitution $\varepsilon > 0$. The extensive margin effect, then again, equals $\left(z - (\varepsilon - 1)\right)\frac{\varepsilon}{\varepsilon-1}\chi > 0$. That is, our model shows that the tariff reduction pushes a number of firms at the margin to switch their manufacturing from North to South, leading to an extra increase in aggregate sales by firms with

GVCs. Putting the two together, the total elasticity equals

$$-\frac{dX^G/d\tau}{X^G/\tau} = \varepsilon + \big(z - (\varepsilon - 1)\big)\frac{\varepsilon}{\varepsilon-1}\chi, \quad (13)$$

where

$$\chi = \frac{\omega^{1-\varepsilon}\tau^{-\varepsilon}}{\omega^{1-\varepsilon}\tau^{-\varepsilon}-1} > 1.$$

Due to the expansion of sales of GVC incumbents and the entry of new of GVC firms, the tariff reduction leads to an expansion of aggregate sales by GVC firms.

Tariff reduction and LVC sales

We can use equation (11) to investigate in a similar fashion the elasticity of aggregate sales with respect to a decrease in tariffs on South . Once again, the effect can be decomposed into an intensive and an extensive margin effect:

$$-\frac{dX^L/d\tau}{X^L/\tau} = -\frac{\tau}{X^L}\left(\int_{\varphi^L}^{\varphi^G}\frac{\partial x(\varphi)}{\partial\tau}dG(\varphi)\right) + \frac{\tau}{X^L}\left(x(\varphi^L)G'(\varphi^L)\frac{\partial\varphi^L}{\partial\tau} - x(\varphi^G)G'(\varphi^G)\frac{\partial\varphi^G}{\partial\tau}\right). \quad (14)$$

We can solve equation (14) to obtain the elasticity of LVC sales to a tariff change. We show that there is no intensive margin since the marginal cost of LVC firms is unaffected by the tariff decline. There is a negative extensive margin effect however. The tariff reduction induces a number of LVC firms to switch from North manufacturing to South manufacturing, which leads to a movement of the threshold productivity and leads to a reduction in the aggregate sales of LVC firms:

$$-\frac{dX^L/d\tau}{X^L/\tau} = -\big(z - (\varepsilon - 1)\big)\frac{\varepsilon}{\varepsilon-1}(\chi - 1) * \frac{X^G}{X^L} < 0 \quad (15)$$

Home-country measures to support outward foreign direct investment: variation and consequences

Florian Becker-Ritterspach, Maria L. Allen, Knut Lange and Matthew M. C. Allen*

The state, especially in emerging economies, plays a key role in influencing firm behaviour, including outward foreign direct investment (OFDI). Often literature on the state's influence on OFDI stresses direct state ownership. However, the state can influence OFDI in several ways, including policy support and subsidies; the literature has largely overlooked these effects. We build on key insights from the comparative capitalisms literature to put forward a series of propositions on how home-country measures – in both emerging and developed economies – to boost OFDI will influence, inter alia, the volume, location and mode of firms' investments abroad. We thus contribute to the literature by showing how government policies across a wide range of countries influence an important aspect of firm behaviour that has economic, social and environmental implications.

Keywords: multinational firms; international business; comparative capitalisms; investment policies; business objectives of the firm

1. Introduction

The international business literature has long recognized how the home country can influence domestic firms' outward foreign direct investment (OFDI). For instance, it has shown how home-country norms shape the location and timing of OFDI (Johanson & Vahlne, 1977), and how the state can influence the capabilities of internationally competitive domestic firms (Narula, 1993). However, although this body of literature has put home-country effects centre stage, it has so far paid limited systematic attention to how home-country measures that states implement to support domestic firms' OFDI vary and how this variation, in turn, affects OFDI.

This rise of emerging-market multinational companies (EMNCs) has led to a focus on the state's role in economic activity (Buckley, Clegg, Cross, Liu, Voss & Zheng, 2007; Ibeh, 2018; Peng, 2012; Zhang, Zhou & Ebbers, 2011). Much of the empirical

* Florian Becker-Ritterspach is at the Hochschule für Technik und Wirtschaft Berlin, Maria L. Allen is at Manchester Metropolitan University Business School, Knut Lange is at Royal Holloway, University of London and Matthew M. C. Allen is at Alliance Manchester Business School. The corresponding author is Matthew Allen (Matthew.Allen@manchester.ac.uk).

research has focused on how either the home country, in general, or direct state ownership, in particular, influences emerging-market firms' investments abroad (Buckley, Cross, Tan, Xin & Voss, 2008; Cuervo-Cazurra & Genc, 2008; Zhang et al., 2011).

Although some studies examine how home-country measures (HCMs) that the state implements to support companies' foreign investments shape OFDI (Luo, Xue & Han, 2010; Narula, 1993; Torres, Clegg & Varum, 2016), such studies are limited in number. In addition, these efforts focus on emerging-market firms, often Chinese ones (Jormanainen & Koveshnikov, 2012). However, there is no a priori reason to assume that it is only emerging-market states that support firms' OFDI strategies (Fiedler & Karlsson, 2016; Narula, 1993). Indeed, in an era of increasing nationalism and the questioning of international free-trade agreements, there may be a role for the state in developed economies as well as emerging ones to promote overseas investment for the purpose of accessing knowledge and other capabilities (Mathews, 2006; Welfens & Baier, 2018). Significant research gaps remain, therefore, related to how states – both developed- and emerging-market ones – vary in their support for OFDI and what effect this variation is likely to have on patterns of OFDI.

In this paper we seek to address these gaps conceptually through a range of propositions that combine recent advances in international business with longstanding insights from international policy papers and the comparative capitalisms (CC) literature. Drawing on policy papers from the Organization for Economic Cooperation and Development (OECD) and the United Nations Conference on Trade and Development (UNCTAD) that coined the term "home-country measures" (HCMs), we define and conceptualize home-country support for firms' investments abroad. We draw particularly on the work of Sauvant et al. (2014), which provides a comprehensive review of policy papers on HCMs. We combine that effort with insights from the CC literature to identify how HCMs differ across countries and, more importantly, how HCMs affect OFDI. Building on four crucial tenets of CC analysis, we illustrate how HCMs are likely to influence OFDI patterns.

Our work makes three contributions. First, we help to explain OFDI patterns by examining the variation and consequences of HCMs, a relatively neglected influence on firms' investments abroad. Second and building on the first point, our work demonstrates the importance of taking HCM variation seriously, both across and within countries. Third, we illustrate how HCMs (1) can fundamentally alter the strategic priorities of firms and (2) should be conceptualized as configurations of several measures rather than as individual ones, challenging best practice suggestions of the past (UNCTAD, 2001) and sensitizing policymakers and researchers to the need to assess – as well as the challenges involved in examining – the OFDI effects of HCMs.

The remainder of this paper has three sections. Section 2 reviews key strands of the international business literature: the country-of-origin perspective, important theories of OFDI and recent perspectives on the nature of EMNCs. While recognizing the important contributions of these three strands of the literature, we address their shortcomings in section 3 by introducing complementary insights from HCM policy papers and the CC literature. In that section, we put forward four broad propositions that set out the principles that are likely to shape the relationship between HCM variation and OFDI. We anticipate that more focused hypotheses will build on each of these propositions; to illustrate how the propositions can be used, we put forward one hypothesis for each proposition. Section 4 concludes, summarizes our contribution to the literature and sets out the implications for policymakers, managers and future research.

2. Review of the International Business Literature

We focus on four important strands of the literature: country-of-origin perspectives, OFDI theories within the international business literature, the "double diamond" framework and recent perspectives on the nature of EMNCs. We show that, while all four propose relationships between some aspects of the multinational corporation's (MNC's) home country and its investments abroad, there is little systematic treatment of how countries differ in terms of HCMs and how this variation is likely to affect OFDI patterns.

2.1 The Country-of-Origin Effect

The country-of-origin effect potentially explains a wide range of behavioural aspects of the internationalizing firm, such as MNCs' product perceptions, knowledge transfer propensity, strategy and structure, and coordination modes, as well as the constitution of their work systems and production models (Elango & Sethi, 2007; Ferner & Quintanilla, 1998; Geppert, Williams & Matten, 2003; Harzing & Sorge, 2003). A substantial body of work shows that MNEs' country of origin influences OFDI patterns (Tan & Meyer, 2011).

The theories underpinning country-of-origin contributions vary substantially. While some contributions use the home country as an explanatory variable with little theoretical grounding, others use theory extensively, with culturalist and comparative theories often dominating. These country-of-origin perspectives have taught us a lot about how the home country influences MNE behaviour (Buckley, 1996; Chen, 2015; Dunning, 1992; Young & Hood, 1992). We see country-of-origin perspectives that are based on the CC perspective and that build on seminal insights from the broader international literature, such as the importance of the state in explaining OFDI (Dunning, 1992; Stopford, 1994; Young & Hood, 1992; Zhan, 1995), as a

fruitful starting point for understanding the constitution and consequences of HCMs, because they have tended to focus on national institutional settings to explain firm behaviour. We therefore build our understanding of home-country support on institutional foundations and extend it to include the important role of HCMs.

2.2 OFDI Theories

This section briefly assesses important OFDI theories, focusing on the extent to which they consider the home context in general and HCMs in particular to explain OFDI patterns. We will discuss the classical mainstream approaches first and then move on to more recent theories on EMNCs' OFDI.

2.2.1 Hymer's Theory of the Multinational Firm

Hymer's (1960) theory of the multinational firm seeks to explain why firms invest abroad. Drawing on industrial organization theory, Hymer (1960) asserts that MNCs have monopolistic advantages, such as privileged access to capital or other resources, economies of scale or government concessions (Forsgren, 2009). Consequently, firms may be able to invest abroad because they can exploit those monopolistic advantages internationally (Forsgren, 2009: 28). This early seminal work is not particularly concerned with the state's activities to promote OFDI. Importantly, proponents of internalization theory, who build strongly on Hymer's ideas of market imperfections, have focused on the role of home-market imperfections to explain EMNCs' OFDI (Buckley, 2018; Rugman, Nguyen, & Wei, 2016). They have not, however, examined HCMs.

2.2.2 Johansson and Vahlne's Uppsala model

Johanson & Vahlne's (1977) work seeks to explain OFDI processes through the lens of learning and contextual distance. Firms move gradually from more to less familiar foreign contexts and their foreign investments move from low to increasingly high commitment. Whereas the former involves moving first into neighbouring countries before entering more distant target markets, the latter is a process that starts with exports, moves into initial foreign investment in sales subsidiaries and ends in fully fledged production sites abroad. This approach has been criticized. For instance, contributions on EMNCs' OFDI (e.g. Guillen & Garcia-Canal, 2009) have argued that contemporary firms often venture almost instantly into radically distant environments and also choose high-commitment modes of entry early on. The Uppsala model (Johanson & Vahlne, 1977, 2009), therefore, tends to overlook the state's proactive promotion of OFDI and how that action can lead to investments in unfamiliar cultural contexts and that do not build on existing company strengths (Hennart, 2012; Mathews, 2006).

2.2.3 Dunning's OLI model

Dunning's (1988) "eclectic paradigm", or OLI model, focuses on the necessary conditions for firms to engage in FDI, arguing that three conditions need to be met: firms need an ownership advantage (O), a locational advantage (L) and an internalization advantage (I). Ownership advantages can differ in kind and can involve, for instance, trademarks, production technique or entrepreneurial skills. The possession of ownership advantages is the most basic requirement for OFDI; without it, a firm cannot overcome its liability of foreignness in the foreign context. However, EMNCs' OFDI raises questions about the need for firms to have organizational advantages before investing abroad. Similarly, the OLI framework does not explain the emergence, development and maintenance of ownership advantages, consequently downplaying the institutionally conditioned creation, change and continuation of organizational capabilities (Whitley, 1999).

Responding to such criticisms, Dunning & Lundan (2008, 2010) incorporated institutional analysis into the OLI framework, suggesting a potential link between national institutions in both home and host countries and their influence on the kinds of organizational advantages firms are likely to develop. Despite these developments, the OLI model does not focus in detail on particular policies and HCMs and how they influence OFDI. This is different to Rugman's work, which focuses on the nexus between country- and firm-specific advantages.

2.2.4 Rugman's FSA-CSA framework

The last major theory of OFDI is Rugman's (1981) FSA-CSA matrix or framework, which aims to explain the key drivers and sources of competitive advantages of the internationalizing firm. The starting point of the framework is a distinction between firm-specific advantages (FSAs) and country-specific advantages (CSAs). FSAs include, for instance, brands, managerial resources and skills, and systems integration, which are unique and idiosyncratic to the firm. CSAs can be advantages that have little to do with a firm's capabilities, but that benefit the firm because of its location. Such advantages may involve access to natural resources or low labour costs.

It is the interplay and recombination of CSAs and FSAs that drives OFDI and offers a key source of MNEs' competitive advantage (Rugman, 1988). However, it can be difficult to achieve. Focusing on China, Rugman, Nguyen & Wei (2016) have argued that the types of FSAs that Chinese firms develop stem from home CSAs, including low-cost labour, cheap financing, a large home market and privileged access to natural resources within China. They conclude that strong reliance on home-country and government support may have helped some Chinese firms to invest abroad but has not been sufficient to enable them to combine home-country

FSAs with host-country CSAs. Rugman's work, hence, highlights the difficulties that firms face when seeking to combine FSAs and home and host CSAs, but does not focus specifically on HCMs.

2.3 Extensions of Porter's Diamond

A further strand of the international business literature builds on Porter's (1990) diamond to develop a "double diamond" model (D'Agostino & Santangelo, 2012; Ghauri & Santangelo, 2012; Rugman & Verbeke, 2003), which can help to explain, inter alia, OFDI. Porter's diamond focuses on firm strategy, structure and rivalry; factor conditions; demand conditions; and related and supporting industries, to explain the competitiveness of industries in different countries. The double diamond model has two key elements that Porter's framework downplays (Rugman & D'Cruz, 1993; Rugman & Verbeke, 1993, 2003). First, to be successful abroad, internationally competitive firms do not rely only on their home country's strengths. Often the interaction between resources located in different countries can explain companies' international success (Rugman & Verbeke, 1993). Second and more specifically, companies often undertake OFDI to access knowledge, expertise and resources that their domestic market does not provide (Rugman & Verbeke, 2001).

2.4 Emerging-market multinationals and the role of the home country

The growing importance of EMNCs' FDI has led to analyses of home countries and their influence on domestic firms' investments abroad (Buckley et al., 2007; Buckley, 2018; Chen, 2015; Pradhan, 2016). Indeed, without examining the home country's role, it is difficult to explain such firms' OFDI. The global shift in OFDI patterns has led to two theoretical developments. First, proponents of classical theories of international investment examined the role of states and home-country institutions in greater detail (Buckley, 2018; Dunning, Kim & Park, 2008; Dunning & Lundan, 2008, 2010; Rugman, 2009). Second, recent work has put forward new theories and empirical analyses specifically tailored towards explaining emerging-market firms' OFDI (Chen, 2015; Hennart, 2012; Luo & Tung, 2007; Mathews, 2006; Ramamurti, 2009, 2012).

Although amended classical theories and new theories on EMNCs posit different drivers of OFDI and firms' competitive advantages in foreign markets (Buckley, 2018; Hennart, 2012), they share an emphasis on the *constraining or enabling* role of home-country institutions. These institutions are often seen as being directly linked to – if not equated with – the state's behaviour in the home country. Hence, the literature has increasingly focused on the importance of the state to explain emerging-market OFDI, but very few studies examine the policies that states have in place to promote OFDI in both emerging and developed economies.

For instance, a few studies focus on China and provide a comprehensive review of HCMs (Li, et al., 2013; Luo & Rui, 2009; Luo et al., 2010). Some of these cover a wide range of HCMs, including various fiscal incentives, such as tax rebates and subsidized loans, insurance against political threats, support from government agencies, treaties to protect investment abroad, and help to deal with host-country governments and to conform to free-trade agreements, such as WTO protocols (Luo & Rui, 2009; Luo et al., 2010).

In sum, OFDI theories have begun to acknowledge the home country's important role. However, there is little systematic understanding of how HCMs differ across countries and how divergent HCMs, in turn, affect OFDI (Buckley, 2018; Sauvant et al., 2014). This gap in the literature is all the more surprising as "HCMs can potentially influence, among other things, the volume, quality, mode of investment, type of investor, sector of investment, and location of OFDI" (Sauvant et al., 2014: 3).

3. Towards a framework of HCM variation and consequences

3.1 Classifications of HCMs

International organizations, notably UNCTAD and the OECD, were among the first to acknowledge the importance of HCMs in explaining OFDI. The initial focus rested on the question of how to incentivize MNCs to invest in developing countries (OECD, 1983, 1993; UNCTAD, 2001). Consequently, UNCTAD published a range of papers defining HCMs and discussing their possible effect on FDI in terms of quality and quantity in developing countries. In general, UNCTAD (2001: 65) understood HCMs as

> [A]ll policy measures taken by the home countries of firms that choose to invest abroad designed to encourage FDI flows to other countries. Their formulation and application may involve both home- and host-country government and private sector organizations.

HCMs can exist at the national, regional and multilateral levels and involve a broad variety of measures, ranging from information provision, technical assistance and capacity-building to financial, fiscal and insurance measures, investment-related trade policies, schemes to promote the transfer of technology and investment insurance (UNCTAD, 2001: 11).

Sauvant et al. (2014: 11–12) define HCMs as advantages provided by home governments that are "meant to facilitate, support or promote outward FDI". Drawing on a comprehensive review of policy papers, Sauvant et al. (2014) were among the first to examine how HCMs vary. They identified five characteristics to distinguish between HCMs. HCMs can be (1) direct or indirect, (2) provided by government and non-government actors, (3) grouped into broad categories of

support and the types of institutional actors that often provide them, (4) different in terms of their objectives and (5) different in their level of development, coherence and integration.

Sauvant et al.'s first distinction is between indirect and direct HCMs. Direct HCMs aim to support domestic firms' OFDI through information and other support services, financial measures and fiscal measures. Indirect measures are subsidies or measures that are related to trade and market access. Sauvant et al.'s second characteristic underscores that the private sector may have a role to play in stimulating OFDI; however, this is not the focus of their framework, which excludes non-governmental measures that aim to promote OFDI (Sauvant et al., 2014: 20).

The focus of Sauvant et al.'s third characteristic is on how government-related HCMs can be grouped into broad categories of support (information and support services, financial and fiscal measures, investment insurance measures and treaties) and the types of institutional actors that typically provide them (government departments and ministries, export credit agencies and development finance institutions, and investment and trade promotion agencies, as well as private organizations fulfilling government mandates).

Sauvant et al.'s fourth characteristic highlights how, apart from the obvious variation in HCM type, HCMs differ in their objectives. Such objectives can span a wide spectrum, ranging from more developmental goals for the host country to the promotion, primarily, of home-country economic interests. These objectives are typically reflected in the eligibility criteria and conditions that are often attached to HCMs, such as protecting the home country's economy as well as developmental, environmental, cultural or social considerations. Sauvant et al.'s fifth characteristic suggests that HCMs vary in their proactive promotion by the state, their transparency and, more importantly, their coherence and integration. This suggests that the interactions of HCMs are important.

In summary, Sauvant et al.'s (2014) work provides an extensive discussion of HCM variation. However, they do not provide a theoretical or analytical basis on which to assess how HCM variation influences OFDI. As we show in the next section, CC analysis is particularly useful for providing this basis, so that a more systematic analytical framework can be put forward to examine the effects of HCMs on OFDI.

3.2 Comparative Capitalisms and Home-Country Measures

We rely on the CC literature to develop a better understanding of how HCMs vary and how that variance relates to OFDI patterns. Before discussing these antecedents and consequences of HCM variation, we outline why the CC literature is a valuable one to review.

There are different strands within the CC literature. Among the best known and most widely cited ones are the National Business System, the Varieties of Capitalism and the Societal Effect approaches (Hall & Soskice, 2001; Maurice, Sorge & Warner, 1980; Whitley, 1999). Although these approaches vary in a number of ways (Allen, 2014), they share the basic premise that firms' priorities, capabilities and behaviour can only be understood within their home-country institutional contexts (Jackson, 2010; Whitley, 1987). Hence, the predominant perspective on institutions has been to examine how configurations of formal institutions at the national level influence firms (Allen, 2013; Whitley, 2005a). On the basis of divergent institutional settings and, hence, dominant firm types and firm relations within different countries, CC approaches distinguish between various categories of market economy (Hall & Soskice, 2001; Maurice, Sorge & Warner, 1980; Whitley, 1999). Since its first expressions, the CC literature has seen some important revisions. Among the most important are that firms are not passive agents but influence institutions as much as they are influenced by them (Hancké, Rhodes & Thatcher, 2007). It has also been recognized that national institutional settings are neither static nor necessarily homogeneous within a national economy (Allen, 2013; Whitley, 2009).

Nevertheless, what has remained a constant in this body of literature is the importance of institutional configurations (institutions as interconnected combinations rather than collections of discrete entities) as well as firm-institutional relationships to explain firm behaviour. Hence, four elements within the CC literature are particularly important: the mutual constitution of institutions and actors, complementarity, sectoral heterogeneity and the role of the state. We discuss their implications for HCM variation and the consequences for OFDI in the following subsections.

3.3.1 Mutual constitution of institutions and actors

Rather than seeing institutions and collective actors, such as firms, as separate entities, the CC literature builds on key insights from sociological theory, such as those of (Giddens, 1984) and (Simmel, 1955), to argue that individuals define or shape the social groups to which they belong and social groups define or shape their members (Jackson, 2010). In other words, neither is more important than the other: each co-constitutes the other (Jackson, 2010).

This has profound implications for how we view firms and how we seek to explain their behaviour. For instance, important national institutions not only encourage or discourage certain actions by firms; they also shape the fundamental nature of firms, their objectives and their abilities to carry out particular actions (Jackson, 2010; Jackson & Deeg, 2008; Whitley, 2010a). As a result, the CC literature highlights how key national institutions, such as corporate governance and the role of the state, constitute as well as constrain or enable firm behaviour both at home and abroad (Jaehrling et al., 2018; Lane & Wood, 2009; Tüselmann, Allen & McDonald,

2015). Consequently, it shows that the nature of firms varies between institutional contexts (Hall & Soskice, 2001; Lange et al., 2015; Maurice et al., 1980; Whitley, 1999). For instance, corporate governance regulations influence who has a say in important strategic decisions, shaping the firm's priorities and its capabilities (Goyer, 2011; Hall & Soskice, 2001; Whitley, 2010a). In other words, key institutions do not exist separately from firms, but are part of them, fundamentally shaping the nature of firms and their priorities; institutions do not just act as incentives or disincentives for firms that are, generally, homogeneous (Jackson, 2010; Whitley, 2010a).

Applied to HCMs, this view suggests that the state, as the "group" in Simmel's terms, is constituted by and constitutes the firms and other organizations that enact its policies and that are its "members". Therefore, the state's priorities, as embodied in HCMs, become the priorities of those companies that are involved in, or wish to be involved in, trying to achieve the state's objectives. One corollary of this is that, depending on the role of the state in the economy, we cannot assume that firms in all countries are profit maximizers. If the state plays a dominant role in shaping economic development, those firms that are expected to contribute towards achieving the state's objectives are likely to have socio-political as well as commercial aims.

For instance, the Chinese word *lishu* signifies a sense of "belonging to" or "directly controlled by" (Buckley, 2018). Such a relationship exists between the Chinese state and some domestic companies; therefore, in those firms, the state can have a direct influence not only on senior management appointments but also on major projects, such as OFDI (Buckley, 2018). As a result, HCMs signal to firms the state's priorities. *Lishu* is likely to mean that the strategic priorities of some Chinese firms reflect political rather than solely commercial objectives, resulting potentially in investments abroad that would not otherwise have occurred. Of course, not all OFDI by Chinese or other emerging-market firms will be influenced in this way (Voss, Buckley & Cross, 2010), but some will (Ramamurti & Hillemann, 2018). For instance, the Chinese state has influenced the location of OFDI and the type of companies that invest in particular projects abroad. China's One Belt One Road initiative, which is related to a government-backed $10 billion credit line to support Chinese investment (an HCM) (Tonchev, 2017), has led to an increase in OFDI in those countries that fall within the initiative, with state-owned companies playing a leading role in infrastructure sectors and private firms being more active in acquisitions not related to infrastructure (Du & Zhang, 2018).

This perspective suggests that political objectives associated with HCMs in some countries and variation, more broadly, in eligibility criteria and in conditionality – in terms of the host countries that attract, for example, funding or tax advantages associated with HCMs – in other countries will not just provide incentives to firms in general to invest overseas, but may inherently alter the strategic priorities of some firms. In other words, an HCM to promote OFDI into a particular country

or region may not only enhance the attractiveness of investing in that country or region for domestic firms, but also may fundamentally alter some domestic firms' strategic priorities, potentially influencing the geographical focus of their OFDI and, hence, both their spatially specific objectives as well as their overall priorities. Thus, HCMs and the conditions associated with them may encourage some firms (but not others) to invest in particular geographical locations or technologies (Sauvant & Chen, 2014). Conversely, eligibility and conditionality criteria may discourage some firms from using HCMs due to their constraining nature (Sauvant & Chen, 2014). We, therefore, put forward the following proposition:

P1: HCMs will influence OFDI patterns (types of actors, volume, location, technology area, mode of entry).

This broad proposition suggests that HCMs will encourage some firms to undertake investments overseas (either in particular countries or technologies) that they would not otherwise have carried out. One possible hypothesis that can be derived from this: HCMs will increase the volume of OFDI to politically favoured locations.

3.3.2 Complementarity

The CC literature highlights how institutions interact with one another; they should be seen as systems rather than as discrete entities with individual and independent effects (Goyer, Clark & Bhankaraully, 2016; Jackson & Deeg, 2008), raising the importance of complementarity (Deeg, 2005; Wood, Deeg & Wilkinson, 2014).

Prominent analytical approaches within the CC literature rely on typological theories, arguing that firm behaviour differs as a result of variation in countries along a number of dimensions (Hall & Soskice, 2001; Whitley, 1999). Consequently, these approaches implicitly draw on Weberian ideal types (Weber, 1949). At the heart of ideal types are the dimensions along which a set of ideal types, which forms a typology, vary (Doty & Glick, 1994). Within the CC literature, some important dimensions along which different types of capitalism exist are the role of the state in economic activity, the degree of centralization of wage negotiations and the relative importance of stock markets in corporate financing (Hall & Soskice, 2001; Whitley, 2005a). Each ideal type should be an internally coherent and logical model that shows the combination of dimensions that are distinct to each ideal type (Weber, 1949). However, in a typology, the ideal types are interrelated, because they vary along the same dimensions, making them different to classification systems (Doty & Glick, 1994). In addition, typologies should provide a logical or theoretical argument to explain why each ideal type's dimensional patterns leads to a particular outcome (Doty & Glick, 1994). For instance, the Varieties of Capitalism framework relies heavily on, but differs from, transaction cost economics to explain how contrasting national institutional regimes result in patterns of comparative advantage (Allen, 2004; Hall & Soskice, 2001).

A corollary of this typological theorizing is that how one institution shapes firm behaviour depends on the other institutions that are present (Jackson & Deeg, 2008). This can lead to systems of institutions that may either mutually reinforce one another (Hall & Soskice, 2001; Whitley, 1999) or compensate for one another, so that one institution may overcome the "deficiencies" of another (Crouch et al., 2005).

When institutions reinforce one another in a country, their effects are greater together than the effects of the institutions individually (Hall & Soskice, 2001; Whitley, 1999). Applied to HCMs, this kind of complementarity suggests that the institutional complementarity in a country may translate into different levels of coherence among the different HCMs. Coherence may, in turn, have a strong effect on the scale and scope of OFDI. This echoes Sauvant et al.'s (2014) work on HCMs as more or less coherent and integrated systems. For instance, one HCM by itself may have only a limited influence, but when coupled with one or more other HCMs, its influence could be quite substantial. Theoretically, then, one HCM (say, information support) may increase OFDI a little but when coupled with another (such as loans) may increase it a lot. HCMs may also stipulate or at least influence the mode of OFDI (joint ventures or wholly owned subsidiaries). Again, if the foci of other HCMs reinforce a particular mode of OFDI, the effects could be substantial.

The alternative view of complementarity suggests that one institution may make up for the deficiencies of another (Crouch et al., 2005). For instance, in the CC literature, strong, active labour-market policies in a country may "compensate" workers for a lack of strong employment rights, enabling workers to maintain their skills, expertise and employment as they are able to find work with different employers (Kristensen, 2016). Applied to HCMs, this insight suggests that some HCMs may make up for the absence or inadequacy of other HCMs. Therefore, research should examine how particular configurations of HCMs – rather than individual HCMs – may lead to the same outcomes. In other words, different sets of HCMs may have equifinality or the same result. They may, of course, have different outcomes as well.

Instead of complementing one another, HCMs and the eligibility criteria and other conditions associated with them may work against one another or be incoherent. As a result, the configuration of institutions may in some ways be complementary but in other respects may be incoherent, making for a complex set of causes that lead to particular outcomes. For instance, China's policy framework supports OFDI, but inefficient administrative procedures can impede investments abroad; despite these limitations, state-owned enterprises seem to benefit from HCMs more than other types of firms (Sauvant & Chen, 2014). In other words, although some institutions promote OFDI, they interact with unclear administrative remits to hinder OFDI; however, the impact of these interactions varies depending on the type of firm that is seeking to engage in investment abroad. Drawing on these two views of complementarity and incoherency, we put forward the following proposition, in broad terms:

P2: HCMs collectively and configurationally (rather than individually and additively) will influence patterns of OFDI.

One hypothesis that follows logically from this proposition is that, for example, government grants to firms to set up overseas facilities will moderate (enhance) the positive effects of tax deferral policies for income earned abroad on OFDI. Such a hypothesis highlights how HCMs are likely to interact with one another rather than act individually, with each having a direct effect on OFDI that is neither moderated nor mediated by other HCMs.

3.3.3 The role of the state

The third insight from the CC literature is the importance of the role of the state. Typologies of the state's involvement in economic activity are manifold, ranging from "predatory" states (Evans, 1995) to "segmented business systems" (Wood & Frynas, 2006) to "arm's length", "dominant-developmental" and "corporatist" states (Whitley, 2005a). As discussed in more detail below, any state's involvement in economic and commercial activities is likely to be sector specific, so these labels should be treated with care as they are unlikely to reflect the actual role of the state and its variation across economic sectors (Allen, Allen & Lange, 2018; Thurbon & Weiss, 2006; Wade, 2012).

Arm's length states, in their ideal typical forms, seek to achieve a level playing field for all firms, so that no firms are directly advantaged or disadvantaged by the state. This means that such states, as ideal types, do not intervene directly in any firm or firms' activities; they do not seek to shape investment decisions, for example, in favour of particular technologies or geographical areas. By contrast, dominant-developmental states, again as ideal types, pursue a strategic and active role in the economy, offering financial or other incentives to specific firms or sectors to encourage the growth of those firms and sectors and/or chosen technologies (Allen et al., 2018; Whitley, 2005a). Corporatist states, as ideal types, have a significant, direct role in economic development. In contrast to both arm's length and dominant-developmental states, corporatist states recognize that independent organizations, such as unions and business associations, can at times play important roles in helping to shape economic policy and implementation (Whitley, 2005a).

The different roles that states can play in guiding (or not guiding) economic development are likely to have important implications for any HCMs that they adopt, particularly regarding their directness. Arm's length states, by definition, are less likely than any of the other ideal types reviewed here to offer direct HCMs to specific firms or sectors to invest overseas in either specific companies or countries. In such states, senior managers in firms should be the ones to decide where to invest and how to do it. However, that does not mean that such states will not have any HCMs, as they do have them (Sauvant et al., 2014).

At the other end of the spectrum, dominant-developmental states are the most likely to devise direct HCMs with clearly defined eligibility and conditionality criteria to guide OFDI in terms of, say, firm type, investment objectives, volume and technology acquisition (Pradhan, 2016; Sauvant & Chen, 2014; Sauvant et al., 2014). They are, therefore, most likely to establish direct HCMs to encourage specific firms or firms more generally in chosen sectors to invest abroad to gain knowledge and access to key resources. For instance, the Chinese government did not allow private Chinese firms to invest abroad before 2003, so all OFDI came from state-owned enterprises (Buckley et al., 2007). The Chinese state promoted investment abroad by these companies in specific sectors between 1999 and 2001 (Buckley et al., 2007).

The influence of the Chinese state on OFDI has continued in more recent times (Rogers, 2019). For example, the China Development Bank, which is a state-owned "policy" bank in China that has a remit to provide medium- to long-term funding to support the country's strategic economic objectives, has provided crucial funding to some domestic solar photovoltaic companies to enable their development, including investments abroad in 2011 (Allen & Allen, 2015). By contrast, the United States, in general, has adopted a broader policy to promote investment abroad that is consistent across countries (Jackson, 2017); such policies typically focus on the provision of information about exporting or investing abroad rather than financial support to promote OFDI. However, some United States policies and government agencies do favour investments in emerging markets (Overseas Private Investment Corporation, 2018). Hence, the role of the state differs between countries, leading to variation in HCMs and OFDI. We therefore put forward the following proposition:

P3: The role of the state in the economy will influence HCM variation and thereby influence broad OFDI patterns (firm types, volume, location, technology area, mode of entry).

One hypothesis that builds on this proposition is that developmental states' HCMs will be both more extensive and more targeted than those in arm's length states. The rationale for this hypothesis is that arm's length states are likely to provide fewer HCMs than developmental states and, with some exceptions we discuss below, HCMs in arm's length states are likely to apply to all companies and all host countries evenly. By contrast, HCMs in developmental states are likely to be numerous and focus on particular firms and sectors as well as specific host countries. As a consequence of this variation, the potential moderating effects of HCMs are likely to be greater for developmental states than they are for arm's length states.

3.3.4 Sectoral heterogeneity

The fourth and final insight from the CC literature is its emphasis on the importance of heterogeneity not just between, but also within different types of national

economy (Lane & Wood, 2009; Wood & Lane, 2012). This diversity reflects, in part, both the sectoral specificity of state support (Lane & Wood, 2014) and differences between firms and their capabilities within any national economy and sector (Allen, 2013; Whitley, 2007). It also builds on the emphasis within the CC literature that institutional configurations are important: to assess the influence of a range of institutions – which can vary across companies and sectors – on firm behaviour, researchers need to know which specific institutions are applicable to particular firms (Allen, 2013).

This may seem like an obvious point; however, if research applies national ideal types to all companies within an economy, important variation can be missed and results may be biased. By neglecting such variation, research can inadvertently turn abstract ideal types into concrete entities that all companies within an economy are assumed to resemble closely. In reality, of course, there is variation among firms within any economy in terms of their ownership, control and direction, employee representation, types of relationships with suppliers and customers, and competition model (Kirchner, 2016).

Even within states, such as the United States, that typically do not intervene with companies and how they are run, some specific sectors receive strong government support (Block & Keller, 2009; Keller & Block, 2015). For instance, the United States Government has given relatively large amounts of funding to companies in the defence and biotechnology sectors but very little to companies in other economic sectors (Allen, 2013). Thus, the role of the United States Government in the economy varies from sector to sector and reflects the economic priorities of the federal government.

Applied to HCMs, sectoral heterogeneity suggests that HCMs within a national economy are likely to vary substantially across sectors, reflecting the economic preferences of the central government (Sauvant et al., 2014). In other words, political processes will shape which economic sectors will have HCMs and which will not, as well as the characteristics of any HCMs in different sectors. This suggests that in order to explain the likely impact of HCM variation we need, first, to understand whether national institutions are directed towards the support of particular sectors of the economy (Sauvant et al., 2014).

Moreover, national institutions are likely to influence the form of HCMs in particular sectors. For instance, depending on the sector, HCMs may be more direct or indirect. Similarly, institutional variation may result in the eligibility and conditionality criteria that are attached to HCMs being designed to promote the OFDI strategies of firms in specific sectors. In the latter case, an HCM may apply generally to all firms in a country but may be relevant only for some of them, perhaps those with limited financial resources or no experience of investing overseas. Similarly, firms that apply for and receive such support may vary systematically from those that

do not (Torres et al., 2016). Furthermore, if firms must meet certain criteria to be eligible for HCMs, this may reinforce dominant firm types within an economy, so that firms in strategically important sectors benefit the most from HCMs (Sauvant & Chen, 2014).

Even though the United States Government tends to operate at arm's length from individual firms and sectors, as noted above, some sectors receive federal funding to promote their growth. In addition, although the federal government does not have high-profile policies to promote domestic firms' OFDI, the Overseas Private Investment Corporation (OPIC), a self-sustaining federal government agency, has a remit to help United States businesses invest in emerging markets. By doing so, it seeks to promote, inter alia, United States foreign policy and national security priorities. In 2017, OPIC lent $630 million to foreign energy projects that involved United States companies, Approximately 90 per cent of this money went to renewable-energy initiatives (Groom, 2018). Hence, even in the United States, which is typically viewed as an arm's length state, some funds are available to promote investment abroad and those funds can benefit certain economic sectors more than others. Building on this empirical evidence as well as on the theoretical arguments outlined above that indicate that firms' institutional specificities are important and that actors and institutions co-constitute each other, we put forward the following proposition:

P4: Countries' HCMs are more relevant to some economic sectors than others.

As noted above, the role of the state will influence how extensive and targeted HCMs are. However, this does not mean that arm's length states will not have any HCMs. It is therefore important to conduct analyses of particular sectors to determine how HCMs influence OFDI. Such policies may not play a major role in influencing OFDI in general for a country, but could be significant in some sectors and for some host countries. A specific hypothesis that follows from this is that, in arm's length states, HCMs are likely to moderate the relationship between firms and their OFDI in those sectors that the HCMs apply to, but not other sectors that do not have any HCMs.

4. Conclusion and policy implications

Compared with how state ownership influences OFDI, HCMs have received limited attention in the international business literature. Although international business research has started to theorize how home-country institutions enable and constrain EMNCs' OFDI, relatively little work has attempted to provide a systematic account of HCMs and their effects on OFDI.

We have sought to fill that gap by putting forward a series of general propositions and more focused potential hypotheses on the links between HCMs and patterns

of OFDI. By doing so, this paper makes three theoretical contributions. First, it suggests that research should consider HCMs holistically, as individual measures are likely to interact with other HCMs; these interactions could increase or impede or, by cancelling each other out, not affect OFDI. Second, our research indicates that HCMs may have a direct influence on OFDI, and, as HCMs vary between different state types, this effect is likely to be greater in developmental states than it is in arm's length ones. We have, therefore, identified an important source of HCM variation, which in turn is likely to affect OFDI. At present, much of the existing literature downplays how HCMs vary across countries, focusing instead on variation in general. As a result, we seek to provide a theoretical grounding for HCM variation. Finally, our work provides some boundary conditions about when HCMs are likely to influence OFDI. In particular, targeted HCMs in countries in which the state typically plays an arm's length role in the economy, such as the United States and the United Kingdom, are likely to apply to firms in a small number of sectors and their investments in a few host countries, potentially only emerging-market economies. Hence HCMs in some countries are only relevant for particular sectors and some host countries; they do not apply to all sectors and all host countries.

In addition, the theoretical implications of our work have consequences for policymakers and for future research to assess the impact of HCMs on OFDI. First, our research suggests that policymakers and researchers should consider the effects of HCMs holistically and sectorally. In other words, HCMs are likely to target specific sectors, so assessments of their effects must focus on those sectors (Fiedler & Karlsson, 2016). In addition, such assessments must examine HCMs collectively – as configurations or "packages" – rather than as individual measures to support OFDI, meaning that the interactions between specific HCMs will influence their effects on firms. This will complicate those assessments. Creating models to examine how the effect of one HCM varies according to the presence (or absence) of other HCMs is likely to require (1) information at the firm level to know which HCMs they use and how they use them, and (2) analytical techniques that can assess how configurations of (or the interactions between) various HCMs influence OFDI.

Second, our work suggests that HCMs may alter the strategic priorities of companies, influencing where they do and do not invest abroad. Indeed, in many instances, this is the raison d'être of HCMs. Assessing their net benefits is, therefore, important. For instance, HCMs may boost domestic firms' OFDI in specific countries, but they may reduce it in others. The effects of that shift in OFDI location may have long-term implications for the international competitiveness of domestic companies that policymakers must consider. This has implications for future research, as it suggests that some OFDI may be diverted away from some countries and into others. It also indicates a need to better understand the motives to invest abroad as a means, in part, to meet political objectives and conform to expectations.

Third, HCMs may merely, in some instances, subsidize domestic firms' OFDI that they would have undertaken in the absence of HCMs. Such assessments of the effects of HCMs may be particularly important when examining the link between HCMs, OFDI and socioeconomic development in emerging economies. As we discussed above, a United States government agency, OPIC, seeks to combine OFDI promotion with United States foreign policy objectives and socioeconomic development in emerging economies; yet, analyses of OPIC, its HCMs and its effects on socioeconomic development in emerging economies are rare.

Finally, if HCMs seek to promote OFDI, as well as potentially inward FDI (Buzdugan & Tüselmann, 2018), as a means to enhance domestic companies' competitiveness by enabling them to tap into resources abroad that are not available at home (Ibeh, 2018), policymakers and managers need to be aware of the challenges that operating across multiple sites will create within one organization (Whitley, 2010b). Integrating and coordinating activities that are geographically dispersed, to create and sustain competencies within a single organization, an MNE, is likely to pose significant organizational and managerial challenges (Gilmore, Andersson & Memar, 2018; Narula, 2014; Rugman & Verbeke, 1993; Whitley, 2005b). Companies will need to be able to develop organizational capabilities to surmount these, potentially affecting how employees in different locations are managed and how extensive organizational careers for different types of employees can be (Whitley, 2005b). For instance, domestic firms that acquire leading technical or scientific capabilities abroad need to ensure that those highly skilled employees who help to constitute key capabilities stay with the firm. To do so, domestic firms may need to open up senior managerial positions to employees from abroad; this may not always be easy (Allen et al., 2018; Whitley, 2012). Consequently, policymakers, if they implement HCMs to improve domestic firms' competitiveness, will have to assess how well HCMs actually enable those firms to create new capabilities or extend existing ones rather than simply whether or not firms use HCMs (Knoerich, 2015). In short, encouraging domestic firms to invest abroad may be one thing; ensuring that they use that investment to boost their competitiveness another. Policymakers will, therefore, need to ensure that they have the means to assess firms' capabilities if they wish to use HCMs to boost domestic firms' competitiveness. Future research can help to provide the basis of that assessment.

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Factors contributing to the strength of national patent protection and enforcement after TRIPS

Nikolaos Papageorgiadis, Chengang Wang
and Georgios Magkonis*

In this paper we study the determinants of the strength of patent enforcement in 43 member countries of the World Trade Organization (WTO) between 1998 and 2011, a period after the signing of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. We do so by building on and expanding the seminal work of Ginarte and Park (1997) on the pre-TRIPS determinants of patent rights in the years 1960-1990. We find that in the years after TRIPS was signed, the strength of patent enforcement of a country is positively determined by two variables that signify the usage of the patent and intellectual property system, the number of patent and trademark applications. We also find that the level of research and development expenditure, the quality of human capital, and the level of development of a country have positive effects on the strength of the enforcement of patent law in practice. Intellectual property rights enforcement is one of the key investment-related policies included in the United Nations Conference on Trade and Development (UNCTAD) Investment Policy Framework for Sustainable Development. Identifying the determinants of strong patent systems will help policymakers at the national and supranational levels to design and implement effective policies that strengthen national patent systems, thereby enhancing economic benefits such as greater levels of commercialization of intangible assets and greater levels of international trade and investment.

Keywords: patent rights; patent system; patent law; patent enforcement; TRIPS

1. Introduction

The signing of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement in 1994 was a key milestone and turning point for the evolution of stronger patent systems in World Trade Organization (WTO) member countries. The TRIPS agreement set the minimum regulatory standards of intellectual property (IP) protection with an aim to "reduce distortions and impediments to international

* Nikolaos Papageorgiadis is with the University of Liverpool & Uppsala University, Chengang Wang with the University of Bradford and Georgios Magkonis with the University of Portsmouth. The corresponding author is Nikolaos Papageorgiadis (n.papageorgiadis@liverpool.ac.uk)

trade" (WTO, 2018). This was because the strength of a country's patent system is an important factor that affects international investments by influencing e.g. the level and extent to which transnational corporations consider investing in and transferring advanced technological assets to a host country (UNCTAD, 2010, 2013, 2015). Effective national patent systems comprise of two components: (a) the strength of patent law on the books, and (b) the strength of the enforcement of patent law in practice (Papageorgiadis and McDonald, 2019). Since the signing of TRIPS, patent law protection in developed and developing WTO member countries has strengthened significantly and become more harmonized (Taubman et al., 2012). While differences in patent legislation do exist, the divergence, especially in terms of minimum standards, is not as wide as it used to be prior to the signing of TRIPS (Park, 2008).

In contrast, the implementation of the TRIPS agreement did not affect the levels of strength of the enforcement of patent law in practice, in the way that this is e.g. applied by public enforcement agents (Brander et al., 2017). Although the TRIPS agreement set clear requirements for the inclusion of specific enforcement procedures in the legislative frameworks of countries, it did not set obligations on how effectively patent law should be enforced in practice (WTO, 2018). Therefore, although a strong patent legislative framework may exist in the post-TRIPS patent system of a particular country, these laws may not be enforced in practice by public enforcement agents (Arora, 2009). As a result there are still wide differences in the levels of patent enforcement strength between countries (Papageorgiadis et al., 2014), and these differences have now become the dominant factor of the divergence between the patent systems of WTO member countries after the signing of TRIPS (Correa, 2009; Fink, 2009). In fact, weak levels of patent enforcement strength are commonly identified as an impediment to international trade and investment, turning the levels of patent enforcement strength into a common area of discussion in bilateral and multilateral trade negotiations (Papageorgiadis et al., 2014; Alexiou et al., 2016). For example, in the recent trade dispute between the United States and China, the Trump administration announced "plans for a 25 per cent tariff on 1,333 Chinese products ranging from industrial robots to locomotives in retaliation for what it said had been decades of state-backed [IP] theft by Beijing" (Financial Times, 2018).

Identifying the key factors that contribute to the strengthening of patent law protection and enforcement can help policymakers design and implement effective policies that will strengthen the patent system of their country or region. Strengthening a country's patent system to a level that is compatible with a country's development and technological capabilities is desirable as this is expected to boost economic growth, by attracting higher levels of foreign direct investment (FDI) and innovation, and lead to greater levels of commercialization of intangible assets (Pereira, 2006; UNCTAD, 2015). For instance, the strength of the United Kingdom's IP system has

enabled growth in IP-protected intangible assets investments from £47 billion in 2000 to £70 billion in 2014 (UK IP Office, 2017). The potential benefits of strong patent systems have motivated the IP offices of some countries to design detailed strategic actions with an aim to improve their IP systems. Such was the case with the 10-year IP master plan of Singapore, which initiated policies that can enable Singapore to strengthen its IP system and become an IP hub in the region. The reforms it implemented involved giving research and development (R&D) incentives to small and medium-sized companies, upgrading the IP capabilities and expertise of the local workforce, and boosting the number of patent applications in the country (Government of Singapore and Intellectual Property Office of Singapore, 2017). Similarly, China's 12th five-year plan (2011-2015) incentivized Chinese firms to make use of the patent system by subsidizing the cost of patent applications (U.S.-China Economic and Security Review Commission, 2011). The main expectation for such subsidies is that as the number of patent owners in a country rises, this will increase the pressure on public patent enforcement agents to enforce patent law more effectively in practice (Yang et al., 2004). The outcome of such initiatives takes time to materialize, and therefore the transition of a country's patent system from weak to strong is expected to take years or even decades (Peng et al., 2017).

The determinants of patent protection strength was the focus of the seminal work by Ginarte and Park (1997), which has been cited more than 1,500 times according to Google Scholar.[1] They investigated the determinants of patent protection of 110 countries in 1960-1990, a time period prior to the signing of the TRIPS agreement, and found that R&D activity, market freedom and openness were important determinants of the strength of national patent law protection as it appears on the books. In other words, these three factors were important characteristics of countries that offered strong patent law protection pre-TRIPS. However, two decades after the publication of Ginarte and Park's study, and after the signing and implementation of TRIPS, patent systems have evolved considerably, and there is no updated empirical evidence regarding the determinants of (a) the strength of patent law protection, and (b) the strength of the enforcement of patent law in practice in the post-TRIPS period.

In this research note we update and expand the study by Ginarte and Park (1997) and make two contributions to the international business literature studying patent systems. First, we study the previously unidentified determinants of the strength of enforcement of patent law in practice for 43 WTO member countries in the post-TRIPS years, 1998-2011. We follow the same methodology as Ginarte and Park; however, we use the composite index of patent systems strength developed by Papageorgiadis et al. (2014) to approximate for the strength of the enforcement

[1] 1,568 citations as of November 2018.

of patent law in practice (Ahammad et al., 2018; Papageorgiadis et al., 2019).[2] We find strong and consistent evidence that higher numbers of patent and trademark applications filed in a country have a significantly positive effect on the strengthening of the enforcement of patent law in practice. In addition, we find that R&D expenditure, the level of economic development and the quality of human capital also stimulate the strengthening of patent enforcement. Second, we update the Ginarte and Park study by investigating the determinants of the strength of protection of patent law in the period after TRIPS. We find consistent evidence that the level of R&D expenditure in a country and the level of economic development continue to be two important determinants of the strength of patent law in WTO member countries in the post-TRIPS time period. We also find evidence to suggest that the quality of human capital in a country is a new post-TRIPS determinant of the strength of patent law.

In the next section, we briefly discuss the two complementary measures used as proxies for two distinct aspects of the strength of patent systems, the strength of patent enforcement and the strength of patent law on the books (Papageorgiadis and Sharma, 2016). Following the Ginarte and Park (1997) empirical approach, in section three we present the empirical model, estimation, and variables applied and focus the discussion on the additional (contemporary) variables that we incorporated in the estimation. We provide the results and discussion of the findings in section four. In section five, we discuss the policy implications of the study and make suggestions for future research.

2. Measures

The dependent variable for the estimation of the determinants of the strength of patent law is the version of the Ginarte and Park (1997) index updated by Park (2008). This version of the index is the most widely used in empirical studies in the literature. The scores of the Park (2008) index capture the availability of patent-related legislation that enables the functioning of a patent system. The index is composed of five components that capture the (i) granting of patent rights for specific innovations, (ii) signatory status of a country to international treaties that are relevant to patent rights (such as TRIPS), (iii) duration of protection for the patent rights granted, (iv) availability of legal mechanisms that can enable the enforcement of patent rights and, (v) legislation that can potentially restrict patent rights. The unweighted sum of these five components determines the overall score for each of the countries included in the index.

[2] The index of Ginarte and Park and its update by Park (2008) measure the strength of patent law protection in a country but not the strength of patent enforcement (Brander et al., 2017).

We use the index by Papageorgiadis et al. (2014) as the dependent variable for the estimation of the strength of the enforcement of patent law in national patent systems in practice. It is important to note that the fourth component of the Ginarte and Park (1997) index, which captures the availability of legislation that can enable the enforcement of patent rights, has been commonly misperceived as a measure of patent enforcement strength (Arora, 2009; Brander et al., 2017). In fact, as Park (2008, p. 761) highlights in the latest update of the index: "This index was designed to provide an indicator of strength of patent protection, not the quality of patent systems". In contrast, the Papageorgiadis et al. (2014) index uses both reports and perceptions of effectiveness to measure the strength of the enforcement of patent law in practice in the time period since the signing of TRIPS (Papageorgiadis and McDonald, 2019). It is the only longitudinal index to do so, and in so doing, this composite indicator measures the strength of eight enforcement-related components of national patent systems, thereby providing the most comprehensive approximation for the overall strength of enforcement of patent law in practice in the literature.

Papageorgiadis et al. (2014) developed the index following methodological recommendations from the Organization for Economic Co-operation and Development (2008). The authors applied a transaction cost rationale to map how ineffective enforcement activities, administration, and governing of enforcement-related aspects of a national patent system increase the transaction costs that patent owners face in 48 countries. The index scores are derived using secondary data that proxy for three types of transaction costs: (a) the servicing costs faced by patent owners in terms of the quality of patent administration in a given country, (b) the property rights protection costs incurred as a result of the ineffectiveness of the judiciary and the judicial process in a country, and (c) the monitoring costs that originate from the ineffectiveness of public and private agencies (e.g. police and customs) in enforcing patent rights, as well as the overall societal attitudes towards the enforcement-related aspects of patent rights which dictate the acceptability of enforcement actions in a given country.

3. Empirical model and estimation

As noted, the empirical approach of this research note follows the Ginarte and Park (1997) study. However, the difference is that we consider the determinants of the strength of patent law as well as the determinants of the strength of patent enforcement. The estimation is based on a panel of 43 WTO member countries for the period 1998-2011, and the estimation model can be written as follows:

$$y_{it}=a+x_{it}+u_{it} \qquad (1)$$

where y is the proxy of the strength of either patent law (first set of regressions, focusing on the determinants of the strength of patent law only) or the enforcement of patent law in practice (second set of regressions, focusing on the determinants of the strength of the enforcement of patent law in practice), x is the vector of all explanatory variables, lagged by one year to control for potential endogeneity (except for political freedom) and u_{it} is the error term.[3] With regards to the explanatory variables, we include the same variables as those used by the Ginarte and Park (1997) study in all specifications. These are (i) GDP per capita, to proxy for the level of economic development (World Bank, 2015a); (ii) R&D expenditure as a percentage of GDP (World Bank, 2015b); (iii) secondary education enrolment rate, to proxy for the quality of human capital (World Bank, 2015c); (iv) the Index of Economic Freedom, to proxy for the level of market freedom in a country (Heritage Foundation, 2015); (v) the sum of volume of exports and imports of a country over GDP, to proxy for the openness of the economy (World Bank, 2015d, 2015e), given that the data of Sachs et al. (1995) used by Ginarte and Park have not been updated with contemporary values; (vi) the political rights data made available by the Freedom House (2015), to proxy for political freedom as the political freedom data of Barro and Lee (1994) (used by Ginarte and Park, 1997) are not available for any of the years considered in our study.

Further to the variables included in the Ginarte and Park (1997) study, we also take into account the potential effects of three additional variables which have become increasingly important in the time period studied. First, we consider the potential effects of the number of patent applications per capita and the number of trademark applications of residents and non-residents (WIPO, 2015). Higher levels of patent and trademark applications in a country indicate the desire of local and foreign companies to gain protection for their IP, as well as to (potentially) effectively enforce their legal rights in practice (Desyllas and Sako, 2013). Higher levels of patent and trademark applications in a country are therefore expected to have a positive effect on the strength of patent law and the strength of the enforcement of patent law in practice. Second, we use a proxy measure for the level of foreign direct investment (FDI), defined as the sum of foreign assets and liabilities as a ratio of GDP (World Bank, 2015f). This is because FDI commonly involves the transfer of technology

[3] Our data set consists of the following countries: Argentina, Australia, Austria, Belgium, Canada, Chile, China, Colombia, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Malaysia, Mexico, the Netherlands, New Zealand, Norway, the Philippines, Poland, Portugal, the Republic of Korea, Romania, Russian Federation, the Slovak Republic, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey and the United Kingdom. The number of countries included in our estimations is determined by the availability of data of the Papageorgiadis et al. (2014) index, which provides annual index scores for the years 1998-2011, for a maximum of 43 countries. Our data set therefore includes 43 countries whereas the Ginarte and Park (1997) data set included 48.

from the headquarters of a company to a subsidiary in the host market (Dunning and Zhang, 2008). Foreign firms frequently apply pressure to local governments to strengthen patent law and the enforcement of patent law in practice, so that they can retain the same business model as the one used in their home country and successfully appropriate the returns from their innovations in the host country (Zhang et al., 2010).

Table 1 and figure 1 summarise the description of the variables together with the measures used and the sources of the data. Table 2 provides the descriptive statistics and Table 3 the correlation coefficients matrix.[4]

Table 1. Variable description, measurement and sources

Variable	Description/Measurement	Data Source
Patent law strength	Index by Park (2008)	Park (2008)
Enforcement strength of patent law	Index by Papageorgiadis et al. (2014)	Papageorgiadis et al. (2014)
GDP per capita	Logarithm of real GDP per capita	World Bank (2015a)
R&D / GDP	% of research and development expenditure over GDP	World Bank (2015b)
Secondary enrolment	% of population that it is enrolled in secondary schools	World Bank (2015c)
Political freedom	Measure of political risk in which higher values indicate a riskier environment	Freedom House (2015)
Market freedom	Measure of market freedom in which higher values indicate more freedom in business transactions	Heritage Foundation (2015)
Openness	Sum of volume of exports plus imports over GDP	World Bank (2015d, 2015e)
Trademark applications per capita	Logarithm of applications to register a trademark with a national or regional intellectual property (IP) office over population	WIPO (2015)
FDI / GDP	Sum of foreign assets and liabilities over GDP	World Bank (2015f)
Patent applications per capita	Logarithm of worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention over population	WIPO (2015)

[4] To consider the potential for multicollinearity, we conducted the variance inflation factor test for all specifications. The scores are all below 10, indicating that multicollinearity is not a concern.

Figure 1. Determinants of strength of patent law and strength of patent law enforcement

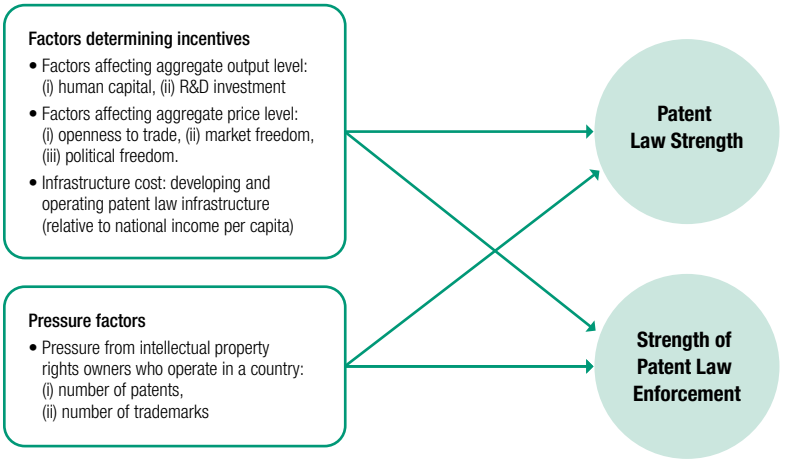

Table 2. Descriptive statistics

Variable	Mean	SD	Min	Max
Patent law strength	3.987	0.662	1.08	4.67
Enforcement strength of patent law	6.42	2.126	2.6	9.9
GDP per capita	9.486	1.191	6.271	11.124
R&D / GDP	1.441	1.082	0.01	4.835
Secondary enrolment	96.747	13.476	42.298	160.619
Political freedom	1.804	1.475	1	7
Market freedom	74.213	12.979	36.3	100
Openness	88.083	57.086	18.756	446.754
Trademark applications per capita	0.046	0.099	0.002	1.307
FDI / GDP	0.817	1.153	0.04	11.034
Patent applications per capita	0.05	0.074	0.004	0.355

Table 3. Correlation coefficients

	Patent law strength	Enforcement strength of patent law	GDP per capita	R&D / GDP	Secondary enrolment	Political freedom	Market freedom	Openness	Trademark applications per capita	FDI / GDP	Patent applications per capita
Patent law strength	1										
Enforcement strength of patent law	0.525	1									
GDP per capita	0.679	0.834	1								
R&D / GDP	0.493	0.662	0.664	1							
Secondary enrolment	0.622	0.671	0.755	0.542	1						
Political freedom	-0.502	-0.563	-0.661	-0.39	-0.533	1					
Market freedom	0.385	0.684	0.682	0.401	0.461	-0.484	1				
Openness	-0.072	0.136	0.111	-0.099	-0.087	-0.036	0.266	1			
Trademark applications per capita	0.479	0.025	0.407	0.169	0.299	-0.209	0.494	0.353	1		
FDI / GDP	0.159	0.343	0.309	0.057	0.082	-0.204	0.424	0.779	0.368	1	
Patent applications per capita	0.643	0.368	0.646	0.634	0.461	-0.346	0.545	0.131	0.532	0.225	1

4. Results

Given the presence of country heterogeneity in our sample, we adopted a panel data analysis approach. In the first set of regressions (table 4) we use the Park (2008) index, which proxies for the strength of patent law as our dependent variable. Subsequently, we repeat the same set of estimations (table 5) using the Papageorgiadis et al. (2014) index, which proxies for the strength of enforcement of patent law in practice. We applied the feasible general least squares estimator, controlling for panel heteroscedasticity and first-order autocorrelation. The common characteristic of the three specifications is that we always include the proxies of the variables originally used in the Ginarte and Park (1997) study. Our specifications consider the variables included in that study together with two or all three of the contemporary variables discussed in section three. More precisely, the first specification (column 1) includes all the variables considered by Ginarte and Park (1997) plus FDI and trademark applications per capita. The second specification (column 2) replaces trademark applications per capita with patent applications per capita. The third estimation (column 3) includes all variables considered in our study.

Table 4. Regression results for the determinants of the strength of patent law

	(1) Patent law strength	(2) Patent law strength	(3) Patent law strength
GDP per capita	0.358***	0.349***	0.376***
	[0.0315]	[0.0290]	[0.0323]
R&D / GDP	0.0556***	0.0573**	0.0535**
	[0.0215]	[0.0233]	[0.0214]
Secondary enrolment	0.00149*	0.00232***	0.00173**
	[0.000869]	[0.000820]	[0.000861]
Political freedom	0.00398	0.00522	0.00348
	[0.00999]	[0.00939]	[0.0100]
Market freedom	-0.00231***	-0.00197***	-0.00218***
	[0.000684]	[0.000652]	[0.000679]
Openness	-0.000558	-0.000621*	-0.000593*
	[0.000359]	[0.000345]	[0.000356]
Trademark applications per capita	-0.440***		-0.270*
	[0.137]		[0.158]
FDI / GDP	0.0183	0.0256*	0.0205
	[0.0157]	[0.0145]	[0.0155]
Patent applications per capita		-0.409	-0.705**
		[0.310]	[0.316]
Constant	0.498*	0.495*	0.333
	[0.285]	[0.269]	[0.293]
LR (Heteroscedasticity) Test	559.12***	621.70***	568.09***
Wooldridge (Autocorrelation) Test	2012.432***	1000.628	961.833***
No. of observations	546	559	546

1. Standard errors in brackets.
2. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
3. Feasible general least squares estimator is applied, assuming a heteroskedastic error structure with no cross-sectional correlation and AR(1).

Table 5. Regression results for the determinants of the strength of patent law enforcement in practice

	(1) Enforcement strength of patent law	(2) Enforcement strength of patent law	(3) Enforcement strength of patent law
GDP per capita	0.956*** [0.0613]	1.179*** [0.0705]	0.929*** [0.0599]
R&D / GDP	0.427*** [0.0642]	0.246*** [0.0642]	0.373*** [0.0668]
Secondary enrolment	0.00516** [0.00231]	0.00876*** [0.00212]	0.00542** [0.00225]
Political freedom	-0.0380 [0.0239]	-0.0347 [0.0222]	-0.0389* [0.0227]
Market freedom	0.00194 [0.00216]	0.00392** [0.00199]	0.00196 [0.00216]
Openness	0.0000661 [0.000849]	0.00100 [0.000741]	-0.000152 [0.000816]
Trademark applications per capita	0.164*** [0.0305]		0.140*** [0.0304]
FDI / GDP	0.0950*** [0.0328]	0.0154 [0.0283]	0.0849*** [0.0306]
Patent applications per capita		0.0617* [0.0319]	0.113*** [0.0321]
Constant	-3.105*** [0.513]	-5.641*** [0.619]	-2.393*** [0.524]
LR (Heteroscedasticity) Test	419.53***	435.53***	460.28***
Wooldridge (Autocorrelation) Test	68.179***	73.159***	69.278***
No. of Observations	546	559	546

1. Standard errors in brackets.
2. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
3. Feasible general least squares estimator is applied, assuming a heteroskedastic error structure with no cross-sectional correlation and AR(1).

4.1 Determinants of the strength of patent law

The results of the estimations focusing on the determinants of the strength of patent law reveal that two pre-TRIPS determinants identified in the Ginarte and Park (1997) study continue to be significant in the era since the signing of TRIPS. More specifically, similar to the finding of Ginarte and Park (1997), we find evidence that the GDP per capita and R&D expenditure have a positive and significant effect on the strength of patent law protection. The logarithm of real GDP is positive and statistically significant at 1 per cent in all specifications, and the same positive sign is also found for the R&D expenditure ($p < 5\%$) variable. Therefore, similarly to the situation in the pre-TRIPS years, the level of economic development and the amount

of funds invested in R&D activities are significant factors that help strengthen patent law protection in all countries in our sample. In addition, while Ginarte and Park (1997) found the secondary enrolment variable to have an insignificant effect, we find that in the years since the signing of TRIPS the quality of human capital has a highly significant positive effect on the strength of patent law ($p < 1\%$). Together, these three aspects of a national economy can help create an ecosystem in which firms can develop higher-quality intellectual assets that require the granting of patent rights so that firms can successfully appropriate the returns on their innovations.

We also find that the variables for market freedom, openness and trademark applications per capita have a negative effect on the strength of patent law protection, with the effect of market freedom being significantly negative ($p < 1\%$) in all specifications. The results for market freedom and openness are contrary to the results of the Ginarte and Park (1997) study. This finding reveals that the positive association between these two factors and patent law strength since the TRIPS signing has been reversed. This might have been caused by the fact that TRIPS helped to solve the international coordination problem but at the same time induced countries to move away from e.g. the Nash equilibrium degree of IP protection that would be predicted by a structured model of trade and innovation (Grossman and Lai, 2004). In addition, we found that the three variables of political freedom, FDI and patent applications per capita have limited to no statistically significant effect across all three estimations (with the exception of FDI in one of the specifications). The insignificant effect of the political freedom variable is consistent with the results of Ginarte and Park (1997). In contrast, FDI levels and patent applications per capita are found to have no significant effect on the strength of patent law. This could be because the levels of FDI and numbers of patent applications can be mainly considered not as determinants but as outcomes, whose size depends on the strength of patent law. Indeed, there is consistent evidence that strengthening levels of patent law attract higher levels of FDI and lead to more firms seeking to formally register their patent rights in the country (Ushijima, 2013).

4.2 Determinants of the strength of patent enforcement

The results of all estimations on the determinants of the strength of enforcement of patent law in practice reveal the significant effect of two different factors compared with those influencing the strength of patent law protection. The results show that the number of patent and trademark applications in a country has a significant positive effect ($p < 1\%$) on the strength of patent enforcement in almost all specifications. Whereas the number of patent and trademark applications was not found to affect the strength of patent law protection, the ability of patent owners to register and gain patent and trademark rights for the innovations that they commercialize in a country was found to positively affect patent enforcement

strength. This may be because higher volumes of intellectual asset ownership in a country could increase the number of requests that public patent enforcement agents receive, potentially leading them to increase their efforts, become more effective and achieve stronger enforcement of patent law in practice (Desyllas and Sako, 2013). This is not the case for the strengthening of patent law protection, given that the assigning of patent and trademark rights is an output of patent law protection and that most countries already offer TRIPS-level minimum standards of legal protection.

The three determinants of the strength of patent law since the TRIPS signing, however, were consistently found to have a strong determinant effect on the strength of patent enforcement. GDP per capita, R&D expenditure and secondary school enrolment consistently had a highly significant positive effect ($p < 1\%$) on the strength of the enforcement of patent law in practice. This important finding showcases that the determinants of the two aspects of the patent systems of countries in the years after the signing of the TRIPS agreement were positively affected by similar economic factors. Contrary to these three factors, the results of the estimations highlight that the remaining four variables have an insignificant effect on the strength of patent enforcement. We found no evidence that the variables of political freedom and openness have any significant effect. These results were consistent across all estimations. We also found evidence in only one out of three estimations that market freedom had a significant effect on the strength of patent enforcement. Finally, the FDI variable was found to be statistically significant and positive in two out of three estimations. Therefore, there is some evidence that FDI might have a positive effect on the strength of enforcement of patent law in practice.

5. Conclusions

Twenty years after the publication of the seminal study by Ginarte and Park (1997) on the determinants of the strength of patent systems, we revisited and expanded their work using data for the post-TRIPS signing time period of 1998-2011. In so doing, we made two contributions to the literature. First, we expanded the focus of the Ginarte and Park (1997) study by considering the determinants of the strength of the enforcement of patent law in practice. The results revealed an important insight on what factors influence the strength of patent enforcement in a country, in that the number of patent and trademark applications has a positive effect on the strength of patent law in practice. This result suggests that the higher the number of IP owners (in the form of ownership of patent or trademark rights) who attempt to commercialize their rights in a country, the higher the likelihood that they will apply pressure on public enforcement agents to effectively enforce their rights in a country. Furthermore, we find that higher levels of GDP per capita, R&D

expenditure and quality of human capital in a country also have a significantly positive effect on the strengthening of patent enforcement. Importantly, all five variables found to determine the strength of patent enforcement are variables that capture the level and quality of economic and social activity in a country, instead of more general variables that relate to e.g. the openness of an economy and political conditions.

Second, we study the determinants of the strength of patent law, focusing on the time period since the signing of TRIPS, which was not captured in the study of Ginarte and Park (1997). We find that the two main determinants that were significant in the Ginarte and Park (1997) study, the level of development of a country and R&D expenditure, continue to have a positive effect on the strength of patent law. In addition, we find that the quality of human capital has a positive effect on the strength of patent law of a country. These are important findings that confirm the contemporary relevance of the Ginarte and Park (1997) study as well as highlight that some of the key determinants of strengthening levels of patent law continue to be the same as prior to the signing of TRIPS. Importantly, we also find that other variables which relate to the general economic and political conditions of a country such as market freedom, political freedom and openness do not have the expected effect on the strength of patent law anymore. The results showcase that after the signing of the TRIPS agreement, variables that relate to the general stance toward trade and the openness of a country no longer affect the strength of patent law, whereas variables that outline the footprint of the level and quality of economic and social activity in a country are important determinants.

This paper offers a statistical analysis of determinants of the strength of patent enforcement at the national level. To develop better understanding of how patent enforcement can be strengthened, future research could devote effort in the following areas. First, researchers could develop case studies to identify the dynamics and mechanisms with which patent and trademark users from different industries and countries influence the development of stronger patent enforcement. For example, anecdotal evidence suggests that in the pre-TRIPS years, the global pharmaceutical industry was influential in lobbying for the strengthening of patent law internationally. The results of our study suggest that in the years after TRIPS, patent and trademark users from a variety of different industries may have influenced the strength of patent enforcement. Second, and related to the above, as more firms become active users of patents and trademarks in a country, future research could analyse the educational activities undertaken by the national IP Offices to support firms in managing, protecting and creating value from their IP and in exploring and exploiting the value of IP owned by others, legally and ethically. Such studies could identify the effect of different educational activities in stimulating IP usage and identify the best educational practices to help develop patent enforcement strength in other countries.

6. Policy implications

The findings of this study have two important implications for policymakers at the national and supranational levels. First, the results suggest that policymakers who aim to strengthen patent enforcement activities need to take actions to educate and incentivize innovative firms to become familiar with and seek to protect their rights in the country. As UNCTAD (2015, p. 65) highlights in its Investment Policy Framework for Sustainable Development report, "As national investors are frequently less aware of their IP rights, they should be sensitized on the issue". Indeed, increasing the number of firms who actively engage with the patent and IP systems of the country will increase the number of firms who seek to commercialize their newly granted IP rights and who will monitor the market to identify when their rights are infringed by competitors. After identifying the infringement of their rights, the new IP owners as well as their collective industry associations will in turn apply pressure on the public patent enforcement agents who are responsible for enforcing patent law in practice (Yang et al., 2004).

A successful example of providing incentives that aim to increase the number of users of a patent system at the national level is found in the targets of China's 12th five-year plan (2011-2015), which aimed to upgrade the capabilities of the Chinese manufacturing sector through scientific development. One of the targets was focused on providing monetary incentives to patent applicants, with an aim of increasing the number of patents in the country from 1.7 to 3.3 patents per 10,000 people in the time period (U.S.-China Economic and Security Review Commission, 2011). This target equalled a 100 per cent increase in the numbers of patents granted. It aimed to enable Chinese firms to become familiar with the benefits of the Chinese patent system and to upgrade their manufacturing capabilities by commercializing their registered innovations (U.S.-China Economic and Security Review Commission, 2011). Indeed, now that the number of patent applications and patents granted in China has risen exponentially over the last years, one of the next areas of focus identified in the Chinese government's 13th five-year plan period is to "ensure strict IPR protection" (SIPO, 2016). Policymakers from other countries could provide similar monetary incentives to the Chinese ones, in order to expand the number of users of their patent system, since in the long term, this is expected to lead to the strengthening of patent enforcement in a country.

At the supranational level, policymakers could also consider providing indirect monetary incentives that can incentivize patent activity, by exploring ways to expand the country coverage of patent protection and (if possible) adopt a regional fee structure for the filing and renewal of patents in a group of countries. For example, the European Patent Office is planning to launch the "Unitary Patent" in 2019, a new form of patent protection that allows IP owners to receive uniform patent protection in 26 member countries of the European Union (EU) for a significantly reduced fee

(EPO, 2018a). The unitary patent is expected to relieve innovators of the validation, translation and maintenance costs of patents in each of the 26 EU countries, at a reduced fee that covers patent protection in all countries. The overall registration and maintenance cost of a unitary patent for 20 years is expected to be €35,555, whereas the equivalent cost of patent registration and maintenance in each of the 26 countries would be €169,667, a projected saving of €134,112 per patent (EPO, 2018b).[5] The European Patent Office (EPO) also provides subsidies for small and medium enterprises (SMEs) and public research organizations, to incentivize them to register their rights (EPO, 2018a). National IP offices in other regions could follow the EPO's example and explore potential collaboration with neighboring countries and make it easier for patent owners to efficiently and cost-effectively receive patent protection in neighboring countries. The Chinese State IP Office has signed agreements with neighboring IP offices such as that of Cambodia, which agreed to validate Chinese patents as of 28 March 2018, and that of the Lao People's Democratic Republic, which agreed to recognize the Chinese patent examination results (Xinhua News, 2018a, 2018b). Such agreements further incentivize patenting activities by Chinese firms as patenting in China can enable the firms to easily expand their protection to other countries in the region.

With regard to the second recommendation, the findings of this study suggest that policymakers should aim to increase overall levels of R&D expenditure and invest in improving the quality of human capital in their country, since both will boost their country's innovation capability, which in turn leads to increased demand for stronger patent enforcement. This is in line with UNCTAD's Investment Policy Framework for Sustainable Development report (2015, p. 42), which highlights that "businesses are more likely to invest resources in R&D and technological upgrading if their innovations are protected". Therefore whereas our first recommendation focused on increasing the capacity of IP owners in a country, our second recommendation focuses on increasing the quality of the innovation outputs of IP owners. Investing in these two factors is expected to enable firms to engage with higher-level and more advanced technologies that are more likely to require an effective patent system, so that patent owners can successfully commercialize their assets (UNCTAD, 2014).

Policymakers can consider incentivizing firms to invest more in R&D, particularly at the early experimental stages of research, which are riskier but, if successful, are expected to lead to the development of valuable IP assets. Contemporary studies generally find that R&D subsidies are expected to increase R&D output in the form of patents, especially in the European context (Buchman and Kaiser, 2018; Szczygielski et al., 2017). With regards to the findings of firms located

[5] The estimates are provided by the EPO using the national renewal fees that were valid as of 1 January 2017.

in developed European countries, R&D subsidies were found to increase the number of collaborative R&D projects of German biotechnology firms (Broekel and Boschma, 2011) and boost their patenting activity (Buchman and Kaiser, 2018). The same positive effect is found for R&D subsidies to small and medium-sized Italian firms; however, the R&D subsidy cost required to produce one additional patent is high, ranging between €206,000 and €310,000 (Szczygielski et al., 2017). A similar positive effect between R&D subsidies and innovation is found for firms from European countries catching up on technology, such as Poland and Turkey (Bronzini and Pizelli, 2016).

An example of a successful R&D subsidy program is the Scientific Research and Experimental Development Tax Incentive Program (SR&ED) of the Canadian government which "encourages and supports scientific research and experimental development…by letting you deduct your SR&ED costs from your income for tax purposes" (Government of Canada, 2018). SR&ED incentives are considered an integral component of the Canadian innovation system, supporting innovative small and start-up businesses and attracting (and retaining) highly qualified human capital in the country (CPA, 2018). Importantly, such incentives can have a multiplying effect in terms of boosting investments in R&D, since successful projects are expected to attract further cycles of R&D funding from internal or external sources. Overall, when policymakers consider developing such policies to influence the determinants of patent enforcement, they also need to simultaneously undertake reforms that directly aim to improve the functioning and effectiveness of patent systems.

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Looking through conduit FDI in search of ultimate investors – a probabilistic approach

Bruno Casella*

This paper presents a novel computational method to determine the distribution of ultimate investors in bilateral FDI stock. The approach employs results from the probabilistic theory of absorbing Markov chains. The method allows for the estimation of a bilateral matrix that provides inward positions by ultimate counterparts for over 100 recipient countries, covering 95% of total FDI stock and including many developing countries. Reconstructing the global FDI network by ultimate investors enables a more accurate and complete snapshot of international production than do standalone bilateral FDI statistics. This has considerable implications for policymaking. It also provides more nuanced context to some contemporary developments such as the trade tensions between the United States, China and others, as well as Brexit.

Keywords: ultimate investors, bilateral FDI, conduit FDI, international production, absorbing Markov chains.

1. Introduction

1.1 International production and the challenge of ultimate investors

For many years multinational enterprises (MNEs) established their international production presence predominantly through foreign direct investment (FDI), building an internalized system of foreign affiliates directly owned and managed by the parent company. Today's globalized production, however, is much more diversified. Companies can exert control over a foreign business through non-equity modes (NEMs) of international production, such as contract manufacturing or services

* Bruno Casella is senior economist at the United Nations Conference on Trade and Development (bruno.casella@unctad.org). Acknowledgements: Sjoerd Beugelsdijk (University of Groningen), Jannick Damgaard (Central Bank of Denmark), Thomas Elkjaer (International Monetary Fund), and Richard Bolwijn, Claudia Trentini and Heinz Tüselmann (UNCTAD) for helpful comments on earlier drafts of the paper, and Juan Carlos Castillo for statistical assistance. Any remaining errors are the author's. The views expressed in this paper are solely those of the author and do not necessarily represent the view of the United Nations.

outsourcing (*World Investment Report*, 2011). The deepening of global value chains has also greatly expanded, fragmented and blurred the traditional sphere of influence of MNEs (from equity-based control to network-based coordination) (*World Investment Report*, 2013; Zhan et al., 2013). At the same time, the 'classic' motivations for MNEs' foreign investment (*resource-seeking, efficiency-seeking, market-seeking*) have broadened, with the scope for financial and tax-driven operations growing (*World Investment Report*, 2015; Bolwijn et al., 2018). FDI financialization, in turn, has resulted in increased complexity in MNE ownership relationships, with the creation of ever deeper and more convoluted corporate structures (*World Investment Report*, 2016). The proliferation and hybridization of modes of international production have been considerably facilitated by digitalization and the rise of intangibles, which have made international business much 'lighter', hence more flexible and mobile (*World Investment Report*, 2017; Casella and Formenti, 2018). These trends have all emerged or been powerfully intensified over the last twenty years, marking *complexity* as a defining feature of the current context of international production.

One of the great challenges for the international community in this context is to devise meaningful ways to describe and measure international production, a necessary condition to inform effective policymaking for inclusive and sustainable development (*World Investment Report*, 2012, 2014). Such analytical efforts require ever richer and more diversified data equipment. In recent years, UNCTAD has complemented its core database of FDI statistics from the national Balance of Payments (BoP) with other data sources such as GVC and value-added trade data (UNCTAD-Eora GVC database),[1] firm level data (from commercial databases, ORBIS Bureau Van Dijk and Refinitiv), project-level data on FDI greenfield projects and cross-border mergers and acquisitions (from fDi Markets and Refinitiv, respectively), and survey-based data (foreign affiliates statistics, mainly from Eurostat and the United States Bureau of Economic Analysis). Nevertheless, FDI statistics from the BoP remain the backbone of most empirical analysis on international production. For many developing countries they are the only available data on the activity of MNEs.

Discussion is ongoing on the extent to which FDI statistics effectively describe the international presence and operations of MNEs (for some references, see section 1.2). A recent paper (Casella, 2019), takes stock of this debate and discusses the pros and cons of using FDI statistics to describe international production. In particular, it argues that the impact of conduit FDI on bilateral FDI positions is a major barrier to a reconciliation between FDI statistics and international production. The main goal of this paper is to make a contribution to overcome this barrier.

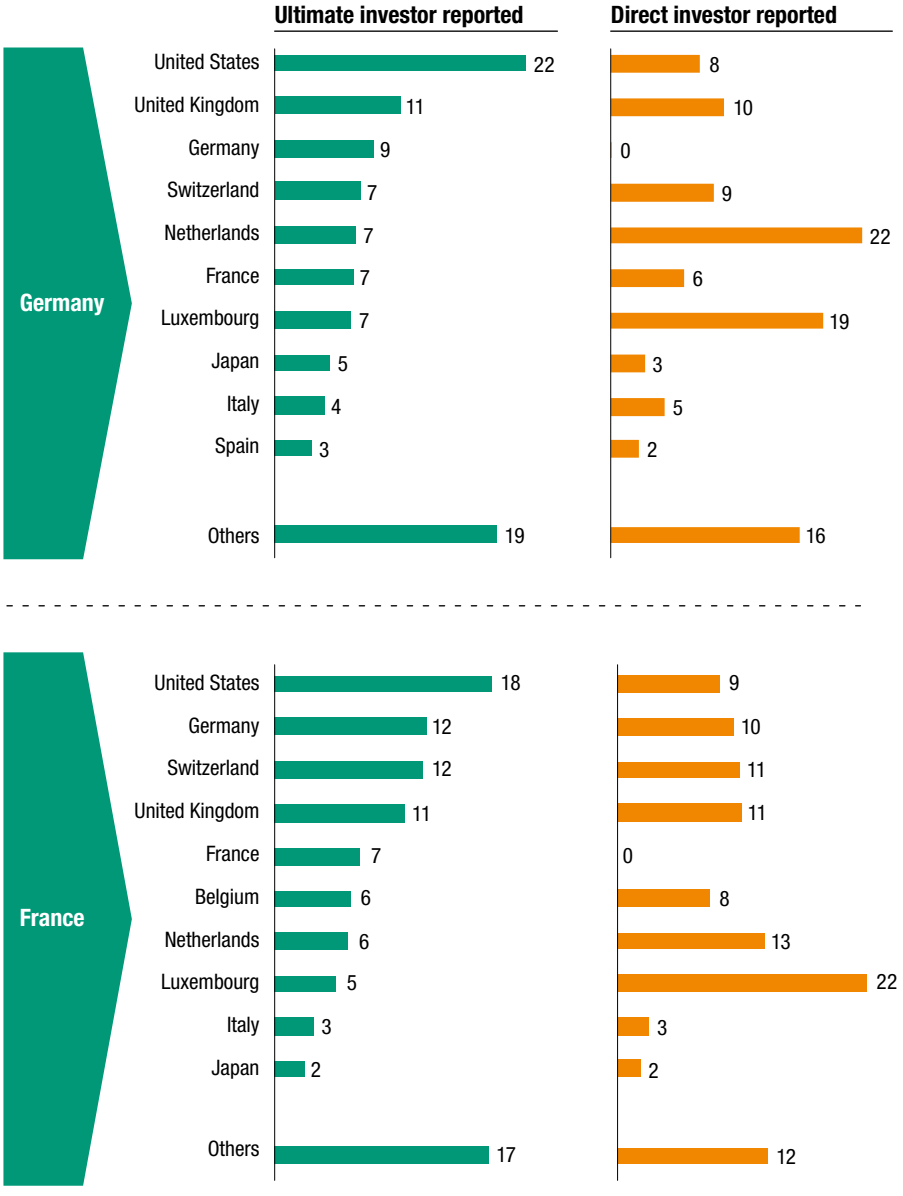
[1] http://worldmrio.com/unctadgvc/

Conduit FDI arises when an MNE investing from home country A in host country B establishes an intermediate step through a third country C. The investment transits first from A to C, and only then, from C to B where it is deployed as productive investment (for example a plant). The intermediate step through C is merely financial, as in country C no real 'productive' investment takes place, and is generally qualified as conduit FDI (but also 'pass-through capital', Borga and Caliandro, 2018; 'indirect FDI', Kalotay, 2012; 'offshore FDI', Haberly and Wójcik, 2015). Most conduit FDI in the world takes place through a limited set of jurisdictions that act as global FDI hubs. These countries allow MNEs to set up Special Purpose Entities (SPEs), which are investment vehicles specifically conceived to optimize MNEs' investment strategies, both from a financial and fiscal perspective. However, a certain limited amount of conduit FDI can take place through operational (non-SPE) entities in standard jurisdictions (Borga and Caliandro, 2018). On the other hand, not all FDI involving offshore investment hubs are conduit or financial (Bolwijn et al., 2018). UNCTAD (*World Investment Report*, 2015; Bolwijn et al., 2018) estimates that between 30% and 50% of total FDI stock is routed through investment hubs as conduit FDI.[2]

A large share of conduit FDI creates a biased picture of international production. In the *inward case* (the direction of the analysis in this paper) not only do conduit FDI inflate inward stock into investment hubs, but they also amplify the role of investment hubs as investors in all other jurisdictions. This is the result of double-counting in the international FDI network: investment does not really originate from the conduit jurisdiction but somewhere else, further up in the investment chain. As a consequence, the increasing role of conduit FDI has widened the gap between bilateral FDI positions by direct investors (as reported by standard bilateral FDI) and those by ultimate investors. Figure 1 shows the problem for France and Germany, two countries that report complementary FDI positions by ultimate investors (currently only fourteen countries provide statistics by ultimate investors; see also figure 2). Compared with the distribution of ultimate investors, bilateral FDI inflates the role of large European investment hubs, such as Luxembourg and the Netherlands, while it depresses the share of some major investor countries such as the United States. What is striking is the magnitude of the gap. For example, the combined share of Luxembourg and the Netherlands makes up 41% of total bilateral FDI in Germany, and the United States only 8%. The ultimate investor view reverts the picture: the share of the United States rises to 21%, and Luxembourg and the Netherlands combined make up only 14% of German inward stock. Similar considerations apply to France and all other countries for which data allow comparison.

[2] This order of magnitude is also confirmed by other studies, such as Haberly and Wójcik (2015).

Figure 1. Comparison between the distributions of ultimate investors and direct investors (Per cent)



Notes: Data from OECD (https://stats.oecd.org), December 2018.

The outcomes illustrated by figure 1 mean standard bilateral FDI data cannot uncover ultimate investor relations. The need for bilateral statistics by ultimate investors as a complement to standard bilateral FDI is now largely acknowledged by the international community. In recent years, as the role of conduit FDI became increasingly unwieldy,[3] there has been growing pressure to report data on ultimate investors. The 2008 OECD Benchmark Definition of Foreign Direct Investment (OECD, 2009) recommends that "*it is strongly encouraged that supplemental inward FDI positions be compiled on an ultimate investing country (UIC) basis*" (page 110). Nevertheless, progress in the reporting of positions based on ultimate investors has been slow. By 2016 data, only fourteen OECD countries reported FDI stock by ultimate investors. Figure 2 shows the current status of reporting and progress made. Notwithstanding the relevance of statistics on ultimate investors for individual countries, the current sample of reporting countries is too limited and developed countries-centred to draw any representative conclusions about ultimate investors at the global level. And, critically, the pace at which developing countries are aligning to recommended standards does not hint at any meaningful progress in the near future.

Against this backdrop, the main question is whether it is possible to estimate the distribution of ultimate investors for a large number of recipient countries, including developing economies. Competent international organizations are actively seeking analytical solutions for this challenging task (see review of the recent studies of the IMF Damgaard and Elkjaer, 2017 and OECD Borga and Caliandro, 2018 in the next section). The transition from reported FDI positions by direct investors to estimated FDI positions by ultimate investors requires: i. To identify the conduit component, i.e. that part of total inward FDI in recipient countries generated by double-counting; ii. To reallocate conduit FDI to genuine investors; this second step implies to find a way to look through conduit FDI, in search of ultimate investors.

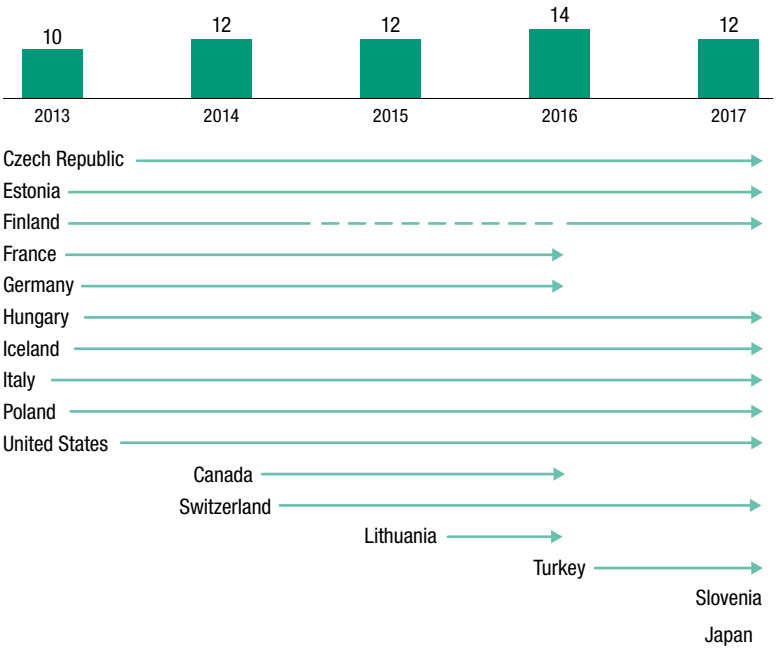
This paper proposes a probabilistic-based methodology to deal with these challenges. The main contribution and the novelty of the approach are to provide a rigorous, analytical way to look through conduit FDI (step ii above), while the identification of the conduit component (step i) is exogenous, relying either on reported data on SPEs (in the spirit of *World Investment Report*, 2015), or on available estimation methods (for example Bolwijn et al., 2018; Damgaard and Elkjaer, 2017; Borga and Caliandro, 2018). The final outcome is a new bilateral matrix providing inward positions by ultimate counterparts for over 100 recipient countries, covering 95% of total FDI stock and including developing countries.

[3] UNCTAD *World Investment Report* (2015) estimates an increase of 50% in the share of conduit FDI in just ten years, between the beginning and the end of 2000s.

The availability of a fairly comprehensive picture of ultimate investors opens a range of important analytical and policy applications. Standard bilateral FDI provide an important map of financial relationships between countries, exposing where financial claims and liabilities are created and when they are held. However, when the focus is on international production, the ultimate investor view reveals the relevant underlying patterns: where the investment decision was taken, where the capital originated from, and who bears the risks and reaps the benefits of the investment. This has considerable implications for the actions and policies of countries. For instance, the paper unveils the potential impact of a trade war between U.S. and China on U.S. MNEs intra-firm trade. According to 2016 inward FDI statistics reported by China, the U.S. share of total Chinese FDI stock is a meagre 3%. Yet, the reconstruction by ultimate investors establishes the U.S. as the biggest foreign investor in China, with a 12% share of total inward Chinese stock. The underlying exposure of U.S. firms to U.S. trade barriers on China therefore only becomes evident when inward Chinese investment is seen through the lens of ultimate investors.

Figure 2. FDI positions by ultimate investors: status of reporting

(Number of countries)



Notes: Status as reported by the OECD (https://stats.oecd.org). Other countries reporting data on ultimate investors include the United Kingdom (not reflected by OECD statistics, but see https://www.ons.gov.uk). Brazil also reports some information on ultimate investors up to 2015 in its latest FDI report, but has no publicly available data (see https://www.bcb.gov.br/Rex/CensoCE/ingl/FDIReport2016.pdf).

1.2 Literature review

A key motivation of this paper is to improve the consistency between FDI statistics and the 'real' dynamics of international production. Concerns about the inadequacy of FDI statistics have been raised by Lipsey (2007), Beugelsdijk et al. (2010), Leino and Ali-Yrkkö (2014), and Blanchard and Acalin (2016). On the other hand, Wacker (2013) and Casella (2019) support the (cautious) use of FDI statistics to analyse patterns of international production. Fukui and Lakatos (2012), Ramondo and Rodriguez-Clare (2013) and Federico (2016) effectively employ FDI statistics to impute missing data of foreign affiliates operations, in efforts to build comprehensive databases of multinational production. FDI statistics are also found to be linked to other meaningful measures of international production such as GVC-related indicators (Zhan et al., 2013; Martínez-Galán and Fontoura, 2019).

In a BoP context, the problem of conduit FDI has been analysed by *World Investment Report* (2015), Haberly and Wójcik (2015), Bolwijn et al. (2018) and Janský and Palanský (2018). These studies arrive at similar estimates of the size of conduit FDI – in the range of 30% to 50% of total FDI stock. The emphasis in these studies is on the link between the conduit jurisdictions and the destination countries where operations take place (and profit shifting potentially occurs). For example, Bolwijn et al. (2018) estimate that exposure to conduit FDI from offshore investment hubs is responsible for a loss of government revenues for developing countries in the order of $100 billion annually, as a consequence BEPS (base erosion and profit shifting). These analyses do not go beyond the conduit component to address the problem of the 'real' origin of the investment.

Firm-level literature has also made important contributions to the research on conduit FDI in the context of the analysis of complex corporate structures. UNCTAD firm-level analysis in the *World Investment Report* (2016) shows that about 40% of foreign affiliates are part of multi-step ownership chains involving shareholders from different countries (i.e. they have *multiple passports*), a number consistent with the estimated share of conduit FDI discussed above. Multi-passport entities are responsible for *investor nationality mismatches*, a notion recalling the challenge of the ultimate investors at the firm-level (*World Investment Report*, 2016; Alabrese and Casella, 2019). The increasing availability of firm-level data on ownership structures and relationships has allowed for network theory and big data algorithms to be applied to map corporate networks of ownership and control at a massive, global scale (Vitali et al., 2011; Rungi et al., 2017; Garcia-Bernardo et al., 2017). The study of Garcia-Bernardo et al. (2017) is particularly relevant because of its emphasis on the role of offshore and conduit jurisdictions, including the useful distinction between *conduit* and *sink* jurisdictions. Finally, firm-level drivers and determinants of complex ownership structures are explored by a large empirical literature.

Since the seminal paper of La Porta et al. (1999), studies have analysed factors influencing the financial and investment choices of MNEs that may in turn affect the structure of ownership chains. Taxation features prominently (Altshuler and Grubert, 2003; Desai et al., 2002, 2006; Mintz and Weichenrieder, 2010; Grubert, 2012), but other considerations also matter, including financing, risk management, policy and institutional issues and even historic accident (Desai et al., 2004, 2003, 2007; Lewellen and Robinson, 2013; Dyreng et al., 2015).

Zooming in on the core subject of this paper – the analysis of ultimate investors' relationships – Kalotay (2012) provides a qualitative review of some relevant statistical and policy challenges. Tissot (2016) advocates for a nationality-based approach to national statistics collection, to complement the current residency-based approach. Interestingly, in the paper of Tissot, the case for integrating standard FDI statistics with consolidated statistics based on the nationality of ultimate investors is motivated by the need to better account for systemic risks and inter-linkages in the global financial system rather than by the desire to analyse international production more accurately. Along the same line of Tissot (2016), in a thorough treatment of pass-through capital, Borga and Caliandro (2018) developed a comprehensive statistical framework for consolidated FDI statistics based on the nationality of MNEs. Their analytical proposal builds on a mixed approach, whereby the share of pass-through capital is estimated using firm-level data from ORBIS and applied to official (outward) FDI statistics to compute an estimate of the amount of conduit FDI at the country-level. The estimation step is affected by significant heterogeneity in ORBIS coverage of firm-level data across countries (with poor or almost no coverage for many developing countries). One very interesting point of the paper is the focus on capital passing through non-SPE entities (in the order of 25% of non-SPE FDI stock, according to the paper estimate), an important and often overlooked analytical element in the treatment of conduit FDI. At the current status, the analytical proposal of Borga and Caliandro covers only the estimation of conduit FDI; however, the possibility to extend the methodology to derive statistics by ultimate investors is mentioned as an avenue for future research.

To my knowledge, one study only, IMF Damgaard and Elkjaer (2017), has taken the analysis of conduit FDI as far as the estimation of an alternative network of bilateral FDI broken down by ultimate investors. The paper makes three important contributions. First, it provides an exhaustive account of the main statistical challenges related to bilateral FDI, namely the presence of large bilateral asymmetries, the role of special purpose entities and the breakdown of FDI by ultimate investing economy. Second, it introduces a way to estimate the SPE component in FDI statistics for countries that do not report such information; this proposal adds to the other available options for the estimation of conduit FDI (e.g. *World Investment Report*, 2015; Bolwijn et al., 2018). Finally, for the first time in the literature, is provided an analytical way to estimate the distribution of ultimate investors.

I will focus on the last point, the most relevant for the purpose of this paper. The main idea of Damgaard and Elkjaer is to assign to each investor (i.e. the counterparts in a inward FDI set-up) an adjustment factor based on twelve countries that report data on ultimate investors (as of 2015). The adjustment factor is the average ratio across the twelve reporting countries between the counterpart's size as direct investor (from standard bilateral FDI) and its size as ultimate investor (from countries' complementary reporting). In other words, for any (reporting) recipient country, the distribution of ultimate investors is calculated from the bilateral FDI statistics, by applying to each counterpart an adjustment factor reflecting the ratio between its weight as direct investor and its weight as ultimate investor, as retrieved from the sample of countries reporting both views.[4] The approach essentially applies to all countries in the world the same relationship between the distribution of bilateral FDI and the distribution of ultimate investors of twelve OECD countries (at most).[5] This extrapolating step has some critical limitations. The role of some jurisdictions to channel conduit FDI may be specific to a recipient country or region (regional hubs).[6] In these cases, adjusting the distribution of all countries in the world as if they behave like the twelve developed countries in the reporting sample would be highly misleading.[7] A second limitation is the caps on the adjustment factors that, for a subset of bilateral positions, may drive the results. The resort to caps is due to the fact that the computation of the adjustment factor is based on a small number

[4] For a particular investor, say A, an adjustment factor equal to 1 means that on average the (twelve) reference countries have reported the same amount of investment from A in the standard FDI view and in the view by ultimate investors. In this case, for all other recipient countries outside the reference sample, the amount of FDI from A remains unchanged in the ultimate investor view. An adjustment factor below 1 means that, on average across the reporting sample, A is a larger ultimate investor than direct investor. In this case, bilateral FDI from A will be adjusted upward in the ultimate investor view. Similarly, if the adjustment factor is above 1, bilateral FDI will be adjusted downward in the transition to the view by ultimate investors.

[5] Coverage of investors across all twelve reporting recipients is not homogeneous; therefore FDI positions for a specific investor may be reported by only a subset of the twelve countries.

[6] The importance of regional hubs is well documented, for example in Haberly and Wójcik (2015).

[7] One particularly challenging case, acknowledged also by the authors (page 19), is Hong Kong. As the main offshore hub for Chinese investment, Hong Kong has massive role as direct investor into China and Asian countries in general but it is expected to be less relevant as ultimate investor. However, given that the conduit role of Hong Kong is limited in the context of OECD countries, the adjustment factor calculated by Damgaard and Elkjaer is close to 1, i.e. it does not differentiate substantially between Hong Kong as direct investor and as ultimate investor. In other words, in the case of Hong Kong, the method fails to look through, missing out one of the most relevant conduit structures in the global economy. Based on the data accompanying the paper, the estimated share of Hong Kong as ultimate investor in China is 46% of total investment in China, a very large share, not substantially different from its share as direct investor, as reported by China, at 48%. The link between Hong Kong and China is not the only important conduit link involving investment to developing countries, potentially not captured by a view driven by OECD countries. Others include for example jurisdictions like Singapore (conduit to Asian countries) or Mauritius (to African countries and India).

of countries, hence it is exposed to outliers owing to country specificities.[8] Finally, tailoring the estimation so closely to the countries already reporting the distribution of ultimate investors raises questions about the validation procedure based on reported data (estimates may closely match reported data by construction).

* * *

The proposal I present in this paper is based on a different and original approach. It taps into the fact that bilateral FDI data, available for a large set of countries, provide the one-step (or direct) distribution in the investment chain. The combination of these distributions and the (exogenous) assumptions on conduit FDI provides a transition rule to link backward final recipient countries to ultimate investors, effectively looking through conduit FDI. In a nutshell, FDI distributions provide the overall exposure of a recipient country j to direct investment from an investor country i, while assumptions on conduit FDI define whether direct investor i is an intermediate or an ultimate investor. In the former case, the investment process iterates until an ultimate investor arises. Framing this simple idea within the probabilistic setting of absorbing Markov chains allows to analytically derive the distribution of ultimate investors. The main intuition behind the approach as well as its formal elaboration are presented in section 2, the core part of the paper. Importantly, this approach is independent from reported statistics on ultimate investors, i.e. it is not driven by a limited sample of developed countries.[9] Instead, reported distributions on ultimate investors are employed for a validation of the methodology, with promising results (section 3). Due to its novelty, this approach is susceptible to significant future refinements; some possible directions are outlined in section 4. The policy implications are potentially far-reaching, as argued in the concluding section (section 5).

[8] The paper mentions two different caps on adjustment factors. i. A cap between 0.33 and 3 applying to all standard jurisdictions to avoid extreme adjustments; ii. A cap between 0.2 and 1, applying to low-tax economies, to limit their size as ultimate investors.

[9] This is an important improvement on Damgaard and Elkjaer (2017). For example, unlike their paper (but in agreement with the expectations), the estimated share of Hong Kong as ultimate investor in China, at 12%, is substantially lower than its share as direct investor at 48% (see also discussion in footnote 7).

2. A new approach to determine the distribution of the ultimate investors

2.1 A simulation exercise

For illustrative purposes, I first present the main idea of the paper in a simplified simulated setting.

Suppose the presence of five (recipient) countries A, B, C, D and E, with two sets of information. (i) First, the bilateral FDI reported by each recipient country; (ii) Second, some prior information on conduit FDI. For example, assume that countries D and E are always conduit jurisdictions, i.e. intermediate steps in a long investment chain; on the other hand, the three remaining countries A, B and C are always the origin of the investment (non-conduit).

The simulation exercise consists of using (i) bilateral information on direct investors and (ii) assumptions on conduit jurisdictions, to trace back the chain of investment from the final ('lowest') recipient up to the ultimate ('highest') investor. Starting from the recipient country j (any country A, B, C, D, E), the simulation employs the distribution of bilateral FDI reported by j to simulate a direct investor i. If the direct investor is a conduit jurisdiction (i = D or E), it iterates the process with country i now acting as reporting recipient: a direct investor to i will be simulated from the distribution of bilateral FDI reported by i, adding an upper layer in the investment chain. If the direct investor is a non-conduit jurisdiction (i = A, B or C), the investment chain stops and the highest simulated direct investor coincides with the ultimate investor. In this simplified setting, ultimate investors can only be the non-conduit jurisdictions A, B and C. I will refer to this process as the *reversed investment process*, because it reverts the usual 'top-down' investment direction (from the investor to the recipient). Figure 3 illustrates the dynamics of the reversed investment process.

Applying a standard Monte Carlo approach (Robert and Casella, 2004) will provide for any country j a suitable approximation $\hat{p}$ of the distribution of its ultimate investors i, say $p^u(j,i)$, as the number N of iterations becomes larger:

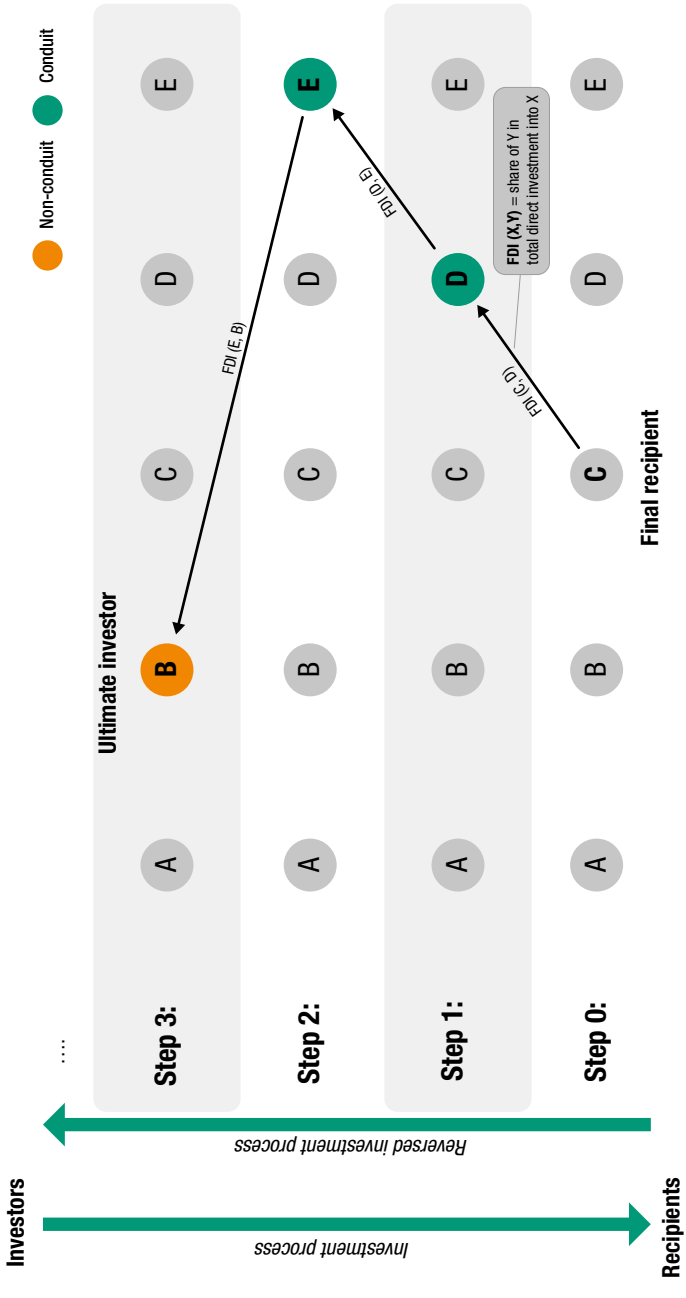
$$p^u(j,i) \approx \hat{p}^u(j,i) = \frac{\sum_{n=1}^{n=N} \mathbb{I}_n\{i \overset{ULT}{\Longrightarrow} j\}}{\mathrm{N}}, \qquad i = A, B, ..., E \tag{1}$$

where $\{i \xrightarrow{ULT} j\}$ is the event that country i is ultimate investor to the recipient country j and $\mathbb{I}_n\{A\}$ is an indicator function taking value 1 if event A occurs at the n-th trial of the simulation, otherwise it takes value 0. By construction of the simulation process, $\hat{p}^u$ is positive when investor countries i are non-conduit (A, B, C) and 0 for conduit jurisdictions (i=D, E). Also, $\hat{p}^u$ respects the unit condition of probability distributions, i.e. $\sum_i \hat{p}^u\ (j,i) = 1$, as required.

I now relax assumption (ii) on conduit FDI. Instead of dividing *jurisdictions* in conduit and non-conduit, the simulation allows for a conduit component in each country (figure 4). In other words, for each direct investor country i, a known share of investment is made through conduit entities (for example SPEs). This approach is more realistic because even in large offshore investment hubs there may be a (limited) portion of 'original' investment (Bolwijn et al., 2018); and, vice versa, standard jurisdiction can be occasionally used to channel pass-through investment (Borga and Caliandro, 2018). The first simulation (figure 3) is a special case, where the conduit share can only be equal to 0 (countries A, B and C) or 1 (countries D and E).

The simulation of the reversed investment process in this more general setting requires an additional step. Every time a direct investor i is sampled, the process simulates its conduit status from a 0-1 (Bernoulli) distribution ('conduit' – 'non-conduit'). If the outcome is 'conduit', a further direct investor is sampled, otherwise the simulation stops and the highest direct investor coincides with the ultimate investor. Unlike the first simulation, ultimate investors can be any country A, B, C, D, E. Application of Monte Carlo (1) then provides a suitable approximation of the distribution of ultimate investors.

Figure 3. Simulation of the reversed investment process with binary conduit status



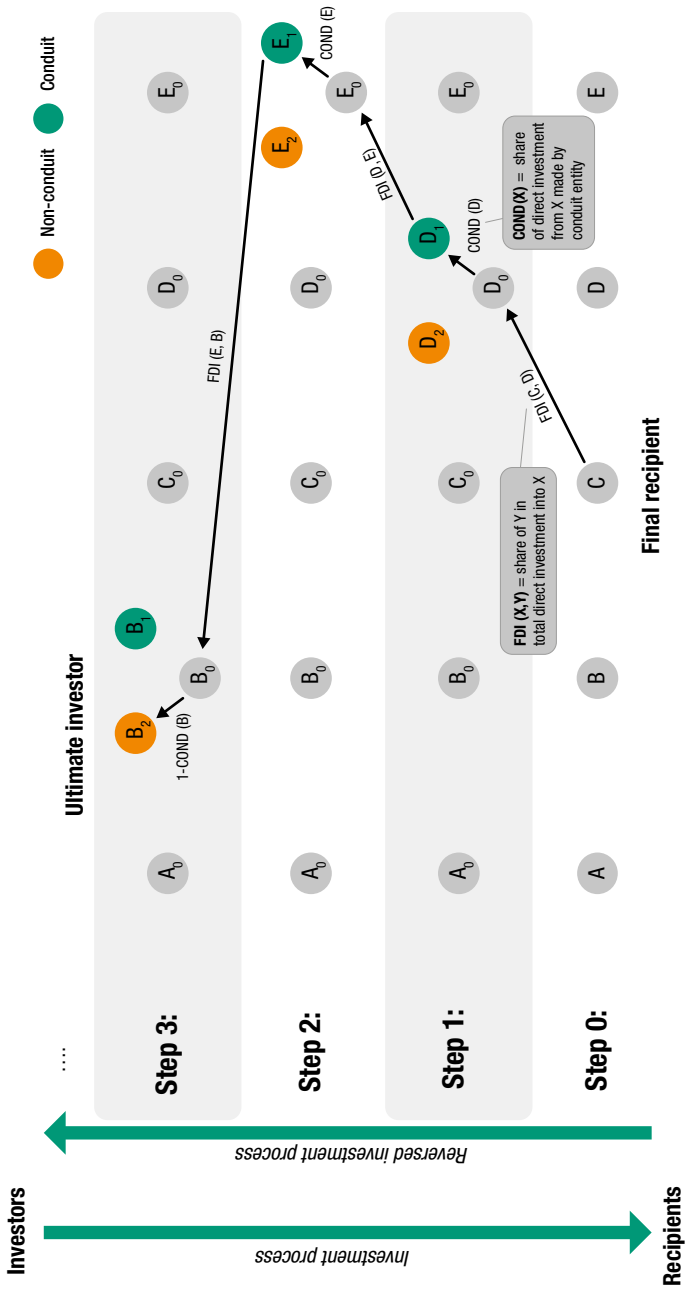


Figure 4. Simulation of the reversed investment process with conduit probabilities

2.2 Preliminaries: Absorbing Markov chains

This section provides a friendly introduction to the theory of absorbing Markov chains, strictly limited to the elements relevant for application in this paper. A more comprehensive and rigorous background can be found in many textbooks on stochastic processes, for example Grinstead and Snell (1997) (chapter 11), for a basic reading, or Stroock (2005) for a more advanced treatment.

Definition 1 (Markov chain). A Markov chain is a sequence of random variables (a stochastic process) in a discrete time frame $\{X_n\}_{n=1, 2,...}$ satisfying the following *Markov property*:

$$\Pr(X_{n+1} = x_{n+1} \mid X_0, X_1, ..., X_n) = \Pr(X_{n+1} = x_{n+1} \mid X_n),$$

for any $n=0, 1,...$ (2)

The probability distribution defined by (2) is called *transition probability*. The Markov property states the defining feature of Markov chains: at any step n, the behavior of the process at the further iteration $(n+1)$ depends only on the current state X_n. The history of the process $\{X_0, X_1,..., X_{n-1}\}$ does not have any impact on its future behavior X_{n+1}, *given* the knowledge of its current status X_n.[10] For this reason, Markov processes are also said to be *memoryless*. The underlying idea is that the present status condenses all the past information needed to predict the future behavior of the process.

A Markov chain is *homogeneous* when the transition probability (2) is the same for all n (i.e. it does not depend on the 'time'). Formally:

$$\Pr(X_{n+1} = a \mid X_n = b) = \Pr(X_n = a \mid X_{n-1} = b) = p(a; b),$$

for any $n=1, 2,...$ (3)

[10] Here the familiar categories of 'past', 'present' and 'future' are used for descriptive purposes but do not necessarily refer to physical time. Often Markov chains describe phenomena taking place at a (discrete) physical time, but sometimes they just refer to an abstract sequence of events. This characteristic is particularly important in the application of this study (section 2.3) where the sequence described by the relevant Markov chain Xn is not driven by physical time; indeed to some extent it reverts the physical time-flow.

The *state-space* of a Markov chain $\{X_n\}$ is the set of all possible values that the sequence of random variables $X_0, X_1, \ldots$ can take with positive probability. The state-space is finite if the Markov chain can assume only a finite number M of values. As a consequence of (2) and (3), the probabilistic behavior of a homogeneous Markov chain on a finite state-space, say $\{a_1, a_2, \ldots, a_M\}$, is fully determined by an initial condition $\{X_0 = x_0\}$ and a *transition matrix* P with dimension $[M \times M]$ and generic elements $\{p(a_k; a_h)\}_{k,\, h=1,2,\ldots,M}$ defined by (3). The rows of the transition matrix P identify the current state while the columns identify the next state; the elements of the matrix are the probabilities to move from a given current state to any next state.

A state a_j of a Markov chain is called *absorbing* if it is impossible to leave it, i.e. it satisfies:

$$Pr\left(X_{n+1} = a_i \mid X_n = a_j\right) = 0,$$

for any $i \neq j$ and any $n = 0, 1, \ldots$ (4)

In Markov chains, a state that is not absorbing is defined *transient*.

Definition 2 (absorbing Markov chain). A discrete stochastic process $\{X_n\}_{n=1,2,\ldots}$ is an absorbing Markov chain if it satisfies the *Markov property* (2), it has *at least one absorbing state* and if, from every state, it is *possible to reach an absorbing state.*

Definition 3 (standard form of transition matrix). Suppose to have an homogeneous absorbing Markov chain $\{X_n\}$ with finite state space $\{a_1, a_2, \ldots, a_M\}$, such that K states are absorbing and the others $M - K$ are non-absorbing (or transient). Then the transition matrix P is said to be in a standard form if absorbing states precede the transient states in the matrix representation:

$$\mathbf{P} = \begin{array}{c} \\ \text{abs} \\ \\ \text{trans} \end{array} \begin{array}{c} \begin{array}{cc} \text{abs} & \text{trans} \end{array} \\ \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{R} & \mathbf{Q} \end{bmatrix} \end{array} \tag{5}$$

where, by definition, I is a $[K \times K]$ unit matrix, while $\mathbf{0}$ is a $[K \times (M - K)]$ null matrix. The n-th transition matrix P_n is then defined as:

$$\mathbf{P}_n = \Pr(X_n \mid X_0) = \begin{array}{c} \\ \text{abs} \\ \\ \text{trans} \end{array} \begin{array}{c} \begin{array}{cc} \text{abs} & \text{trans} \end{array} \\ \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{R}_n & \mathbf{Q}_n \end{bmatrix} \end{array} \tag{6}$$

The focus here is on the limiting matrix $\mathbf{P}^*$ describing the long-term behavior of $\mathbf{P}_n$, when $n \to \infty$:

$$\mathbf{P}^* = Pr\{X^* \mid X_0\} = \lim_{n\to\infty} \mathbf{P}_n = \lim_{n\to\infty} \Pr(X_n \mid X_0) \tag{7}$$

Then the key result on the distribution of the limiting transition matrix $\mathbf{P}^*$ follows.

Main result (limiting distribution of absorbing Markov chains). If $\{X_n\}$ is an absorbing Markov chain with transition matrix $\mathbf{P}$ in the standard form (5), then the limiting transition matrix $\mathbf{P}^*$ is given by:

$$\mathbf{P}^* = \Pr(X^* \mid X_0) = \begin{array}{c} \\ \text{abs} \\ \\ \text{trans} \end{array} \begin{array}{c} \begin{array}{cc} \text{abs} & \text{trans} \end{array} \\ \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{R}^* & \mathbf{0} \end{bmatrix} \end{array} \tag{8}$$

such that:

$$\mathbf{R}^* = \mathbf{F} * \mathbf{R} := (\mathbf{I} - \mathbf{Q})^{-1} * \mathbf{R} \tag{9}$$

with $\mathbf{R}$ and $\mathbf{Q}$ defined by (5). The matrix $\mathbf{F} := (\mathbf{I} - \mathbf{Q})^{-1}$ is called the *fundamental matrix* of the absorbing Markov chain $\{X_n\}$. The result (8) and (9) provides a nice and simple characterization of the long-term behavior of an absorbing Markov chain $\{X_n\}$. It implies that the Markov chain will always be absorbed in the long-run (it will end up in one absorbing state with probability 1) and it provides the probability of each absorbing state, given any possible starting state (transient, by definition).

This result will be the key to determine the distribution of ultimate investors in the application to bilateral FDI stock presented in the next section.

2.3 Harnessing Markov chains to locate ultimate investors

Main proposition

This section leverages some of the results from the probabilistic theory of absorbing Markov chains to compute the distribution of ultimate investors in bilateral FDI positions. The main proposition is the same as illustrated by the simulation exercise in section 2.1, i.e. to use (i) bilateral FDI and (ii) assumptions on conduit FDI to define a suitable and realistic transition rule linking backward recipient countries to ultimate investor countries. Remarkably, while simulation is a useful and intuitive way to approach this problem, the actual computation of the distribution of ultimate investors does not require simulation and Monte Carlo (1) but it can be derived analytically. This derivation is the main objective of this section.

As a first step, the reversed investment process, introduced in section 2.1 (in particular the version of figure 4), has to be reframed and formalized within the probabilistic setting of absorbing Markov chains (section 2.2). It is important to state ahead that this approach is only *instrumentally probabilistic*. Probability theory is used here merely to address a computational problem: the procedure does not require any probabilistic assumption regarding the 'future states of the world'. Likewise, no formal definition of a probability space (Ω, F, P) is needed to perform a purely computational task.

I model the reversed investment process as a Markov chain, say $\{X_n\}$. The initial state of the chain $X_0 = x_0$ is the recipient country of the investment (or final destination). X_1 is the direct (or immediate) investor country into X_0; X_2 is the direct investor into X_1. More generally, X_{n+1} is the direct investor into X_n. Intuitively, the ultimate investors in X_0 will be a set of countries, say X^u, acting as steady or limiting states for the process; formally, for any given investment path $\{X_0 = x_0, X_1 = x_1, X_2 = x_2,...\}$, there exists n such that $x_n = x_{n+h} := X^u$ for all $h = 1, 2,...$. This intuition will become clearer later in the section.

Formalization of the Markov chain

I proceed now to the description of $\{X_n\}$, by defining first the state-space of the process, i.e. the possible values (states) that the variables $\{X_n\}$ can take at any step n. Then, I characterize its transition matrix: the set of probabilities governing the transition from one state X_n to the next state X_{n+1}, including conditions at the starting states X_0 to initialize the process.

Let M be the total number of countries in the perimeter of interest; in this context, all countries for which the distribution of the ultimate investors is needed. For each country $i = 1, 2,..., M$, the process allows two states, a transient state i_T and an absorbing state i_A. In the logic of the reversed investment process, the two states can be described as follows:

- Transient state i_T := 'country i has a direct investor'
- Absorbing state i_A := 'country i has no direct investor'

At any iteration, the Markov chain $\{X_n\}$ can then take $M \times 2$ different values, each corresponding to one country $i = 1, 2,..., M$ and one state, transit (T) or absorbing (A). Thus, the state-space of the Markov chain $\{X_n\}$ is given by $\{i_T, i_A\} i=1, 2,..., M.$

I am now ready to define the probabilistic structure of $\{X_n\}$, or equivalently its transition matrix $\mathbf{P} := \Pr(X_{n+1} \mid X_n)$ of dimension $[2M \times 2M]$ with generic element:

$$p_{j,h;i,k} := \Pr(X_{n+1} = i_k \mid X_n = j_h) = \Pr\{i_k \overset{DIR}{\Longrightarrow} j_h\},$$

$$i, j = 1, 2,..., M;\ h, k = T, A \tag{10}$$

where $\{i_k \overset{DIR}{\Longrightarrow} j_h\}$ represents the event that country i in state k is direct investor in recipient country j in state h.

The most convenient way to represent the transition matrix $\mathbf{P}$ is through four sub-matrix blocks of dimension $M \times M$:

$$\mathbf{P} = \begin{bmatrix} \mathbf{P}^{A,A} & \mathbf{P}^{A,T} \\ \mathbf{P}^{T,A} & \mathbf{P}^{T,T} \end{bmatrix} = \begin{bmatrix} \begin{pmatrix} p_{1,1}^{A,A} & \cdots & p_{1,M}^{A,A} \\ \vdots & \ddots & \vdots \\ p_{M,1}^{A,A} & \cdots & p_{M,M}^{A,A} \end{pmatrix} & \begin{pmatrix} p_{1,1}^{A,T} & \cdots & p_{1,M}^{A,T} \\ \vdots & \ddots & \vdots \\ p_{M,1}^{A,T} & \cdots & p_{M,M}^{A,T} \end{pmatrix} \\ \begin{pmatrix} p_{1,1}^{T,A} & \cdots & p_{1,M}^{T,A} \\ \vdots & \ddots & \vdots \\ p_{M,1}^{T,A} & \cdots & p_{M,M}^{T,A} \end{pmatrix} & \begin{pmatrix} p_{1,1}^{T,T} & \cdots & p_{1,M}^{T,T} \\ \vdots & \ddots & \vdots \\ p_{M,1}^{T,T} & \cdots & p_{M,M}^{T,T} \end{pmatrix} \end{bmatrix} \tag{11}$$

with generic elements defined, for any row j and column i, as follows:

$$p_{j,i}^{A,A} := p_{j,A;i,A} = \Pr\{i_A \overset{DIR}{\Longrightarrow} j_A\} = \begin{cases} 1 & \text{if } i = j; \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

$$p_{j,i}^{A,T} := p_{j,A;i,T} = \Pr\{i_T \overset{DIR}{\Longrightarrow} j_A\} = 0 \tag{13}$$

$$p_{j,i}^{T,A} := p_{j,T;i,A} = \Pr\{i_A \overset{DIR}{\Longrightarrow} j_T\} = p_d\,(j,i)\,(1 - p_c(i)) \tag{14}$$

$$p_{j,i}^{T,T} := p_{j,T;i,T} = \Pr\{i_T \overset{DIR}{\Longrightarrow} j_T\} = p_d\,(j,i)\;p_c(i) \tag{15}$$

In (12) – (15), for any country $i, j = 1, 2, ..., M$, $p_d\,(j, i)$ defines the probability that country i is direct investor in recipient country j (*direct investment probability of i given j*) and $p_c(i)$ is the probability that direct investment from country i occurs through a conduit entity, or equivalently, that country i is in a conduit state (*conduit probability of i*):

a. *Direct investment probability of i given j:*

$$p_d(j,i) := \Pr\{X_{n+1} = i \mid X_n = j\} = \Pr \quad \{\text{Country } i \text{ is a direct investor in recipient } j\} \tag{16}$$

b. *Conduit probability of i:*

$$p_c(i) := \Pr\{X_{n+1} = i_T \mid X_{n+1} = i\} = \Pr \quad \{\text{Direct investment from country } i \text{ is conduit}\} \tag{17}$$

From equations (12) and (13), when the reversed investment process reaches an investor country j in an absorbing state A, it stops there with country j qualifying as ultimate investor. Instead, equations (14) and (15) describe the transition of the process in presence of conduit states. When investor country j at iteration n is conduit, the reversed investment process continues, assigning a positive probability to a foreign direct investor (i into j) at the upper investment level $n+1$. Such direct

investment from country i can be made either by a conduit entity or by a non-conduit entity. The probability of the former is given by (15), as the product between the direct investment probability of i given j, $p_d(j,i)$, and the conduit probability of i, $p_c(i)$. Similarly, the probability that the direct investment from i into j is non-conduit (14) is derived as the product between the direct investment probability of i given j and the complementary of the conduit probability of i, $1 - p_c(i)$. Finally, the definition of the Markov chain $\{X_n\}$ is completed by adding the initial condition:

$$X_0 = j_T, \text{ for any recipient country of interest } j = 1, 2, \ldots, M \tag{18}$$

which ensures that the possible set of initial states is limited to transient states only; this condition is needed in order to initialize the investment process. Notice that the sum of each row in the transition matrix (11), is equal to 1 as required; for any $j = 1, 2, \ldots, M$, from (12) and (14):

$$\sum_{i=1}^{M} p_{j,i}^{A,A} + \sum_{i=1}^{M} p_{j,i}^{A,T} = 1 + 0 = 1 \tag{19}$$

and from (14) and (15):

$$\sum_{i=1}^{M} p_{j,i}^{T,A} + \sum_{i=1}^{M} p_{j,i}^{T,T} = \sum_{i=1}^{M} p_d(j,i) * (1 - p_c(i)) + \sum_{i=1}^{M} p_d(j,i) * p_c(i) = \sum_{i=1}^{M} p_d(j,i) = 1 \tag{20}$$

The key result

Expressions (12) to (15) define an absorbing Markov chain, with a transition matrix $\mathbf{P}$ (11) in the same standard form as (5):

$$\mathbf{P} = \begin{bmatrix} \mathbf{P}^{A,A} & \mathbf{P}^{A,T} \\ \mathbf{P}^{T,A} & \mathbf{P}^{T,T} \end{bmatrix} = \begin{bmatrix} \mathbf{P}^{A,A} \equiv \mathbf{I} & \mathbf{P}^{A,T} \equiv \mathbf{0} \\ \mathbf{P}^{T,A} \equiv \mathbf{R} & \mathbf{P}^{T,T} \equiv \mathbf{Q} \end{bmatrix} \tag{21}$$

From (8) and (9) the long-run distribution of the Markov chain $\{X_n\}$ is given by:

$$\mathbf{P}^* = \Pr(X^* \mid X_0) = \begin{array}{c} \\ \text{abs} \\ \\ \text{trans} \end{array} \begin{bmatrix} \text{abs} & \text{trans} \\ \mathbf{I} & \mathbf{0} \\ \\ \mathbf{R}^* & \mathbf{0} \end{bmatrix} \tag{22}$$

where $\mathbf{R}^* = \mathbf{F} * \mathbf{P}^{T,A}$ and $\mathbf{F}$ is the fundamental matrix of the Markov chain defined by (9):

$$\mathbf{F} := \left(\mathbf{I} - \mathbf{P}^{T,T}\right)^{-1} \tag{23}$$

The rows of the matrix are the initial states X_0 (recipient countries); the columns are the final states X^* (ultimate investors). The interpretation of the limiting matrix $\mathbf{P}^*$ (22) in terms of the reversed investment process $\{X_n\}$ is the following: from any recipient country $j = 1, 2,..., M$, after a sufficiently large number of (reversed) investment steps, the process will select an ultimate investor (modelled as an absorbing state) with probability 1 (blocks $\mathbf{I}$ and $\mathbf{R}^*$ in the left side of the matrix (22)). The initial condition (18) limiting X_0 to transient states (blocks $\mathbf{R}^*$ and $\mathbf{0}$ at the bottom of (22)) ensures that the investment process actually moves away from the recipient country, or in other words, that the initial investment link is foreign.

In this context, the sub-matrix $\mathbf{R}^*$ of dimension $[M \times M]$ is the key result of this approach, providing for each recipient country $j = 1, 2,..., M$ (by row) the distribution of the ultimate investors $i = 1, 2,..., M$ (by columns). Formally,

$$\mathbf{R}^* = \left(\mathbf{I} - \mathbf{P}^{T,T}\right)^{-1} \times \mathbf{P}^{T,A} = \begin{pmatrix} p^*_{1,1} & \cdots & p^*_{1,M} \\ \vdots & \ddots & \vdots \\ p^*_{M,1} & \cdots & p^*_{M,M} \end{pmatrix} \tag{24}$$

where, for any given recipient country j,

$$p^*_{j,i} = Pr\left(X^* = i \mid X_0 = j\right) = Pr\{i \overset{ULT}{\Longrightarrow} j\}, \qquad \text{i=1,2,..., M} \tag{25}$$

defines the probability that country i is its ultimate investor.

3. An empirical application

Parameters: $\hat{p}_d$ *and* $\hat{p}_c$

The purpose of this section is twofold. The first objective is to exemplify how the approach works in concrete applications with real numbers. The second is to validate the approach, providing sound, although preliminary, evidence that results are consistent with reported data on ultimate investors (available for a handful of countries). This application is mainly illustrative; it does not have the ambition to provide the optimal way to compute the distribution of ultimate investors. Yet, it gives a clear indication that the probabilistic method proposed in this paper is a viable option and a promising avenue to obtain a more accurate gauge of ultimate investors. Further research and empirical work to refine both the inputs into, and the settings of, the computational machine are expected to yield further improvements in the results.

The first step of an empirical application is to assign the parameters of the reversed investment process modelled as the Markov chain $\{X_n\}$ (section 2). This essentially means defining the transition matrix (11), according to (12)–(15). While (12) and (13) are given by definition, the valorization of (14) and (15) requires assigning values to $p_d\,(j,\,i)$ (16) and $p_c(i)$ (17), for all countries i, j in the perimeter of interest.

For the direct investment probability p_d, the obvious available choice is to use investor countries' shares in inward bilateral FDI data. Thus, the parameter $\hat{p}_d$ assigned to the target probability p_d is defined as follows:

$$\hat{p}_d(j,i) = \frac{FDI(j,i)}{\sum_{k=1}^{M} FDI(j,k)} \tag{26}$$

where FDI (j, i) is the amount of FDI reported by recipient country j from investor i. For any recipient country j, $\hat{p}_d\,(j,\,i)$ represents the share of investment from country i in total FDI stock in country j (as reported by country j).

The treatment of the conduit probability p_c is less straightforward. The application in this section relies on a refined version of the approach to sizing conduit FDI in Bolwijn et al. (2018), combining data on SPEs reported by countries and estimates of the conduit component through the *implied investment method*. The appendix describes the approach in some detail and reports the resulting estimates of conduit probabilities $\hat{p}_c(i)$ (table 1).

Results and validation

I use official inward bilateral FDI stock for 2016 (as reported by UNCTAD, the OECD and the IMF),[11] to assign values to $\hat{p}_d\ (j,i)$ according to (26). The values of the conduit probabilities $\hat{p}_c$ (reported in table 1 in the appendix) are derived from available information on outward SPEs, complemented by estimates from the application of the implied investment method as described in the appendix and in Bolwijn et al. (2018).

The comparison with reported data on ultimate investors allows to appreciate to what extent the methodology contributes to covering the gap – sizable for most recipient countries – between the breakdown of FDI positions by direct investors and by ultimate investors. The analysis is based on FDI positions by direct and ultimate investors reported by the OECD,[12] for twelve countries (Canada, Czech Republic, Estonia, France, Finland, Germany, Hungary, Iceland, Italy, Poland, Switzerland and the United States) with a historic record in reporting data on ultimate investors for at least three years, as of 2016 (see also figure 2).

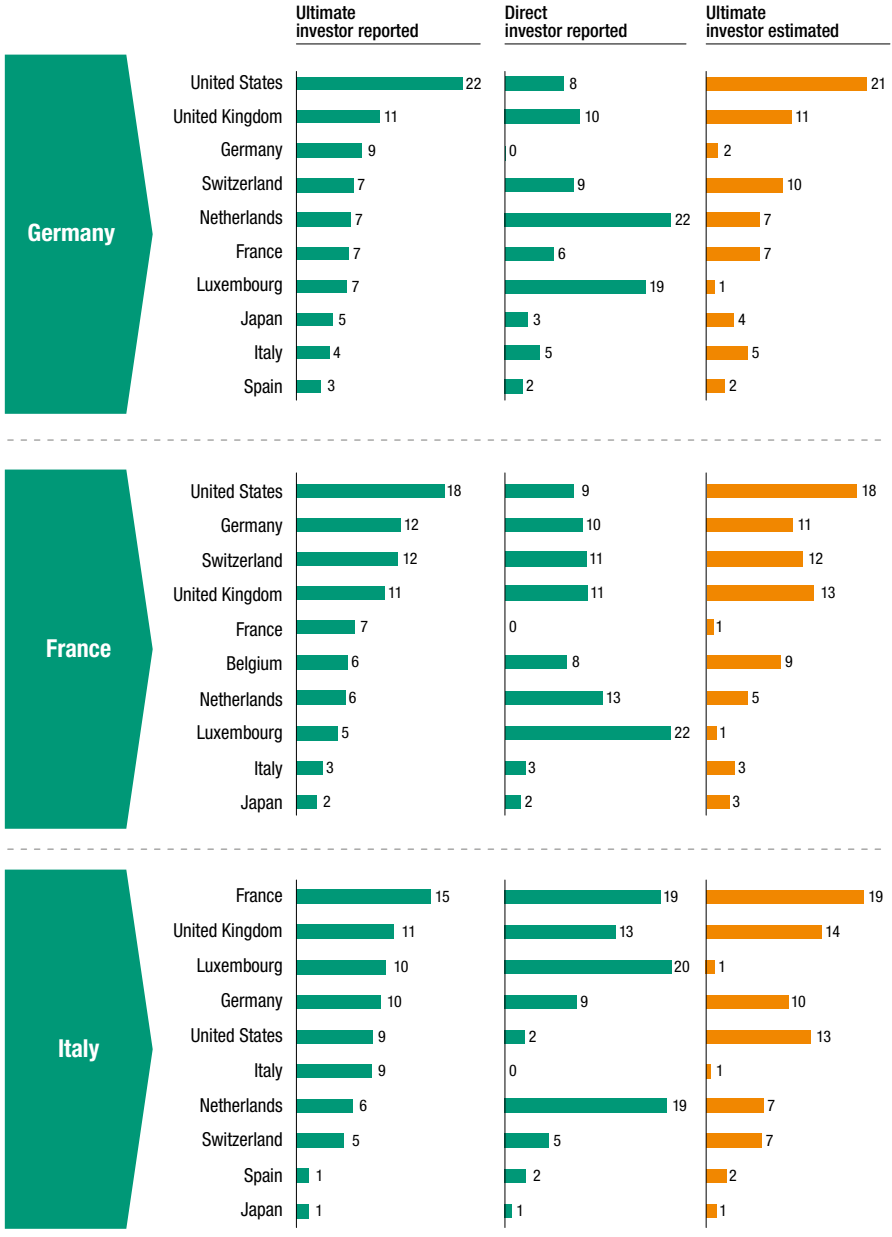
For six large recipient countries in the sample, figure 5 shows a comparison between the distribution of the ultimate investors reported by the country, the distribution of bilateral FDI (direct investors) and the distribution of the ultimate investors estimated by the probabilistic approach. In all cases, and particularly for Germany, France, Switzerland and the Czech Republic, the estimated distribution proxies the reported distribution of ultimate investors much better than does the distribution of bilateral FDI. In particular, the methodology takes care of the most relevant conduit schemes – such as those involving the Netherlands and Luxembourg – that play a major role in the diversion of bilateral FDI from the origin of the investment. The application of the probabilistic approach re-establishes realistic ranking between the investors, not only aligned with reported data on ultimate investors but also consistent with the economic size of the countries. The results for the other six countries in the benchmark are similar.

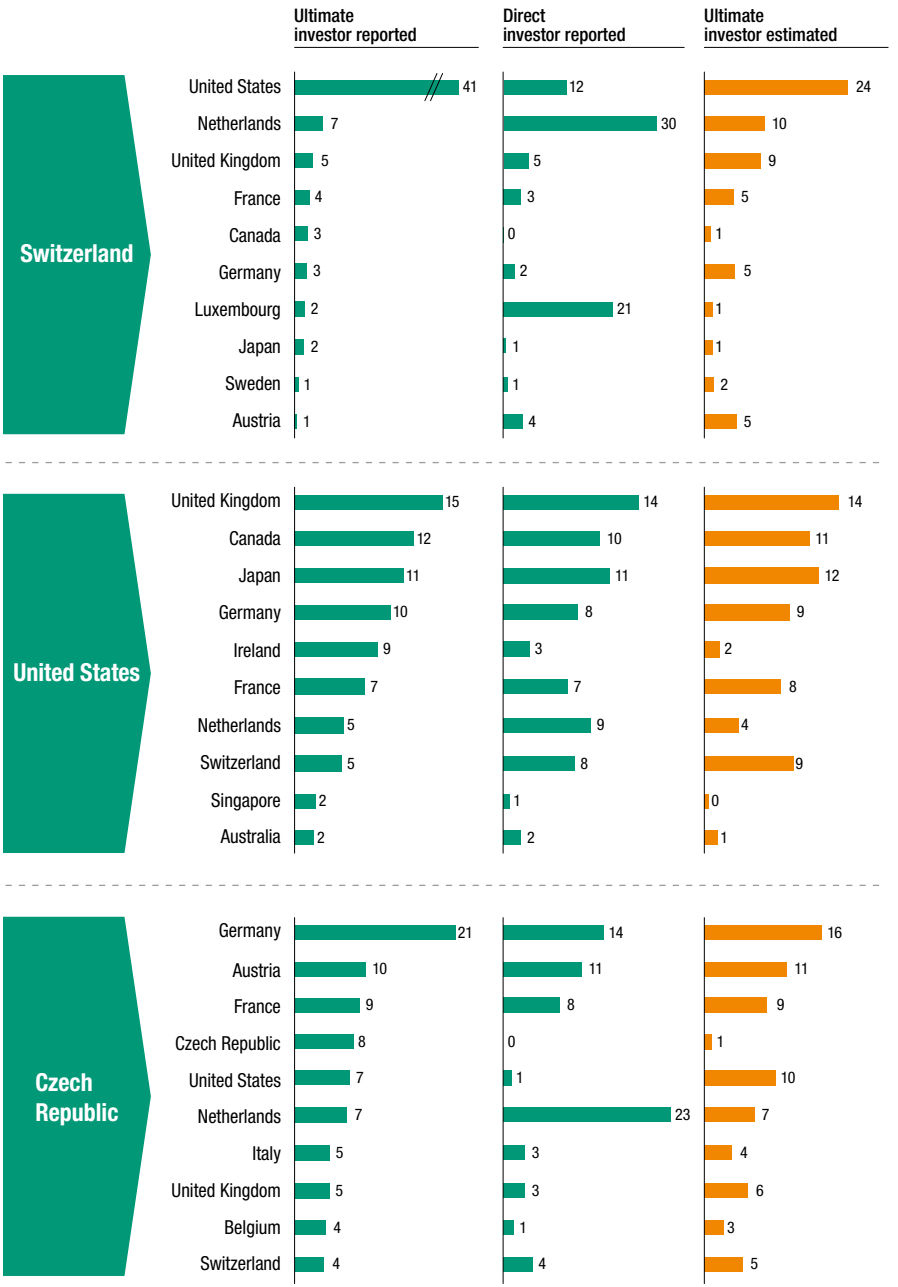
Figure 6 compares for all twelve countries the total variation distance between the distribution of bilateral FDI and the distribution of ultimate investors with the distance between the estimated distribution and the reported distribution of the ultimate investors. For all countries the estimated distribution more closely approximates the reported distribution than standard bilateral FDI. In eight out of twelve cases, the improvement is considerable, with a decrease in total variation distance over 40%.

The good results in figures 5 and 6 are even more promising considering the ample scope for refinement of the methodology. Some directions for future improvements are discussed in the next section 4.

[11] Primary source UNCTAD internal data; complemented by OECD statistics (https://stats.oecd.org) and data from IMF Coordinated Direct Investment Surves (http://data.imf.org).
[12] https://stats.oecd.org.

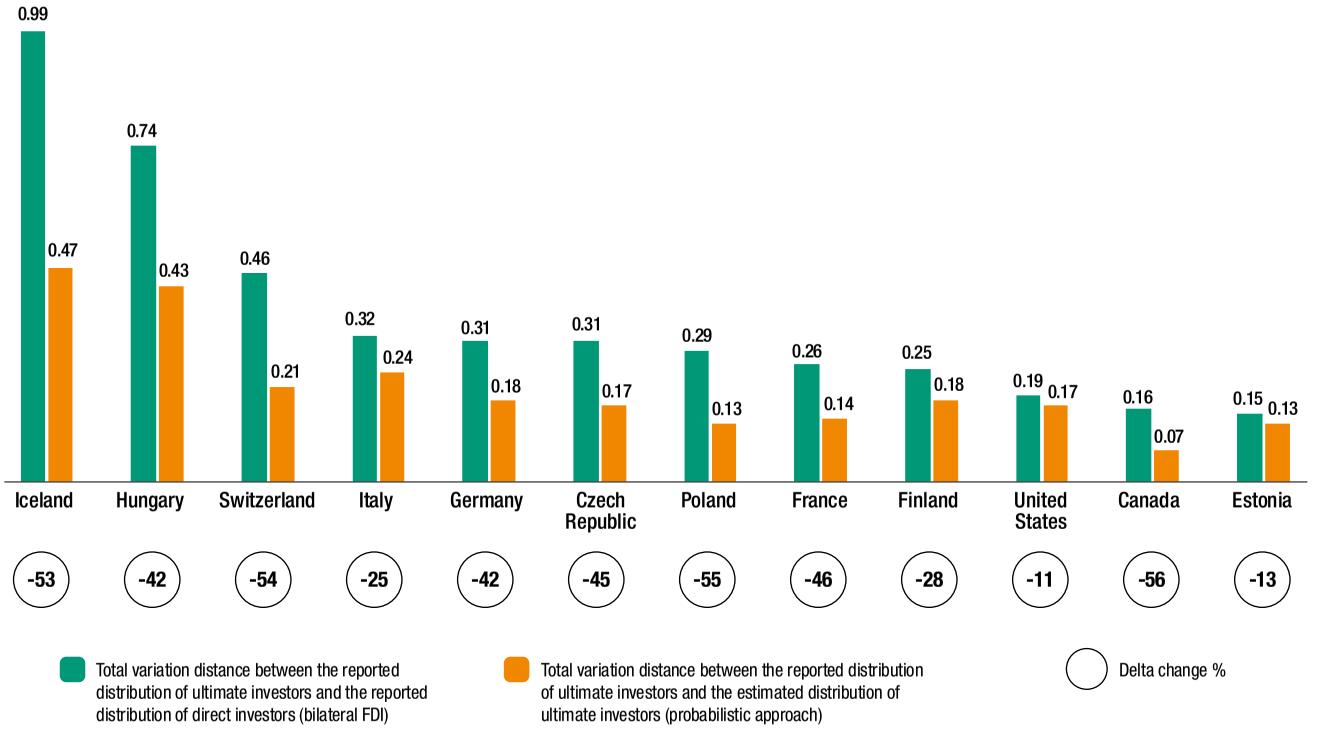
Figure 5. Comparison between reported positions by ultimate investors, reported positions by direct investors (bilateral FDI) and estimated positions by ultimate investors (Selected recipient countries, per cent)





Notes: Reported data on positions by ultimate investors and by direct investors from the OECD (https://stats.oecd.org), December 2018. For each recipient country, the top ten (reported) ultimate investors were selected.

Figure 6. Distance from the reported distribution of ultimate investors: bilateral FDI versus probabilistic approach



Notes: Reported data on positions by ultimate investors and by direct investors from the OECD (https://stats.oecd.org), December 2018. Distance measured in terms of total variation distance. Countries ranked based on the total variation distance between the reported distribution of ultimate investors and the reported distribution of direct investors.

4. Limitations and future directions

Issues: country-specific effects and round-tripping

Notwithstanding encouraging results presented in section 3, figure 5 also exposes some of the limitations of the methodology. A major one is related to the ability to capture country-specific effects. The methodology works well to remove more systematic and cross-cutting 'conduit noise' affecting bilateral FDI. However, the approach struggles to capture country-specific issues. An example is the role of Irish investment in the United States. In figure 5, Ireland features as a relatively large ultimate investor in United States, while it is generally considered, and indeed is treated by the methodology, as a conduit jurisdiction. A likely explanation for this effect is the recent wave of *re-domiciliation* of MNE parents from the United States to Ireland as a consequence of tax inversion. In this case, the probabilistic approach, capturing the systemic conduit role of Ireland in international investment, points the computation in the wrong direction, and amplifies the gap with the reported data of ultimate investors. Reassuringly, comparing the distributions across all countries, the anomalies are limited, while the effect of systemic conduit schemes, such as those involving the Netherlands and Luxembourg, is marked. A second issue concerns the treatment of round-tripping. Unlike standard bilateral FDI, the probabilistic approach allows for the possibility of round-tripping. However, the estimates of its share tend to be systematically biased, too small where round-tripping is more relevant (for example in Germany or Italy) or too large where it is relatively limited (United States). In the rest of this section, I will discuss potential remedies for these issues, focusing in particular on two interesting directions of research: the refinement of the calibration of the conduit probabilities and the relaxation of the Markov property to allow path-dependence.

Calibrating conduit probabilities

The main focus of this paper is on the computational machine, i.e. on setting up the modelling approach and the computational procedure that generate a good estimate of the distribution of ultimate investors *given* reasonably realistic inputs. The main inputs in this context are the distribution of direct investors, denoted by p_d, and the probability of conduit investment, p_c. The results' accuracy depends critically on how well the parameters are assigned. The empirical application of section 3 employs some simple parametrization, whereby $\hat{p}_d$ is derived from bilateral FDI (26) and $\hat{p}_c$ employs a refined version of the approach in Bolwijn et al. (2018) (see appendix). The treatment of $\hat{p}_d$ is not particularly problematic as (26) seems an obvious choice. The second parameter $\hat{p}_c$, the conduit probability, is more challenging and subject to improvement. The approach of Bolwijn et al. (2018) is only one possible way to size conduit FDI;

alternative approaches include *World Investment Report* (2015); Damgaard and Elkjaer (2017); Borga and Caliandro (2018). It would be useful to compare the results of the probabilistic approach across alternative methods. An attractive option could also be to combine the approach in *World Investment Report* (2015) or Bolwijn et al. (2018), focusing on SPE-related conduit FDI, with Borga and Caliandro (2018) targeting conduit investment through operational (non-SPE) entities. Departing from existing methods, bolder options could also be explored. In the current specification, conduit probabilities are assigned at the level of individual investors based on the conduit role that the jurisdiction plays in the overall international investment network. This approach is essentially driven by big numbers. It puts at the centre of the analysis the *global* investment hubs and allows for the major conduit structures – either affecting many recipient countries or some very large ones – to be captured. There are, however, country-specific issues that the method may fail to address. In the case of Irish investment in the United States described above, a jurisdiction (Ireland) that generally behaves as conduit plays the role of ultimate investor for a specific recipient (United States). Vice versa, some investor countries that do not appear as large conduits in the global picture may play that role for a specific recipient. Capturing such country-specific dynamics would require finding a way to estimate conduit probabilities $\hat{p}_c$ not only by investor countries i $(\hat{p}_c(i))$ as in the current formulation, but also by recipient country j $(\hat{p}_c(j,i))$. This would provide a much more granular picture of conduit FDI, and ultimately a more accurate profile of ultimate investors.

Relaxing Markov property to allow path-dependence

Over and above the improvements in the calibration of the parameters, the probabilistic approach itself (the 'computational machine') can be tuned. I discuss here one potential direction, dealing with the hypothesis of Markovianity (2). Condition (2) applied to the reversed investment process implies that the distribution of direct investors depends exclusively on the immediate recipient and not on other links downstream in the investment chain. In other words, it requires to 'forget' what is already known about the reversed investment process and focus only on the very last step of the Markov chain (the 'highest investor'). This assumption is particularly useful because it allows for the problem to be framed within the standard analytical setting of Markov chains, significantly reducing the modelling and computational complexity. However, in certain cases, the memoryless feature of Markov chains is particularly restrictive. One notable case is round-tripping, where, in fact, the results of the probabilistic approach tend to poorly match reported data (figure 5). Because of the Markov property, the approach does not recognize round-tripping as a special case. Round-tripping results mechanically when ultimate investors coincide with final recipients. In other words, round-tripping is not treated as a special case, i.e. differently from any other potential realization of the investment process.

This explains the under-estimation of round-tripping for those countries that are more prone to these practices and the over-estimation for countries for which round-tripping is relatively less relevant. Relaxing the Markov property to allow some path-dependence is an option that warrant further consideration, paying attention, however, to the trade-off between the marginal improvement in the results and the increase in computational and modelling complexity. Another, more pragmatic, option to deal with round-tripping is to assign a round-tripping probability *ex-ante*, aside from the computational approach, based on outside-in information on the individual countries (there is quite rich anecdotal and country-specific information on round-tripping, see for example Geng, 2004; Ledyaeva et al., 2015).

5. Conclusions and policy implications

This paper proposes a methodology to compute the distribution of ultimate investors for the set of recipient countries covered by inward bilateral FDI (including more than 100 countries, exceeding 95% of total FDI stock). The approach combines the information provided by bilateral FDI with assumptions on conduit investment to link final recipients and ultimate investors (reversed investment process). The investment dynamics implied by the reversed investment process can be modelled as an absorbing Markov chain where the absorbing states act as ultimate investors. For each starting point (recipient country), the limiting probability of absorbing states – analitically available – corresponds to the target distribution of ultimate investors. Comparison with the actual distribution of ultimate investors for twelve countries reporting this information shows that the methodology effectively looks through the main conduit jurisdictions providing a good approximation of the distribution of ultimate investors.

FDI statistics are first and foremost a picture of economic and financial integration among countries. Together with trade data and, more recently, GVC data they are the key indicators of the positioning of a country in the global economy. In a globalized world, these types of data are the empirical basis for many decisions of economic policy at the national and international level. FDI by ultimate investors add to countries' data equipment a key perspective on the underlying business linkages and 'real' financial and productive inter-dependencies, cleared of the 'noise' generated by financial intermediation. Such a perspective is not only complementary to standard FDI statistics but can, and increasingly does, provide alternative insights. Such insights have key implications for different areas of policymaking including investment and trade policies and international taxation.

One notable example concerns the investment effects of *trade tensions* between the United States and China. The impact on intra-firm trade between United States MNEs and their Chinese foreign affiliates can only be fully appreciated when the

exposure of Chinese FDI to United States investors is assessed through the lens of ultimate investors. In fact, the U.S. share of Chinese official inward FDI is low, at 3% of total FDI stock, due to the 'filter' imposed by conduit FDI, particularly through Hong Kong. Reassessing ultimate investors' weight through the probabilistic approach brings the U.S. share to 12%,[13] establishing the United States as the largest global investor in China. Interestingly, in another major international quandary such as Brexit, the ultimate investor analysis points in a different direction. The view by ultimate investor neutralizes the amplifying effect of European conduit jurisdictions and puts in perspective the share of European Union as investor in the United Kingdom, at 32%,[14] a sizable share but lower than the 41% indicated by standard bilateral FDI (2016 data).

More generally, international trade and investment treaties are formulated and scoped based on the nationality of the parties. In investment treaties, the main counterpart to focus on would be the investment decision maker, i.e. the ultimate investor. However, the presence of intermediate jurisdictions augments and blurs the scope of international treaties, producing a *de facto multilateralizing* effect. The *World Investment Report* (2016) argued that up to a third of apparently intra-regional foreign affiliates in major (prospective)[15] mega-regional treaty areas, such as the Trans-Pacific Partnership (TPP), the Transatlantic Trade and Investment Partnership (TTIP) and the Regional Comprehensive Economic Partnership (RCEP), would be ultimately owned by parents outside the region, raising questions about the ultimate beneficiaries of negotiations and treaties. In reality, what often happens is that intermediate investment routes follow the network of bilateral treaties, particularly Double Taxation Treaties (DTTs) and Bilateral Investment Treaties (BITs) – a well documented practice known as 'treaty shopping' (*World Investment Report,* 2016). From the perspective of a country involved in treaty negotiations or monitoring, and particularly for developing countries that are more exposed to the risk of information asymmetry, complete data and information, including on ultimate investors, are key elements for a 'deeper' analysis of investment relations to better inform treaty making. While developing the technical capabilities to collect this type of data, the probabilistic approach presented in this paper can provide reliable and relatively accessible estimates.

Likewise, at the level of national investment policies, any strategy aimed at attracting foreign investment (or boosting outward investment) should rely on a comprehensive view of the overall investment network in which the country is

[13] Result from the empirical application of the probabilistic approach of section 3.

[14] Result from the empirical application of the probabilistic approach of section 3. Estimated share in line with the share resulting from the data on ultimate investors reported by the UK National Statistics (https://www.ons.gov.uk).

[15] Under discussion at the time of the *WIR16* analysis.

embedded. Such view should go beyond the first layer of immediate investors or recipients and extend to ultimate investors where investment decisions are made (or, correspondingly, final recipients, where the actual productive activity takes place). From a more theoretical but related perspective, policy strategies for attracting FDI have traditionally been grounded in rich econometric literature on FDI drivers and determinants that often use standard bilateral FDI as empirical basis for gravity-type equations. In this context, employing as dependent variable bilateral links based on ultimate investors may lead to additional insights and inputs into investment policymaking.

International taxation is another natural policy area for the application of this study. The most important, although not unique, motivation of conduit FDI is MNE fiscal optimization and international tax avoidance (Bolwijn et al., 2018; Janský and Palanský, 2018). Studies on the link between FDI and tax avoidance focus on the relationship between conduit jurisdictions and recipient countries, and tend to overlook the role of home countries, partly due to a lack of data connecting conduit FDI to ultimate investors. However, as pointed out by the *World Investment Report* (2015), tax avoidance is a systemic issue. It involves offshore hubs that materially provide the legal and financial infrastructure. It affects host countries that are primarily affected by, but sometimes in their attempt to lure investment also complicit to, profit shifting. Tax avoidance also involves the home countries of investors, often because they do not have effective legislation in place to prevent the use of hub-based structures or unintentionally encourage the use of such structures by their MNEs. The view by ultimate investors adds the home country perspective to the puzzle of international taxation and investment. This is an important step towards the effective reform of international tax legislation, requiring a truly multilateral effort, achievable only with the contribution and commitment of all parties involved.

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Appendix. Approach to sizing conduit probabilities

The objective of this appendix is to present the methodology for sizing conduit probabilities employed in the empirical application of section 3. In the context of this paper, the conduit probability of a given jurisdiction i is the probability that outward investment from i are made by a conduit entity (see definition (17) in section 2.3). The approach is essentially a refinement of UNCTAD approach initially introduced in the *World Investment Report* (2015) and further developed by Bolwijn et al. (2018), in the context of the analysis of MNE fiscal contribution and tax avoidance. The methodology is based on a segmentation of jurisdictions based on their conduit and offshore role in the global investment network.

Group 1: Tax havens. A list of 38 small jurisdictions originally defined by the OECD. It includes small countries whose economy is entirely, or almost entirely, dedicated to the provision of offshore financial services.[16] Accordingly, the share of conduit investment in outward stock from these countries (i.e. the conduit probability) is 100%.

Group 2: Other investment hubs. This qualification applies to countries with substantial real economic activity (unlike tax havens) that also act as investment hubs for MNEs owing to a favorable tax and investment regime, typically granted through the option to operate by means of SPEs. Two subsets are identified.

> ***Group 2a. Self-reporting SPEs.*** When countries themselves report outward investment through SPEs, the preferential choice is to use their data to assign the conduit probability. In this case the conduit probability is given by the ratio between outward investment through SPEs and total outward investment, as reported by the countries.
>
> ***Group 2b. Estimated investment hubs.*** When the countries do not report the SPE component, the *implied investment method* provides a way to detect relevant investment hubs and estimate their conduit component. The method is based on the assumption of a linear relationship between GDP and FDI, or in other words, a relationship between the size of an economy and its (inward and outward) investment. Such straightforward relationship (supported by very high correlation coefficients) is broken when jurisdictions with a large share of conduit FDI are involved, because these investment are mainly financial and do not fully translate into GDP creation. A natural way to proceed is then to

[16] Anguilla, Antigua and Barbuda, Aruba, the Bahamas, Bahrain, Belize, Bermuda, British Virgin Islands, Cayman Islands, the Cook Islands, Cyprus, Dominica, Gibraltar, Grenada, Guernsey, Isle of Man, Jersey, Liberia, Liechtenstein, Malta, the Marshall Islands, Mauritius, Monaco, Montserrat, Nauru, Netherlands Antilles, Niue, Panama, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, San Marino, Seychelles, Turks and Caicos Islands, United States Virgin Islands and Vanuatu.

define a band (*confidence interval*) around the regression line corresponding to the normal relationship between GDP (x-axis) and (outward) FDI (y-axis), at a certain sufficiently high probability p. It is assumed that observations lying above the band are over-sized because of significant presence of conduit FDI, hence identifying the large investment hubs. For these hubs, the conduit component responsible for the outsize amount of FDI can be estimated as the delta between the observation and the corresponding upper band of the confidence interval, i.e. the additional FDI component that qualifies the jurisdiction as conduit. (Another, less conservative, option would be to calculate the conduit component as the delta between the observed value and the regression line.)

Group 3. Non-conduit jurisdictions. All jurisdictions that do not fall in the group 1 or 2 are assumed to have no conduit FDI, or equivalently, are assigned a conduit probability equal to 0.

Expression (27) summarizes the parametrization of the conduit probabilities p_c resulting from the application of this approach:

$$\hat{p}_c(i) = \begin{cases} 1 & \text{If } i \text{ is a tax haven (Group 1)} \\ \frac{SPE^{out}(i)}{FDI^{out}(i)} & \text{If } i \text{ reports } \textbf{\textit{SPEs}} \text{ (Group 2a)} \\ \hat{p}_{IMPL}(i) & \text{If } i \text{ is large hub but not reporting } \textbf{\textit{SPEs}} \text{ (Group 2b)} \\ 0 & \text{Otherwise (Group 3)} \end{cases} \tag{27}$$

where $SPE^{out}(i)$ is the total amount of outward investment made by SPEs in country i; $FDI^{out}(i)$ is the total amount of outward FDI from country i. Thus the second row in (27) is the share of investment made by SPEs (conduit entity) in total outward investment from country i, as reported by i. Instead, $\hat{p}_{IMPL}(i)$ in the third row denotes the conduit component estimated through the implied investment method described above.

This approach *improves* on the approach introduced in the *World Investment Report* (2015) and Bolwijn et al. (2018) in two aspects. First, it extends the scope of self-reporting SPEs from four countries (Austria, Hungary, Luxembourg and the Netherlands) to fourteen countries reporting SPEs, fully acknowledging and exploiting all available information (group 2a). Furthermore, it refines the methodology to select and size estimated hubs (group 2b). The original formulation of *World Investment Report* (2015) and Bolwijn et al. (2018) relied on some heuristic

criteria to identify large hubs, based on threshold for the ratio between FDI stock and GDP (conveniently set at 1). Once the conduit jurisdictions were identified, then the size of the conduit component was trivially given by the delta between the actual level of FDI and the GDP-implied level as estimated by the regression line. In the current formulation, the selection of the large hubs is based on a more robust statistical approach[17] and the sizing of the conduit component follows directly from the same procedure.

Table 1 provides for each selected conduit jurisdiction the resulting share of conduit FDI (i.e. the conduit probabilities).

Table 1. Conduit probabilities by jurisdiction

Group	Jurisdictions	$\hat{p}_c$ (Per cent)
1. Tax Havens	38 jurisdictions	100
2a. Self-reporting SPEs	Luxembourg	95
	Hungary	87
	Netherlands	73
	Iceland	37
	United Kingdom	21
	Portugal	15
	Denmark	13
	Switzerland	9
	Spain	7
	Estonia	6
	Sweden	5
	Belgium	4
	Norway	2
2b. Estimated hubs	Hong Kong	78
	Ireland	65
	Singapore	57

For group 1: see note 16. For group 2a: the list of reporting jurisdictions and the corresponding shares of outward SPEs is based on 2016 data reported by OECD (https://stats.oecd.org/), as of February 2018. For group 2b: selection of jurisdictions and estimates of conduit probabilities are based on the implied investment method (threshold probability for confidence interval at 0.9) with data for GDP and outward FDI stock from UNCTADStat. For simplicity, estimated investment hubs are limited to large jurisdictions, i. e. in the first quartile in terms of outward stock, covering around 99% of the total FDI stock. For Hong Kong, the estimate of the conduit probability is consistent with the share of business activities in outward FDI reported by Hong Kong national statistics (at 78% of total outward FDI according to the latest data, 2015). Countries not listed in the table are assigned conduit probability equal to 0 (group 3).

[17] The illustrated methodology based on confidence intervals is equivalent to using *studentized residual* for the detection of the outliers, a standard approach to the identification of outliers in a linear regression setting.

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