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# TRANSNATIONAL CORPORATIONS

INVESTMENT AND DEVELOPMENT

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UNITED NATIONS



Volume 30 • 2023 • Number 3

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**United  
Nations**

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# CONTENTS

## ARTICLES

- Peter Enderwick and Peter J. Buckley** 1  
Accelerating achievement of the SDGs: International business and the deployment of traditional knowledge
- Pascal Mayer and Christopher Albert Sabel** 29  
Subsidies and MNE investment location choices: Unravelling the effects of firm specificity and immediacy
- Onur Biyik** 59  
Exploring knowledge spillovers and GVC participation to understand double counting in GVCs: A case study of Japan

## FOCUSED SECTION

### World Investment Forum 2023: Key issues and elements of a forward-looking research agenda

- Introduction 87
- Kunal Sen** 91  
The drivers of investment and savings rates: An exploratory note
- Paul M. Vaaler** 101  
Discussion, debate and dissent about investment and sustainable development at the 2023 World Investment Forum
- Ari Van Assche** 109  
Why it is time for a “Global Value Chains for Least Developed Countries Initiative”
- Rudolf R. Sinkovics, Denanjalee Gunaratne and Noemi Sinkovics** 119  
Game-changer business models for sustainable development

## UNCTAD INSIGHTS

- Harald Pühr, Jakob Müllner and Claudia Trentini** 129  
An innovative measure for digital firms’ internationalization



# Accelerating achievement of the SDGs: International business and the deployment of traditional knowledge\*

Peter Enderwick<sup>a</sup> and Peter J. Buckley<sup>b</sup>

## Abstract

This paper explores traditional knowledge and its possible utilization by multinational enterprises (MNEs) in achieving the United Nation's Sustainable Development Goals, with a particular focus on Goal 13, Climate Action. We argue that traditional knowledge has been overlooked by business leaders and policymakers who have failed to explore its potential in tackling some of the "grand challenges" facing the global economy. We suggest that achievement of the Sustainable Development Goals could be accelerated with the active involvement of MNEs. The key issues are what sort of involvement should they seek and what challenges must be overcome. We also outline policies to support the wider dissemination of traditional knowledge through MNE involvement.

**Keywords:** climate action, cultural capital, multinational enterprises, SDGs, traditional knowledge

**JEL classification codes:** F23, O33, O34, Q01, Q57

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## 1. Introduction

The current global economy is at a turning point, with economic, political and social anxieties increasingly apparent. These anxieties are fuelled by growing recognition of the immensely complex economic and social problems that the world faces and yet struggles to address, principal among them climate change, poverty and hunger, social inclusion, universal education and sustainable growth, all of which challenge the concept of sustainable prosperity, and how this might be achieved.

The 2015 United Nations resolution “Transforming Our World” reflected broad societal concern emphasizing sustainable development through 17 Sustainable Development Goals (SDGs) comprising 169 specific targets to be achieved by 2030. The SDGs draw together a wide range of actors – government, business and civil society – guiding both policy and strategy. Achieving the Goals implies the need to tackle complex “wicked problems” (Rittel and Weber, 1973). The defining characteristic of such problems is a lack of agreement on the precise nature of the problem and hence, its preferred solution.

We believe that one important source of relevant knowledge – traditional knowledge – already exists but is underutilized. Traditional knowledge refers to the practices of local communities developed from experience, gained over the long term and adapted to the immediate environment. Such knowledge is collectively owned, orally transmitted and practically focused with application to areas including agriculture, health care and environmental management. Its primary contribution is to facilitate adaptation to changing conditions. In this paper we explore the ways in which achievement of the SDGs, with a specific focus on climate change (SDG 13), could be accelerated through the mobilization of traditional knowledge. Utilization of traditional knowledge faces significant challenges, and we argue that international business, and multinational enterprises (MNEs) in particular, can play a key role in expanding awareness and application of this underutilized knowledge source.

These concerns are central to the future of business, and in particular, international business since MNEs play a critical role in global prosperity. They are major users of global resources, their investment decisions affect employment and growth opportunities, and their innovation efforts contribute possible technological and organizational solutions to many of the world’s problems. At the same time, such firms are seen as key participants in the continuation or worsening of many significant problems. They dominate many of the most environmentally damaging industries – mining, logging, agriculture, international travel, automobile manufacturing and electronics. Their marketing activities encourage ever-expanding consumption. Their significance in these problems has provoked broad responses. They face growing societal pressure, with responses such as the adoption of economic, social and governance reporting or corporate social responsibility activities.

They experience greater regulation, such as emissions targets, as well as calls from academic commentators for them to play a growing role in tackling these “grand challenges” (Buckley et al., 2017). Earlier work on MNEs and climate change (Kolk and Pinske, 2008; Rugman and Verbeke, 1998) examines the creation and reconfiguration of “green” firm-specific advantages. We suggest a possible extension of these ideas to explore new sources of environmental technologies that offer alternative approaches and policies for tackling climate change – in effect, dynamic capabilities at the firm level.

Evaluation of the contribution of traditional knowledge, and in particular traditional ecological knowledge (Berkes, 1999), coincides with a growing recognition of the human impact on the global environment. The 2021 Intergovernmental Panel on Climate Change (IPCC) report acknowledges the highest CO<sub>2</sub> concentration in 2 million years, the fastest rise in sea levels in 3,000 years and the lowest recorded level of Arctic sea ice in 1,000 years (IPCC, 2022). These results are widely experienced as global warming, with intense rain and flooding in some parts of the world and extreme heat, droughts and bush fires in others. Continuing melting of ice sheets and glaciers is pushing up sea levels, endangering low-lying areas.

Though scientific inquiry has established the seriousness of climate change, policy action to address the problem has been hampered by lack of agreement on effective and coordinated responses, particularly attempts to mitigate climate change. The limited progress has drawn attention to alternative perspectives on climate change and, in particular, complementary strategies that highlight adaptation. Traditional knowledge, embedded in the practice of adaptation to changing dynamics between humans and their environment, offers a crucial alternative perspective (IPCC, 2023). Although such knowledge systems are increasingly acknowledged, their adoption is often general and uncritical (Ford et al., 2016; Petzold et al., 2020). In part, this valuation may result from a view of indigenous people as primarily “victims” of climate change (Belfer et al., 2017): indeed, the negative impacts they face far outweigh their contribution to the problem (Althor et al., 2016). However, it is now broadly accepted that transformational policy change is urgently needed (Diaz et al., 2019) and that underpinning such change is a reconsideration of human values and world views that inspire and guide policy (Cameron et al., 2021).

Bridging traditional and Western knowledge (Mistry and Berardi, 2016) offers advantages in that the former brings valuable time-series observations based on large samples, involves practitioners as researchers and offers an inexpensive form of scientific corroboration (Moller et al., 2004). However, such interactions are often characterized by power imbalances (Wheeler et al., 2020); it is important to ensure community relevance and participation, and demonstrate benefits to the indigenous community as well as mutual capability building (Ball and Janyst, 2008). In many cases there is also an urgent need to help build indigenous leadership and capacity (Cameron et al., 2023).

This paper offers a conceptual contribution, examining the role that MNEs might play as intermediaries in mobilizing and applying traditional knowledge beyond its local context as well as the challenges that this role presents. It argues that MNEs would benefit from incorporating such knowledge in their strategies as they respond to growing regulative and social pressures. We also suggest that MNEs may be uniquely placed to address the challenges that come with attracting, protecting and combining traditional knowledge with modern science. For the sake of brevity and clarity we illustrate our arguments through the vehicle of climate action (SDG 13) as a primary SDG. The need for effective climate action has never been more urgent, with United Nations leaders now talking of “global boiling” rather than global warming.<sup>1</sup>

The discussion is organized in seven sections. Following this introduction we discuss the SDGs, the primary framework for the global development agenda, and some of the reasons for the limited progress in achieving them. We then consider traditional knowledge, exploring its possible contribution to the Goals. Section four outlines the potential benefits to both MNEs and traditional communities of combining their resources. Sections five and six consider the challenges of utilizing traditional knowledge and the policy implications of these hurdles. The concluding section summarizes the contribution of the paper and highlights areas where further work is required.

## **2. SDGs: importance and complexity**

As indicated above, the SDGs are aspirational goals for a prosperous, sustainable and equitable global economy. Achieving them presents numerous and complex challenges. Standard policy responses, whether the use of markets, regulation, outsourcing or private-public partnerships, have failed to provide effective solutions (Head, 2008). Rittel and Webber (1973) in their classic analysis of wicked problems identified the key features as a lack of agreement on both the cause and scope of the problem, as well as its solution. Divergence of views on causes and responses impedes consensus in discussion and policy approaches. This is readily apparent in the climate change debate where there is disagreement on causes (manufactured or natural, unique or cyclical) and even whether a problem really exists (Benestad et al., 2016). Climate action (SDG 13) is a wicked problem because it is actually a series of related problems (air pollution, water management, waste disposal, reliance on fossil fuels and so on), for which the costs and benefits of policy interventions are extremely difficult to evaluate, the impacts are spatially dispersed and any response creates significant equity issues (Head, 2008).

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<sup>1</sup> Ajit Niranjana, “‘Era of global boiling has arrived’ says UN chief”, *The Guardian*, 27 July 2023.

Contention over causes and solutions to problems such as climate change highlights the value of exploring alternative frameworks and approaches. Indeed, there is growing acceptance that conventional scientific approaches that focus on climate mitigation may not be sufficient. Modern science approaches are reductionist and place little value on the experiences of affected stakeholders (hence the significant involvement of younger people in the climate action debate). These problems may not be solvable from a pure engineering perspective (Schon and Reid, 1994). Engineering solutions may also have limited appeal in a pluralistic global society where some see such solutions as reductionist, underrating the complexity of natural and human-impacted environments. The underlying disciplinary basis of modern science promotes specialization and segmentation when more holistic approaches may be revealing (Lawrence, 2010).

A further argument for seeking new sources of knowledge on complex problems such as climate change is overcoming path dependency. Path dependency exists when successive policies are underpinned by similar goals, values and institutional structures. Policymakers become locked in to repeated responses to the same or similar problems and engineered solutions. Institutional arrangements define recent problems in similar terms, trust the same knowledge sources and rely on past analytical techniques. Stakeholder groups are consistently and narrowly defined, and solutions are evaluated using customary metrics (Parsons et al., 2019). In light of these arguments, we suggest that traditional knowledge, part of the cultural capital of a number of societies, has much to offer in the analysis of complex problems such as those the SDGs seek to resolve.

The argument for alternative approaches is compounded by the reality that attainment of the SDGs has not progressed at a rate sufficient to meet the planned time frame, and in some cases, including on climate action, progress has been reversed (United Nations, 2019). A number of impediments hamper progress. First, recent conditions – the COVID pandemic (van Zanten and van Tulder, 2018), conflicts in Europe and political uncertainty – have refocused attention to other areas. The United Nations reports that because of only modest international investment in the SDGs, the SDG funding gap in developing countries has increased from \$2.5 trillion in 2015 to more than \$4 trillion per year today.<sup>2</sup>

Second, the Goals themselves have been criticized as vague or simply aspirational,<sup>3</sup> overly complex because of the interactions between them (ICS, 2022) and varying

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<sup>2</sup> United Nations Conference on Trade and Development, “Global FDI momentum weakened in 2022 with downward pressure on projects after Q1. Decline expected for 2023”, *Investment Trends Monitor*, No. 44, January. [www.unctad.org](http://www.unctad.org).

<sup>3</sup> William Easterly, “The SDGs should stand for senseless, dreamy, garbled”, *Foreign Policy*, 28 September 2015.

in the attention or priority they attract (Yang et al., 2020), thus requiring a carefully coordinated policy response – something particularly problematic for developing economies (Saguin and Howlett, 2022).

A third impediment results from the challenges of defining and measuring progress towards SDG targets. In the case of SDG 13 (climate action), more than half of the indicators are still under development (UNEP, 2021). A number of countries see the data requirements of reporting progress as an imposition (Sachs et al., 2022), with some adopting alternative proxies or regional measures, both of which make evaluation of global progress difficult.

Fourth, implementation of the SDGs will require considerable investment in capacity building, particularly strengthening of institutions and governance. Developing countries may lack the capital to make such investments or the ability to attract and implement the necessary technologies (United Nations, 2019). They may also face powerful lobbying efforts by entrenched interests (Dunlap and McCright, 2010). As the United Nations observed, in 2017 among the most powerful global economic units (nation States and MNEs), 7 of the top 25 were industries based on fossil fuels (United Nations, 2019).

Finally, perhaps the greatest impediment to achieving the SDGs is a failure to recognize that they require transformational rather than simply incremental changes (Filho et al., 2020). SDG climate targets have not been fulfilled within any single nation (O'Neill et al., 2018), and on current trends, are unlikely to be achieved before 2092 (Sachs et al., 2022). Transformational change will require new partnerships, novel alliances and unconventional approaches (United Nations, 2019).

### **3. The nature of traditional knowledge**

All societies generate cultural capital, which can be defined, following Thorsby (1999), as the stock of cultural value embodied in an asset. Beyond their economic value, such assets promote social and cultural creativity. Intangible cultural capital includes the ideas, beliefs, values and traditions that distinguish and unify a given group of people or society. It includes traditional knowledge that captures the skills, values and practices accumulated by societies through long and close interaction with their environment. It is holistic institutionalized knowledge, transferred orally, containing the observations and adaptations of previous generations and their connections to the natural environment. Traditional knowledge has aspects of the “knowledge commons” (Hess and Ostrom, 2007) in that the knowledge is collectively owned and applied by a communal group. This knowledge is sometimes referred to as indigenous knowledge where it has been accumulated by the original inhabitants of “settler societies” (Parsons et al., 2019). We use the terms traditional and indigenous interchangeably. Traditional knowledge is predominantly



tacit and is held internally by the affected group (Osunade, 1994), in part because of a lack of formal legal protection, which makes it vulnerable to appropriation. Its manifestation occurs through lifestyle adaptation in response to the changing local environment. While having particular relevance to the local ecosystem, some traditional knowledge may be of value in other locations.

The potential role of traditional knowledge in tackling complex problems such as achieving sustainable development is considerable, as it both augments and complements modern scientific approaches. As indicated above, analysis of wicked problems emphasizes the benefits of a variety of analytical approaches in problem definition and solution. Consensus on problems of this type is not likely to be reached simply as the result of further empirical evidence (Head, 2008). Differences between traditional knowledge and modern science enrich debates on the causes of and workable solutions to these problems. Traditional knowledge offers an alternative view of economic activity that embeds human activity within a cultural context, highlighting informal social rules that have long been used to reduce risk and provide assurance to members of a community. The resulting sense of stability and belonging are undervalued in modern or Western economic and scientific analysis (Sandhu, 2020). Traditional knowledge offers ways of increasing participation in policy formulation and implementation where alternative institutional arrangements such as joint ownership of projects are stressed. The holistic nature of traditional approaches to resource management also aligns closely with the SDGs, in particular highlighting the three Es of economics, environment and equity.

Traditional knowledge also serves to offset the shortcomings of modern science – the reductionist approach, discipline specialization, generalization of findings from limited data sets and emphasis on average as opposed to extreme values (Petzold et al., 2020). Furthermore, modern science focuses on climate change mitigation (stabilizing or reducing detrimental climatic changes) as opposed to adaptation, which underpins the application of traditional knowledge. Adaptation emphasizes a reduction of the detrimental impacts of climate change, providing the foundation for sustainability.

Adaptative strategies are strongly represented in traditional knowledge sources. Pastoralist societies have long practised stockpiling of emergency animal fodder, diverse herd composition to overcome extreme climate conditions and selective culling to ensure sufficient supplies for the strongest herd members. Nomadic movement reduces pressures on less productive land areas. Soil carbon can be conserved through mulching or the suspension of tilling. Traditional agroforestry enables a sustainable balance between the production of food crops and carbon retention through forestry. Forests also facilitate experimentation with shade-tolerant crops as average temperatures rise (Nyong et al., 2007). Limited progress towards agreement on mitigation policies (UNEP, 2022) has elevated the debate on adaptation, with the two strategies increasingly viewed as complementary.

There is growing acceptance of the need to rethink global sustainability, including a broadening of knowledge sources as well as conceptual approaches to its understanding; indeed, the present time could be seen a critical juncture in this debate (IPCC, 2022). The increasing incidence of events such as natural disasters (WMO, 2021), widespread public protests (Bugden, 2020) and radical changes in political leadership (Galaz et al., 2010) are all characteristic of this criticality. In addition, a number of settler societies (Australia, Canada and the United States, for example) are recognizing the value of traditional knowledge as they seek to redress historical grievances. High-level policy analysis also advocates greater consideration of traditional knowledge (IPCC, 2014).

Despite these positive developments, there has been limited adoption of traditional knowledge in climate policy, particularly in a formal way (Petzold et al., 2020). This reluctance to consider “de-Westernized” knowledge (Lim and Lee, 2018) has been attributed to several considerations. One is the belief that traditional knowledge lacks the scientific rigour and legitimacy of modern science derived from the most developed economies (Ellen et al., 2000; Stewart, 2019). Debate over this belief, which has been highly combative in places such as New Zealand,<sup>4</sup> is misplaced. What is critical is an understanding of what distinguishes traditional knowledge from modern science: its holistic perspective, cultural immersion, practical nature and focus on acquiring knowledge (coming to know) as opposed to discovering or knowing as a specific endpoint. This latter aspect is illustrated by the focus of Mongolian pastoralists who highlight the quality (soft or hard) and specific locations of forecast rains, rather than simply the quantity (Sneath et al., 2011). Furthermore, traditional knowledge is transformed through a systematic process of observation, testing and revision. The belief that traditional knowledge is “unscientific” appears in some cases to be simply incorrect. Stellar scintillation has long been used by indigenous peoples around the globe to predict likely rainfall levels and wind speeds. The scientific basis of this highly effective technique is the way that changes in humidity and air density alter the colours and intensity of stars. For example, higher levels of atmospheric water absorb the green and red spectrums of light, making stars appear uncharacteristically blue (a change in the refractive index) (Sofieva et al., 2013).

Second, many of the values that underpin traditional knowledge appear inconsistent with capitalist economic thinking. Capitalism sees people as owners rather than custodians of resources. It has implanted a mechanical as opposed to an organic representation of the world, seeks to codify knowledge as a restricted and tradeable resource, and has formalized institutions (Busingye and Keim, 2009).

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<sup>4</sup> David Lillis and Peter Schwerdtfeger, “The Matauranga Maori-science debate”, 12 December 2021, New Zealand Centre for Political Research, [www.nzcprr.com/the-matauranga-maori-science-debate](http://www.nzcprr.com/the-matauranga-maori-science-debate).

It also imagines unbounded material progress achieved through technological and economic advancement. This world view hinders exchange of knowledge and policy insights between the two groups. Traditional knowledge may also suffer from a form of “cultural distance”. While cultural distance initially referred to differences in norms and values between countries (Hofstede, 2001), in the case of traditional knowledge it can also apply within a country. For example, historical restrictions on the use of indigenous languages, the decline of traditional schooling or the disparagement of indigenous knowledge could all contribute to an internal cultural separation, hindering the exchange of ideas.

Third, in the face of rapid climate change some argue that traditional knowledge is becoming obsolete and has little to offer in the current debates (Gomez-Baggethun, 2022). This view is based on a static interpretation of traditional knowledge and fails to recognize its dynamism, which focuses on adaptation and learning, both of which contribute to longevity. An example is provided by the application in New Zealand of Maori Mātauranga (traditional knowledge) to tackle the contemporary problem of invasive weed growth on lake beds. The development of woven flax mats has provided a solution that stifles weed growth by cutting light levels while allowing native plants and fish species to recover. The flax mats – woven by local weavers, and thus providing valued employment – have replaced imported hessian mats made from jute.

In summary, we suggest that traditional knowledge offers a valuable and complementary knowledge source for securing sustainable global security and achieving the SDGs. There have been several calls to combine traditional and modern science knowledge (Brown et al., 2010; IPCC, 2014). We have argued that such complementarity could be invaluable in tackling the problems addressed by the SDGs. The critical question then is how to identify, mobilize, protect and commercialize such knowledge. The following section suggests potential benefits for MNEs in engaging with traditional knowledge and for holders of such knowledge in engaging with MNEs.

#### **4. Benefits to MNEs and traditional communities**

We believe that both MNEs and traditional or indigenous communities could benefit from a closer relationship in utilizing traditional knowledge, particularly knowledge relevant to climate action. We begin with the factors stimulating MNE interest in traditional knowledge. The first are the strong societal pressures that businesses now face to contribute to tackling global challenges, and in particular, to contribute to achieving the SDGs. These pressures are considerable and emanate from a wide range of stakeholders – employees, customers, financiers and industry regulators – raising the significant potential costs of failure to tackle climate concerns (United Nations, 2019).

MNEs would benefit from mustering traditional knowledge both directly and indirectly. Directly, MNEs' global spread means they face considerable risks and costs from climate change. Weather events affect locational choices, resource costs and availability, and supply chain reliability. Any mitigation of such risks is in the best interests of all firms, particularly the most global (Pinkse and Kolk, 2012). In addition, MNEs that are under considerable pressure to respond to growing environmental concerns are realigning their goals and strategies accordingly. Increasingly common are triple-bottom-line and environmental, social and governance reporting (Arvidsson and Dumay, 2021; Elkington, 1997) that considers environmental, social and business opportunities that a shift towards global sustainability could create (Business and Sustainable Development Commission, 2017). The SDGs provide a framework for achieving global prosperity that could be used to guide the transitions that society increasingly demands of MNEs. Combining modern and traditional scientific knowledge would better enable firms to achieve these goals as strategies for adaptation are developed. Social legitimacy would benefit from a commitment to pioneering novel technologies. Such strategies would be of particular appeal to MNEs that are engaged in the more environmentally sensitive sectors such as agriculture, mining and energy.

Indirectly, failure to reflect society's growing concern is likely to see MNEs facing significant costs and growing regulation as environmental mitigation standards for air pollution, water usage and waste minimization become more restrictive. Greater utilization of novel approaches, particularly those that offer sequential steps towards sustainability, could reduce the likelihood of reliance on extreme mitigation policies. Incorporating traditional knowledge could also contribute alternative organizational and governance approaches. Although historically privatization of common resources including land, broadcasting spectrum, seed genetics and even outer space has involved corporatization (Rowe, 2008), this is not inevitable and alternative ownership models are likely to be required when managing traditional knowledge. The experience that MNEs gain in developing organizational modes such as trusts, joint management and individual participation could facilitate a move from short-term financial gain to longer-term resource husbandry.

The mobilization of traditional knowledge would also provide opportunities for MNEs to realign their involvement with the SDGs. Evidence suggests that to date companies have emphasized only targets that they can affect within their operations and that focus on the reduction of harmful impacts (van Zanten and van Tulder, 2018). Worryingly, investment in climate mitigation in large-scale renewables has declined in recent years (UNCTAD, 2023). Applying traditional knowledge to some of the most challenging global problems would redress this imbalance and facilitate MNE involvement in promoting traditional knowledge.

Such engagement also needs to consider the costs of both acquiring such knowledge and integrating it with modern technologies. MNEs possess unique attributes that are needed for such an endeavour, including complementary resources and risk-management capabilities, organizational flexibility and relevant management experience. MNEs enjoy resources that are critical to the innovation, production and distribution of new technologies. Resource capital encompasses financial, technological and human capital that is firm-specific and highly specialized (Oliver, 1997). Its prior application provides the context to absorb new and novel technologies and to complement traditional knowledge, which may lack legitimacy beyond its indigenous purpose. Such resources are reinforced by institutional capital that supports industry infrastructure (sourcing, production and distribution facilities, skilled workforce and so on). Institutional capital also offers industry acceptance and legitimacy, crucial in the introduction of novel technologies and organizational forms. Incorporation of traditional knowledge within an existing organization or industry value chain enables the combination of the novel and the familiar.

MNEs are also well placed to assess the perceived usefulness of novel technologies. While MNEs may not be experts in traditional knowledge, their industry experience and legitimacy makes them experts in existing technologies (and their shortcomings), enabling them to both evaluate and broker insightful traditional skills. They are equipped to authenticate industry standards, evaluate performance and identify market opportunities, capabilities that may not be present within traditional society groups. In addition, their organizational form in stages of value adding (innovation, production, marketing, distribution and so on) enables them to cluster complementary expertise, thereby enjoying synergies that may be difficult to achieve in traditional societies.

Established MNEs are also well placed to evaluate the ease of use of adopted technologies. They are likely to have considerable experience in the management of commercialization risks, something that traditional societies often lack. Risk is high when resources are amorphous, their origin unclear and their continuing value uncertain (Lampel et al., 2000). Combining novel skills with existing technologies can provide risk mitigation, particularly where partner organizations offer corresponding capabilities. Furthermore, traditional knowledge is largely tacit and embodied in, or controlled by, a limited number of key individuals. Many MNEs have experience in dealing with intangibles, operating across diverse cultures and levels of economic development. This provides them with insights into how to manage cross-functional and cross-cultural teams both on-site and off-site. They also have considerable expertise in digital technologies which may be usefully applied to elements of traditional knowledge.

Their experience also extends to differing institutional logics, a key characteristic of traditional knowledge in its development, protection and commercialization. Experienced MNEs may operate in economies characterized by market logic,

State determination or tribal organization. This is valuable in that traditional societies may place limited reliance on market forces and instead, develop significant and complex social and tiered networks (Wellman and Berkowitz, 1988). More experienced firms are better placed to undertake the complex negotiations and adopt the distinctive ownership and governance structures that traditional groups may require. MNEs are malleable and have evolved in both their organizational structures and their boundaries (Buckley, 2011). Experience with intrapreneurship (Halme et al., 2012), open innovation (Huizingh, 2011) and crowd sourcing (Ghezzi et al., 2018) are all valuable in the mobilization of traditional knowledge.

Closer relationships with MNEs may also be beneficial for traditional communities. Although indigenous peoples comprise only about 6 percent of the global population, they protect 80 percent of the world's biodiversity and areas that form major carbon sinks. Closer relationships with market-driven partners such as MNEs – if such arrangements provide stronger protections than currently exist – could reduce the risk of misappropriation of traditional knowledge. Traditional knowledge is often seen as a “public good”, a shared heritage for which payment is neither necessary nor appropriate. In contrast, Western scientific efforts are typically afforded legal mandates.

Traditional communities would likely benefit in terms of capacity-building as they interact with a wider range of partner organizations and governance arrangements. Partner organizations such as MNEs may provide access to lower-cost finance, facilitating project adoption (UNCTAD, 2023). Indigenous knowledge would also benefit from closer links with Western science as traditional forms of climatic predictions now face greater uncertainty as a result of anthropogenic impacts on environmental developments (Ullah et al., 2023). There are also considerable emerging opportunities for traditional communities to engage in carbon markets and emissions trading schemes, areas where MNEs are likely to have relevant knowledge. The complexity of such markets places a premium on experience.

## **5. The challenges of assessing traditional knowledge**

Despite these clear motivations and capabilities, the assessment and mobilization of traditional knowledge with outside partners is fraught with difficulties. These difficulties arise from the nature of the knowledge under consideration as well as inconsistencies between traditional groups and MNEs.

Significant conceptual differences exist between traditional and modern views of knowledge. Traditional communities see knowledge in a connected way: connected to people, places and environment. Such knowledge is localized, although there may be similarities across systems (Kolawole and Cooper, 2022). In contrast, Western knowledge is seen as disembodied, with a separation

between those who generate knowledge and those who use it. Western science also sees knowledge as universal and effectively value free, applicable in a range of localities (David-Chavez and Gavin, 2018). Traditional knowledge holders seek reciprocity, ensuring that knowledge does not involve trade-offs or harm to other areas of society. In contrast, trade-offs are acceptable to Western science. For example, highly nutrient-rich fertilizers may create problems for waterways through runoff, but this is often an acceptable cost of increased agricultural productivity.

Critical traditional knowledge is embedded at the community level. It is shared only with community members and remains largely tacit. It is not based on a separation between knowledge generators (scientists and researchers) and knowledge users (end users). Traditional knowledge is closely interwoven in the cultural and social context in which it was created and refined. In many cases it is gender based (Fernandez, 1994). This suggests the need to develop close contacts with members of traditional communities, an enduring process likely to show limited returns in the short term (Rajan et al., 1981). An array of traditional community members is likely to be involved in negotiations, and desired outcomes may differ between the parties. MNE management must avoid a perception of knowledge extraction, instead promoting one of co-evolution. It is likely that many traditional communities, already endangered by climate change, will be willing to share knowledge, if not from a commercial view, then with the view of assisting others. Full accreditation of traditional knowledge sources is essential, as in the past such knowledge has sometimes been misappropriated and its legal status is not always clear (Robinson et al., 2017).

These difficulties are compounded by the view of MNEs held by some traditional community groups. For many indigenous groups, MNEs are part of colonialist or imperialist processes, usurping land, mineral resources and trading opportunities at the expense of the original population (Gedicks, 2001; Macklem, 2001). MNEs' technological and economic resources make them unequal partners in the negotiation process. Similarly, their entrenched commitment to profit and shareholder return does not align with the values of most community groups. There is likely to be an initial lack of trust in any joint enterprise; these are significant challenges, considering the complexity of the SDG agenda and the absence of institutional arrangements for achieving cross-sector and multisector collaboration. These have been addressed elsewhere (Eweje et al., 2020; Heuer, 2011; Selsky and Parker, 2005; van Tulder and Keen, 2018). Although the oral tradition of knowledge sharing may appear to differ radically from the knowledge management practices of MNEs, this is not necessarily the case, with such stories fulfilling a key role in legitimizing new ventures to collaborating parties (Lounsbury and Glynn, 2001).

A further consideration is the impact of facilitating (or inhibiting) conditions. We have already noted key facilitating factors that result from the limited progress in achieving some of the SDGs and resultant pressures for change that international

businesses face. But there are also key impediments at the firm level that could restrict the move from motivation to intention. The first of these is the problem of stranded assets (Semieniuk et al., 2022). Stranded assets are those that become obsolete or uneconomic prematurely, as a result of technological change, policy shifts or changes in demand and social values. Effective climate action – by limiting CO<sub>2</sub> emissions – would mean a massive reduction in the use of fossil fuels and thus asset redundancy in the need for reserves and processing facilities, as well as downstream activities. Although policy actions such as regulation, carbon pricing and tax incentives can be used to discourage investment in such assets, radical changes in strategy are discouraged by the fact that many MNEs in the energy sector are vulnerable to this problem. The greatest risk of stranded assets is likely to result from strict mitigation measures, whereas the propagation of traditional knowledge focuses on adaptation and thus could be beneficial.

A second impediment likely to be experienced by mature MNEs is a result of their longevity. Established routines and ways of thinking become established within corporate cultures, and radical change is seen as a threat to an existing culture. Where the long-established business model has produced profits, there may be broader stakeholder concern about radical strategic change. Disruptive technological change may be seen as “competence destroying” (Anderson and Tushman, 1990). Our argument that combining traditional knowledge with modern science enhances adaptation (Reeder-Myers et al., 2022), could help to reduce such anxieties.

MNE management will need to adopt novel approaches to cross-sector collaboration and power-sharing, participatory decision-making and the allocation of returns. As the generators and users of knowledge are brought together, co-ventures can ensure the enhanced relevance and applicability of such knowledge. Closer relations may encourage trust-building as the credibility of both parties is observed, leading to a reevaluation of alternative scientific perspectives and the limitations of knowledge bias. However, such approaches are costly. They are time-consuming, requiring detailed face-to-face exchanges employing scarce competencies that develop slowly over time and require both transparency and confrontation of complex power dynamics. Given these costs, it may be worthwhile pursuing relationships through stages. Sutherland et al. (2017) suggest an initial focus on co-assessment, where knowledge is collated and assessed by the two parties with a view to establishing its validity and applicability. Such an approach could also help identify potential problems of “biocultural hysteresis”, where the combination of traditional knowledge and mainstream science proposes protectionist environmental policies that constrain future adaptation to environmental developments (Lyver et al., 2019). Resolving agreed knowledge deficiencies could result in a second stage, co-production. A staged approach is likely to be less costly and affords opportunities to develop trust and understanding.



While not wishing to underestimate the challenges involved, we believe that this critical juncture, which the United Nations has declared a “Decade of Action”, makes it imperative for such parties to initiate contact with a view to offering new ideas, values and approaches in tackling problems that Western science, economics and politics have failed to resolve.

## 6. Policy implications

As indicated in the preceding discussion, broadening the appeal of traditional knowledge is a complex task, one that would benefit from stronger policy in several areas. For example, intellectual property protection legislation has limited applicability to traditional knowledge. Patenting and other forms of knowledge protection focus on individual and corporate knowledge as private property, failing to address community transgenerational knowledge. Where there is no clear or single attributable “owner”, knowledge is already in the public domain and it is embedded within a living milieu, prevailing protective approaches appear inadequate. Western knowledge protection is heavily weighted towards new knowledge, often regarding older and traditional knowledge as unfettered collective heritage. The finite timespan of modern intellectual property protection is also at odds with the evolving nature of traditional knowledge. Protection of traditional knowledge requires a focus on control rather than ownership of knowledge, as well as a recognition of its collective sharing and development. Its foundation in alternative belief systems as opposed to simply a return on scientific input must be acknowledged. Differences in the way knowledge is diffused are a further complexity. Modern scientific knowledge, perceived to have universal appeal and application, is openly disseminated through a range of forums including conferences and journals built on a shared knowledge system. Traditional knowledge is varied, in both its sources and its potential application, relying on obscure linked networks when it is shared. As a result of historical injustices, any framework to protect traditional knowledge must also be based on the principle of free, prior and informed consent (UNCTAD, 2023).

Several international instruments recognize the value and uniqueness of traditional knowledge. Key among these are the Universal Declaration of Human Rights, the International Covenant on Economic, Social and Cultural Rights, and the Declaration on the Rights of Indigenous Peoples. Although the Declaration covers a range of economic and intellectual rights, its focus is on individual rather than collective rights, which some legal theorists argue are not human rights (Donnelly, 1989). Furthermore, enforcement of the provisions of the Declaration resides with the State, and some States have been reluctant to extend all rights to indigenous populations. The Declaration on the Rights of Indigenous Peoples, article 31, states that “indigenous peoples have the right to maintain, control, protect and

develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions". The Declaration imposes a requirement for the state to uphold such rights. When first introduced in 2007 four nations with significant indigenous populations (Australia, Canada, New Zealand and the United States) initially opposed the Declaration. Since then, all four have reversed their decision and now endorse it. However, the Declaration is aspirational rather than a formally binding treaty. In some cases, such as China, which initially supported the Declaration, the authorities see no obligations once they declared that China has no indigenous peoples.

International trade and investment agreements also fail to offer adequate protection for traditional knowledge. The Agreement on Trade-Related Aspects of International Property Rights (TRIPS) encourages signatory states to develop patent protection but its criteria – any product or process must be new, nonobvious and capable of industrial application – are inconsistent with most traditional knowledge, which rarely is new, represents an inventive step or is applicable to industry. International investment agreements that could stimulate MNE interest in alternative technologies are also of limited value for traditional knowledge sharing. Nearly 90 percent of such agreements are older-generation agreements (prior to 2012) that do not emphasize climate action initiatives, often containing inconsistencies related to sustainable development. State regulatory discretion is unclear, resulting in numerous investor–State dispute settlement cases, many involving energy investors. The primary incentives that these agreements offer are either tax based or subsidies, loans and risk reduction mechanisms (UNCTAD, 2023). Reform of these agreements is urgently needed, and some of the reform proposals (e.g. flexible performance measures linked to development, reform or carve-out of investor–State dispute settlement, binding corporate social responsibility obligations for international investors) would certainly assist the co-assessment of traditional knowledge. Pleasingly, there have been a number of important government-driven initiatives in recent years. Canada's 2019 Impact Assessment Act requires the incorporation of indigenous knowledge and traditional practices in project evaluation to facilitate equitable and sustainable development.<sup>5</sup> New Zealand began to integrate Maori knowledge into public funding initiatives in 2005 through its Vision Mātauranga initiative.<sup>6</sup> One project reflecting this approach is the combination of indigenous knowledge and mainstream science to safeguard the country's food supply. The United States National Science Foundation recently launched a new Center

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<sup>5</sup> Impact Assessment Agency of Canada, "Guidance: Indigenous knowledge under the Impact Assessment Act", 3 March 2023, [www.canada.ca](http://www.canada.ca).

<sup>6</sup> New Zealand, Ministry of Research, Science and Technology, "Vision Mātauranga. Unlocking the Innovation Potential of Maori Knowledge, Resources and People", July 2007, [www.mbie.govt.nz/assets/9916d28d7b/vision-matauranga-booklet.pdf](http://www.mbie.govt.nz/assets/9916d28d7b/vision-matauranga-booklet.pdf).

for Braiding Indigenous Knowledges and Science, bringing together 57 indigenous communities and multiple institutions across a number of science disciplines.<sup>7</sup> Such initiatives are important for complementing the private sector strategies we are advocating.

There are also strong incentives for action at the local level. In addition to protest action to limit adverse impacts on local habitats, more proactive work involves collating and recording traditional knowledge. For example, the Traditional Knowledge Revival Pathways projects of the Kuku-Thaypan community in Cape York, Far North Queensland, enable elders to use modern media technology to record and preserve traditional knowledge. The projects use a variety of media – film, print, database and geolocation – to create a broad network to develop training and educational initiatives, which have been shared with similar communities in other parts of Australia and New Zealand. Media documents and databases empower indigenous communities in their dealings with outside organizations and in the management of their own knowledge systems.

This example highlights an important initiative, both local and national, that of capacity-building. Indigenous communities are generally poorly prepared for dealing with outside organizations. Globally, more than 80 per cent of indigenous peoples are found in middle-income countries, but almost half of employed indigenous peoples have no education, compared with just 17 per cent of their non-indigenous counterparts, and the shortfall is even higher for women (ILO, 2019). The 2020 Agenda for Sustainable Development includes a commitment to increase educational access for indigenous peoples (United Nations, 2015), but there is an urgent need for a range of institutions, both public and private, to contribute to capacity-building within traditional communities. Equally important is the capability of private organizations, particularly MNEs, to engage with indigenous communities. MNE management, while typically having global experience, rarely interacts with traditional communities, and any such interactions are generally challenging. There are few opportunities for training for such collaboration. Capability development within MNEs must recognize the need to ensure meaningful, transparent and equal engagement of traditional communities in any discussion, adherence to the principle of free, prior and informed consent, and protection of traditional interests and knowledge. While it could be argued that MNE managers often possess experience with alliances and mergers and acquisitions, these activities are generally undertaken for competitive rather than cooperative reasons and may not provide an appropriate foundation.

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<sup>7</sup> “NSF announces new Center for Braiding Indigenous Knowledges and Science”, 7 September, [www.nsf.gov](http://www.nsf.gov).

These managerial and policy challenges suggest the benefits of considering alternative approaches, particularly in the protection of traditional knowledge. One neglected mechanism is trade secrets. Traditional knowledge has characteristics that align closely with widely accepted interpretations of what constitutes a trade secret: it has potential commercial value, it is known only to a limited number of people and reasonable steps have been taken to keep it secret. Traditional knowledge generally meets the second criterion and its integration within traditional culture, its oral tradition of sharing and its often sacred nature, is consistent with the third criterion. As trade secrets can apply to both technical and commercial information, they are likely to be particularly useful when traditional and modern knowledge are combined. Successful examples can be found in bioprospecting where, for example, modern cancer drugs such as paclitaxel are derived from natural sources, in this case the Pacific yew tree. Partners in the commercialization of traditional knowledge could explore non-disclosure agreements, particularly in the early stages of co-assessment. Trade secrets do not give protection from other agents developing the same product or process independently, even through reverse engineering, yet combining traditional and modern knowledge to create new products or processes could enable stronger protection through patenting. Many MNEs have both experience with trade secrets and the resources to defend or enhance them. They also have the resources to meet or develop industry standards for novel products and processes. What is key for MNEs will be public perceptions of firm legitimacy and social responsibility as they broaden policy and production options to form novel and fruitful partnerships that contribute to widely supported sustainability goals.

## **7. Conclusions**

Our discussion addresses the possibility of accelerating achievement of the SDGs through the utilization of traditional knowledge. For ease of exposition, we have focused the discussion on Goal 13, Climate Action. We argue that traditional knowledge has been overlooked by both businesses and policymakers who have failed to explore its potential in tackling some of the “grand challenges” facing the global economy (Buckley et al., 2017). There is broad agreement that achieving the SDGs will not be possible without the active involvement of MNEs (Ghauri, 2022); the key issue is what sort of involvement they should seek and what challenges must be overcome.

We offer a contribution to this debate in several ways. First, we set out a way to move from the normative agenda of the SDGs framework to a strategic perspective enabling MNEs to make a substantial contribution to global prosperity and not simply reputational gains (Gneiting and Mhlanga, 2021). Traditional knowledge could offer significant benefits in the development of climate adaptation

strategies, an alternative to regulatory mitigation. Furthermore, a focus on the innovative characteristics of traditional knowledge enables its incorporation with the firm's value chain and not its marginalization as a function of corporate social responsibility or public relations (van Tulder and van Mil, 2022).

Second, we illustrate a route through which MNEs could revert from a reactive to a more proactive role in achieving the SDGs (Mio et al., 2020). The limited engagement of MNEs is seen as one reason for the slow progress in attaining the SDGs (van Tulder et al., 2021) and for the call in 2020 for a "Decade of Action". The nature of MNE investment will require change to more impact investment, intended to achieve social or environmental benefits as well as financial returns. Mobilizing traditional environmental knowledge would enable the rapid application of ideas that already exist, knowledge that would also contribute to the achievement of other SDGs including poverty eradication (Goal 1), reduced inequality (Goal 10) and partnerships (Goal 17).

A third contribution is in identifying an alternative route for MNEs to contribute to the SDGs. Whereas one way is to increase positive (and reduce negative) externalities associated with MNE activity (Montiel et al., 2021), we highlight a more direct and complementary route, that of mobilizing valuable new technological and institutional solutions. Our approach is consistent with the concept of externalities and could generate considerable technological spillovers as restricted technologies are used more widely.

Fourth, we embed our discussion within well-defined business concepts. We highlight the value of drawing upon partner resources, suggesting in this case positive synergies between traditional environmental knowledge and modern science (Cuervo-Cazurra et al., 2022). We also highlight the value of climate adaptation as opposed to mitigation. Our strategic perspective provides a path to future market opportunities and to the creation of new institutional arrangements that facilitate the multi-sector partnerships that must underpin achievement of the SDGs (Cornell et al. 2013; Sachs and Sachs, 2021).

Finally, we offer an alternative mechanism for governance of the global commons (biodiversity, land, atmosphere and the oceans). These are all areas that traditional knowledge recognizes as interlinked and unbounded by national borders. They are also areas where governance has failed: natural capital is being depleted in part because it lacks a broad definition and accurate pricing (Cole, 2015). The expanded application of the best elements of modern science and traditional knowledge offers alternative and adaptive governance and the opportunity to learn, essential in achieving the SDGs (Folke et al., 2005; Pahl-Wostl, 2009).

Although we offer a conceptual framework for increasing MNE effectiveness in making progress towards the SDGs, operationalizing these ideas will be challenging. There are challenges for policymakers in ensuring representation of

traditional knowledge in decision-making, in protecting such knowledge and in ensuring equitable interactions. There are significant opportunities for further work to provide practical guidance to MNE managers. The difficulties of cross-sectoral partnerships are well understood, but more work is needed in this area and particularly from the perspective of traditional knowledge holders. Similarly, new insights into acceptable institutional solutions for traditional stakeholders would assist the likelihood of knowledge being made available, the terms of such availability and the extent of application. Accepting the unique cultural contexts within which such knowledge is entrenched suggests that a wide range of studies will be required, drawing on a number of disciplines and geographies. It also suggests the value of cross-cultural research, something in which international business scholars have proficiency. Cross-industry analyses would be useful in identifying those MNEs most likely to seek engagement in projects of this nature. It may be that firms in the most climate-sensitive industries (mining, agriculture, resource processing and so on) are those with the most to gain, and also those requiring the most significant strategic adjustments. These are ambitious research needs but fundamental in achieving sustainable global prosperity.

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# Subsidies and MNE investment location choices: Unravelling the effects of firm specificity and immediacy\*

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## Abstract

Industrialized countries increasingly use targeted subsidies to lessen firms' disadvantages caused by climate change, geopolitical realignment of trade relationships and local COVID-19 pandemic dislocations. The debate over the United States Inflationary Reduction Act and the European Union criticism of it because of its effect on firms' investment location choices exemplify how subsidies affect investment flows. We investigate to what extent different subsidy schemes affect firms' investment location choices and explore the effect on two dimensions: immediacy (direct versus indirect) and firm specificity (firm-specific versus non-firm-specific). Using a sample of United States MNEs and their investments in subsidiaries in the European Union and China, we find that direct subsidies have a greater positive effect on investment than indirect subsidies, and that non-firm-specific subsidies have a greater positive effect than firm-specific subsidies. Our study establishes a more nuanced understanding of subsidy effects, suggesting that policymakers should align their subsidy schemes for attracting foreign direct investment accordingly.

**Keywords:** foreign direct investment, institutions, investment location choice, policy support, subsidies

**JEL classification codes:** D04, D78, H29, L52

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## 1. Introduction

The rapid succession of recent and ongoing international crises, such as the COVID-19 pandemic (WHO, 2023), the Russia–Ukraine war<sup>1</sup> with its resulting shock to food and energy prices<sup>2</sup> and the growing rivalry between the United States and China (Li et al., 2022), as well as efforts to combat climate change (UNCTAD, 2021), have upended business-as-usual policymaking and led to a paradigm shift toward a more interventionist role of the State.<sup>3</sup> The European Union, for example, has tried to entice the production of electric vehicle batteries with a \$7 billion plan that included \$1.5 billion of public subsidies, with the express goal to capture a share of the global production of this strategically important industry (UNCTAD, 2020). The United States Inflationary Reduction Act and the European Union Green Deal, both containing extensive subsidies for specific industries, are emblematic of this fundamental pivot. The heated debate on “how Europe should answer the [United States] Inflation Reduction Act” (Kleimann et al., 2023), as well as specific examples of firms reconsidering their investment plans,<sup>4</sup> illustrate the impact of subsidies on firms’ investment location choices.

Location choice by multinational enterprises (MNEs) is a longstanding topic in the academic literature (Delios and Henisz, 2003; Georgallis et al., 2021; Maggioni et al., 2019). This stream of research has investigated various factors that influence location choice and has established that subsidies, as part of a country’s formal institutional framework, attract foreign investment (Georgallis et al., 2021). Further studies have demonstrated that subsidies are linked to industry emergence (Georgallis et al., 2019) or industrial change (Bohnsack et al., 2015). However, the UNCTAD *World Investment Report 2023* (UNCTAD, 2023) also shows that subsidies can prevent the renewal of industries by increasing the attractiveness of fossil fuels relative to sustainable alternatives. Most research so far has conceptualized host-country subsidies and their effect on MNEs’ foreign location choices as monolithic. In fact, subsidies have several dimensions, with presumably varied effects on location choice. For example, Georgallis et al. (2021) find a positive relationship between direct feed-in tariffs (per-unit subsidies paid when electricity generated from renewable energies is fed into the grid) and location choice. Yet, Tesla turned down €1.1 billion in European Union aid in 2021, citing the extensive administrative burden before receiving the funds as the reason for withdrawing

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<sup>1</sup> *The Economist*, “Why Ukraine must win”, 1 April 2022; “Vladimir Putin’s war is failing. The West should help it fail faster”, 15 September 2022.

<sup>2</sup> World Bank Group, “Food and energy price shocks from Ukraine War could last for years”, Press release, No. 2022/056/EFI, 26 April 2022.

<sup>3</sup> *The Economist*, “Business and the State: The new interventionism”, 15 January 2022.

<sup>4</sup> Silvia Amaro, “Tesla is not the only company reviewing its Europe investment after Biden’s Inflation Reduction Act”, CNBC News, 3 March 2023.



its funding application.<sup>5</sup> Thus, depending on their configuration, subsidies do not seem to be universally positive in attracting foreign investment. Given the high costs for governments to create subsidy schemes and the administrative burden for MNEs to access them, it is important to understand which types of subsidies attract foreign investment.

The goal of this study is to examine the effects of different subsidy configurations on MNEs' choices of international investment location. We use institutional theory (North, 1990 and 1991) and specifically the institutions-based view (Peng et al., 2009) to examine this relationship for two dimensions of subsidies: immediacy and firm specificity. These dimensions are not chosen at random or self created. For immediacy, we resort to an established taxonomy of subsidies from the Organisation for Economic Co-operation and Development (OECD) (2021). Subsidies can be either direct – such as an operating grant, which is a cash payment, or indirect – such as a government buffer stock, in which no immediate cash transfer from State to company takes place (OECD, 2021). For firm specificity we adopt a categorization of subsidies by Global Trade Alert, a think tank affiliated with the University of St. Gallen in Switzerland (Evenett and Fritz, 2021). Subsidies can be either firm-specific, meaning that the beneficiary is a known firm or group of firms, or non-firm-specific, meaning that firms are not predefined and many are eligible upon application (Evenett and Fritz, 2021).

As a baseline, we follow prior work (Georgallis et al., 2021) and hypothesize that subsidies have a positive effect on foreign location choice, because firms tend to engage in jurisdiction shopping, a concept describing the inclination of multinational firms to choose those locations that offer the most generous conditions (Findlay, 2014; Georgallis et al., 2021). We extend this research and hypothesize that the effect on foreign location choice is greater for direct subsidies than for indirect ones because direct subsidies immediately and palpably benefit the firm conducting foreign investment, whereas indirect subsidies may benefit the firm later when other conditions are fulfilled after the investment. Furthermore, we hypothesize that the effect of non-firm-specific subsidies is greater than that of firm-specific ones. We assert this because non-firm-specific subsidies may be available to all applicants in a specific target group – industry, sector, topical – whereas firm-specific subsidies are granted only to set beneficiaries. Although firm-specific subsidies may signal the availability of additional future support, they are by no means a guarantee. Thus, non-firm-specific subsidies reduce the risk for investing MNEs to a greater extent than firm-specific subsidies.

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<sup>5</sup> Peter Campbell, Joe Miller and Edward White, "Tesla forced to turn down €1.1bn in EU support for German battery plant: Delays to factory near Berlin meant carmaker unable to meet European State aid conditions", *Financial Times*, 26 November 2021; Nadine Schimroszik and Victoria Waldersee, "Tesla decides against state aid for German battery plant as Musk opposes subsidies", Reuters, 26 November 2021.

We find empirical support for our hypotheses in a large sample of public United States MNEs and their investment decisions in countries of the European Union and China between 2009 and 2019. We restrict our sample to this period and these locations because we are relying on a new data set of all subsidies implemented in the European Union and China during this time frame (Evenett and Fritz, 2021). To our knowledge, no comparable cross-industry database of subsidies exists to date.

We contribute to the literature on MNE location choice and subsidies in several ways. First, we provide a starting point for future research on subsidies by offering a detailed framework of subsidy configurations. Extending prior work (Georgallis et al., 2021) that investigated the effect of one specific type of subsidy (direct, non-firm-specific) on foreign location choice, we show that the effects of subsidies depend to a large extent on the configuration of subsidy schemes in terms of immediacy and firm specificity. This framework not only can guide research on location choice but also may help to explain heterogeneity in entry modes, variations in subsidiary performance or differences in behaviour of State-owned and privately owned MNEs. Second, our findings may provide guidance for evidence-based policymaking. Since policymakers face tight budget constraints, plentiful demands for action and high administrative costs, it is crucial that they design appropriate subsidy schemes. Our findings suggest that direct as well as non-firm-specific subsidies are best suited for attracting MNE investment in foreign subsidiaries. Third, our study contributes to the understanding of managers and policymakers. On the one hand, we aim to inform managers about the benefits and costs of different subsidy schemes. On the other hand, we aim to inform policymakers about which subsidy schemes attract foreign investment by MNEs. Both perspectives are important because managers have high search costs in looking for the schemes that support their strategies, and policymakers have high administrative costs in designing and managing these schemes. Taken together, our study adds to the rich body of literature analysing the relationship between formal host-country institutions (North, 1991; Williamson, 2000) and MNEs' international investment decisions (Delios and Henisz, 2003).

## **2. Literature review and hypotheses**

### **2.1 Formal institutions as policy support**

Management research has focused on host-country determinants as a predictor of foreign direct investment for decades (Dunning, 1980). Prior research has established that different host-country characteristics are crucial in firms' decisions to invest. In particular institutional factors in the host country have been found to be key determinants in foreign firms' location choices (Donnelly and Manolova, 2020).

We follow the perspective of New Institutional Economics, put forward by North (1990 and 1991), which characterizes institutions as “rules of the game” that are crucially important for economic behaviour and economic outcomes. For example, in the context of international business, strong host-country institutions reduce uncertainty and thus transaction costs (North, 1991) for MNE operations (Hotho and Pedersen, 2012). The demarcation of institutions by North (1990 and 1991) into formal institutions, such as explicit rules and laws, and informal institutions, such as behavioural norms, taboos and customs, has helped to identify many relevant antecedents of MNEs’ foreign direct investment. In particular, formal institutions have been used to study MNEs’ decisions to enter foreign countries. Prior work has shown that bilateral investment treaties (Albino-Pimentel et al., 2018), intellectual property rights regimes (Coeurderoy and Murray, 2008) and industry-support policies (Georgallis et al., 2021) attract foreign MNEs. Similarly, studies have demonstrated that countries with stricter employment regulation attract cross-border mergers and acquisitions (Alimov, 2015) and that local labour standards affect firms’ location choices (Maggioni et al., 2019).

The second strand of institutional theory we utilize is the institution-based view (Peng et al., 2009), which posits that institutional environments are crucial antecedents for firms’ strategic choices. In this perspective, firms are conceptualized as autonomous agents that pursue their interests and make strategic choices within the formal and informal constraints in an institutional environment (Peng et al., 2009). The essential element in this view is the tenet that the institutional framework influences firm behaviour.

Relatively recently, the academic conversation about host-country formal institutions put a spotlight on host-country policy support, defined as institutional arrangements that are designed to support specific sectors or firms, and its effects on MNEs’ foreign location choices (Georgallis et al., 2019; Georgallis et al., 2021). This is in contrast to a historically more constraining view of institutions, exemplified by the notion that firms choose foreign locations with the least binding regulation (Ahuja and Yayavaram, 2011). Two examples of this are pollution havens (Copeland and Taylor, 2004), in which legal constraints against pollution are lax (Siegel et al., 2013), and MNEs’ practice of outsourcing socially irresponsible practices to foreign subsidiaries in response to institutional pressure from stakeholders in their home country (Witt and Lewin, 2007).

Research on policy support argues that MNEs are attracted by more stringent and enabling formal institutions. For example, Georgallis et al. (2021) showed that MNEs in the renewable energy sector choose to locate their investments in countries that have a higher level of policy support in the form of more generous feed-in tariffs (Glenk and Reichelstein, 2019). Such policy support can also help

nascent industries to gather momentum, enabling the emergence of local industry (Georgallis et al., 2019). These studies either focused on one particular type of policy support (e.g. Georgallis et al., 2021; Georgallis et al., 2019); looked at policy interventions on a broader level, such as command-and-control, market-based and voluntary policy instruments (Bohnsack et al., 2015); or compared different policy support systems qualitatively (Lewis and Wisser, 2007). However, many market-based policy interventions in the form of subsidy configurations have not been compared empirically. Thus, much of the heterogeneity of subsidies and their effects on MNEs' foreign location choices have not yet been studied.

## **2.2 Two key dimensions of subsidies: immediacy and firm specificity**

International business research has so far conceptualized policy support in the form of subsidies as homogeneous. Yet, policy support is multifaceted, with potentially heterogeneous effects on MNEs' foreign investment location choices, depending on the type of subsidy. Although multiple classifications for subsidies exist, we put forward two salient dimensions that are in line with a taxonomy of the OECD and a classification of Global Trade Alert: immediacy and firm specificity.

### **2.2.1 Immediacy**

Immediacy refers to the degree to which a subsidy affects firms' cash stock. The OECD provides a taxonomy in which subsidies are classified as direct transfer of funds when they refer to a direct payment to a beneficiary under clear, predefined conditions, such as output bounties, deficiency payments, operating grants, input-price subsidies or wage subsidies (OECD, 2021). We classify direct transfers of funds as direct subsidies. The other categories of the taxonomy, which we classify as indirect subsidies, refer to future payments or benefits that may be granted under certain conditions, such as reduced rates of income tax, production tax credits, forgone tax revenues, transfers of risks to government or induced transfers such as monopoly concessions (OECD, 2021).

We subsume the latter classifications as indirect subsidies because they do not provide an immediate and direct transfer of cash to the beneficiary but necessitate that a potential beneficiary first make an investment and start business activities that may later receive a form of rebate. This may be a tax rebate, a payment in case certain risky investments did not realize a predicted return or price regulation (OECD, 2021), such as in the form of feed-in tariffs for renewable energy (Georgallis et al., 2021). This dimension of immediacy (direct or indirect) of subsidies is important because it affects the risk that foreign MNEs bear when entering a market – and thus firm strategy – considerably. For an overview of the direct and indirect categories, see table 1.

**Table 1. Demarcation of direct and indirect subsidies**

Immediacy		Examples, based on OECD classification
Direct subsidies		<ul style="list-style-type: none"> <li>• Output bounty or deficiency payment</li> <li>• Operating grant</li> <li>• Input-price subsidy</li> <li>• Wage subsidy</li> <li>• Capital grant linked to acquisition of land</li> <li>• Grant tied to the acquisition of assets, including foreign ones</li> <li>• Government research and development</li> <li>• Unit subsidy</li> </ul>
Indirect subsidies	Tax revenue forgone	<ul style="list-style-type: none"> <li>• Production tax credit</li> <li>• Reduced rate of income tax</li> <li>• Reduction in excise tax on input</li> <li>• Reduction in social charges (payroll taxes)</li> <li>• Other government revenue forgone</li> <li>• Investment tax credit</li> <li>• Tax credit for private research and development</li> <li>• Value added tax or excise tax concession</li> </ul>
	Other government revenue forgone	<ul style="list-style-type: none"> <li>• Waiving of administrative fees or charges</li> <li>• Underpricing of a government good or service</li> <li>• Underpricing of access to government land or natural resources</li> <li>• Debt forgiveness or restructuring</li> <li>• Government transfer of intellectual property rights</li> <li>• Underpricing of access to a natural resource harvested by final consumer</li> </ul>
	Transfer of risk to government	<ul style="list-style-type: none"> <li>• Government buffer stock</li> <li>• Third-party liability limit for producers</li> <li>• Assumption of occupational health and accident liabilities</li> <li>• Credit guarantee linked to acquisition of land</li> <li>• Loan guarantee; non-market-based debt-equity swap and equity injection</li> <li>• Price-triggered subsidy</li> </ul>
Induced transfers		<ul style="list-style-type: none"> <li>• Import tariff or export subsidy; local content requirements; discriminatory government procurement</li> <li>• Monopoly concession</li> <li>• Monopsony concession; export restriction; dual pricing; provision of below-cost electricity by a State-owned utility</li> <li>• Wage control, land use control</li> <li>• Credit control; below-market loan by a State-owned bank</li> <li>• Deviations from standard intellectual property right rules</li> <li>• Regulated price; cross subsidy</li> </ul>

Source: Authors presentation based on OECD (2021).

Direct subsidies are exemplified in the financial grant (\$62 million) paid to Sikorsky Aircraft by the United States Department of Defense to conduct research in science and engineering.<sup>6</sup> In contrast, an example of indirect subsidies is the State loan granted to Tesla Motors by the United States Department of Energy in 2010.<sup>7</sup> Tesla received the loan with favourable terms under the condition to “produce fuel-efficient advanced technology vehicles”. To be eligible for the direct loan programme for advanced technology vehicles, projects must produce products in accordance with predetermined requirements, establish or modernize new facilities, be situated in the United States and have a realistic probability of repayment.<sup>8</sup> These examples show that direct subsidies affect a firm’s finances immediately, whereas indirect subsidies may improve firms’ finances when certain conditions are met in the future. Thus, firms bear more risk for a longer time with indirect subsidies than with direct subsidies.

Strategy research has shown that cash stock is an essential asset (Kim and Bettis, 2014) for dealing with uncertain economic decisions because those unutilized resources can be easily allocated to unforeseen activities in foreign markets (Asseraf and Gnizy, 2022). In the case of investment decisions in host countries, firms operate in an unfamiliar environment and thus face uncertain economic conditions in the form of liability of foreignness (Hymer, 1976; Sethi and Guisinger, 2002; Zaheer, 1995) and added costs of doing business abroad (Hymer, 1976). Thus, cash stock is a crucial asset for business endeavours in foreign host countries. The effect of subsidies on cash stock is not homogeneous though, which is apparent in the OECD classification of government support.

Furthermore, indirect subsidies are harder to quantify than direct subsidies, both *ex ante* and *ex post*. Whereas direct subsidies can be detected and measured rather precisely, indirect transfers are more difficult to quantify both for the OECD and for firms specifically (OECD, 2019). The amounts granted through direct subsidies as, for example, operating grants or input-price subsidies are easy to quantify (OECD, 2021) and can thus be easily priced into corporate calculations of return on investment. In contrast, the effects of indirect subsidy mechanisms such as an import tariff or a monopoly concession are more difficult to assess. For investment location decisions, it is crucial for firms to have a very thorough understanding of the benefits of each location, since decision makers are confronted with

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<sup>6</sup> Global Trade Alert, “United States of America: The Department of Defense provides a financial grant to Sikorsky Aircraft Corporation”, [www.globaltradealert.org/intervention/97649](http://www.globaltradealert.org/intervention/97649) (accessed 21 September 2022); United States Government, “Grant summary – Sikorsky Aircraft Corporation”, [www.usaspending.gov/award/ASST\\_NON\\_W911W61320003\\_2100](http://www.usaspending.gov/award/ASST_NON_W911W61320003_2100) (accessed 21 September 2022).

<sup>7</sup> Global Trade Alert, “United States of America: \$465 million loan to Tesla Motors from the Department of Energy”, [www.globaltradealert.org/intervention/72259](http://www.globaltradealert.org/intervention/72259) (accessed 21 September 2022).

<sup>8</sup> United States, Department of Energy, Loan Program Office, “Advanced Technology Vehicles Manufacturing Loan Program”, [www.energy.gov](http://www.energy.gov) (accessed 14 November 2022).

complex environments in which gathering information and conducting analysis is crucial (Maitland and Sammartino, 2015). The importance of subsidies in the investment calculations of firms can also be seen in their reaction to the withdrawal of previously granted subsidies. For example, in the case of *Micula v. Romania (I)*, Swedish investors legally fought the post-investment withdrawal of previously granted investment subsidies (UNCTAD, 2022b).

Following prior work (Georgallis et al., 2021) and our own assertions, we hypothesize that subsidies in general, whether direct or indirect, should attract foreign MNEs to invest in host countries. We additionally hypothesize that the effect of subsidies on MNEs' location choices should be stronger for direct than for indirect subsidies. This is so because MNE finances are immediately positively affected by direct subsidies but not by indirect ones, which reduces the MNEs' risk of foreign investment.

***Baseline hypothesis 1:*** *Host-country subsidies are positively related to the likelihood of MNEs investing in that foreign country.*

***Hypothesis 2:*** *The positive effect of direct subsidies on the likelihood of foreign MNE investment is stronger than the effect of indirect subsidies.*

### 2.2.2 Firm specificity

Firm specificity refers to the degree to which a subsidy scheme is directed only to specific preselected firms (firm-specific) or is open for applications of firms that are not predefined (non-firm-specific). Many subsidies are targeted only at specific firms and are inaccessible to firms that do not belong to the predefined group (Evenett and Fritz, 2021). The examples of Sikorsky Aircraft and Tesla Motors are both firm-specific because those firms specifically had access to a specific subsidy. In contrast, European Union feed-in tariffs for renewable energy firms are non-firm-specific and open to any firm that would feed electricity from renewable sources to the grid (Georgallis et al., 2021). Other examples of non-firm-specific policy support are a production subsidy for United States farmers (\$143 million) approved by the United States Department of Agriculture in May 2018,<sup>9</sup> and the 2009 dairy export incentive programme that was available for bidding by private exporters.<sup>10</sup>

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<sup>9</sup> Global Trade Alert, "United States of America: The Department of Agriculture provides a production subsidy to multiple farmers worth USD 143 million.", [www.globaltradealert.org/intervention/94668](http://www.globaltradealert.org/intervention/94668) (accessed 21 September 2022); United States, Department of Agriculture, "Farm Bill", [www.usda.gov/farmbill](http://www.usda.gov/farmbill) (accessed 21 September 2022).

<sup>10</sup> Global Trade Alert, "United States of America: Dairy Export Incentive Program", [www.globaltradealert.org/intervention/15301](http://www.globaltradealert.org/intervention/15301) (accessed 21 September 2022).

The importance of firm specificity in research on host-country institutions was first put forward by Blake and Moschieri (2017), who find that MNEs face a firm-specific institutional environment in host countries. They show that legal disputes between foreign MNEs and host countries lead to divestments of MNEs as they perceive a deterioration of the host-country investment environment for them specifically. In general, it can be expected that subsidies are more attractive to a wider audience of firms when they have not been granted only to a single firm or group of firms. While firm-specific subsidies can also indicate to non-eligible firms that the institutional environment of a country is generally positive within a sector, such subsidies are less attractive than subsidy schemes that are not open only to a predetermined set of firms, i.e. non-firm-specific subsidies. As a result, we hypothesize that the effect of subsidies on MNEs' location choices should be stronger for non-firm-specific subsidies than for firm-specific subsidies.

***Hypothesis 3:*** *The positive effect of non-firm-specific subsidies on the likelihood of foreign MNE investment is stronger than the effect of firm-specific subsidies.*

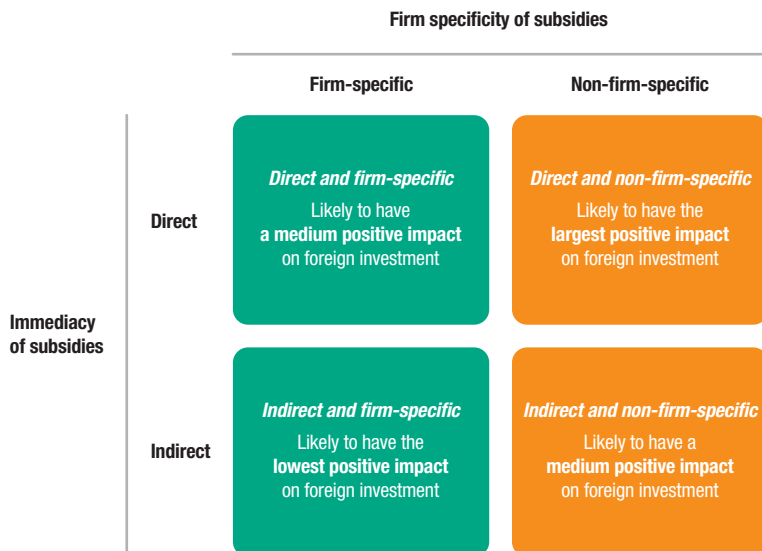
Given these considerations, it may follow that these effects are additive in nature. To explore the additivity of immediacy and firm specificity, we hypothesize that direct and non-firm-specific subsidies exhibit the strongest positive effect on investment location choice, whereas indirect and firm-specific subsidies exhibit the weakest effect. For an overview of the immediacy–firm-specificity framework of subsidies, see figure 1.

***Hypothesis 4a:*** *Direct and non-firm-specific subsidies have the largest effect on the likelihood of foreign MNE investment when compared with all other combinations of immediacy and firm specificity.*

***Hypothesis 4b:*** *Indirect and firm-specific subsidies have the smallest effect on the likelihood of foreign MNE investment when compared with all other combinations of immediacy and firm specificity.*



**Figure 1. The immediacy–firm specificity framework**



Source: Authors' conceptualization and visualization.

### 3. Methods

#### 3.1 Sample

We analyse the heterogeneous effects of different types of subsidies on investment location choice using a large sample of investments in foreign subsidiaries made by publicly traded United States firms between 2009 and 2019 in several host countries that provide subsidies. In our analysis, data availability on subsidies determine the set of host countries: member States of the European Union and China.

To construct the sample, we collected corporate and financial data from Standard & Poor's Compustat Fundamentals Annual database. Information on firms' subsidiary locations we obtained from the LexisNexis Corporate Affiliations database. Data on host-country subsidies was sourced from Global Trade Alert, which monitors policies affecting world commerce and released an inventory of corporate subsidies issued by China, the United States, and the individual member states of the European Union (Evenett and Fritz, 2021). As a supranational institution, the European Union has special rules for State aid of its member States in order to prohibit distortion of the European Union's single market. Article 107 of the Treaty on the Functioning of the European Union specifically addresses the European Union's competition policy.

Under this legislation, State aid is generally prohibited “unless exceptionally justified”.<sup>11</sup> The body that oversees this regulation is the directorate-general for Competition of the European Commission, the executive branch of the European Union. According to Article 107, State aid is deemed compatible with the internal market under certain circumstances. This is the case, for example, when the State aid has a social character, when it relieves “damage caused by natural disasters” or when it “promote[s] economic development of areas where the standard of living is abnormally low”.<sup>12</sup> However, even with those rules, European Union member States are making use of discriminatory State aid, with larger States intervening more often (Evenett, 2019).

Additional country-level data were acquired from a variety of publicly available sources. From the World Bank, we use macroeconomic data from the World Development Indicators database (World Bank, 2022a) and data from the World Governance Indicators database for indices measuring governance quality (World Bank, 2022b). Furthermore, trade data were obtained from the United Nations Conference on Trade and Development (UNCTAD, 2022a) to capture bilateral trade relationships between home and host countries.

Our final sample is an unbalanced longitudinal data set that allows us to analyse the determinants of MNEs’ investment location choices. The sample contains more than 4,000 United States firms and their subsidiaries in 29 countries in the time period between 2009 and 2019. The time variable of the panel data set is years, and the unit of analysis is the firm-country dyad. Our final sample contains 42,584 observations at the firm-country-year level.

### 3.2 Variables

The main dependent variable in our data set, *Subsidiaries*, is the number of subsidiaries per firm-country-year and thus an integer. With this approach concerning our dependent variable, we follow prior research that examined MNEs’ foreign investment levels (Oh and Oetzel, 2011).

Since we are concerned with the impact of subsidies on firms’ investment location decisions, our focal independent variables are subsidies in their various manifestations. We constructed the subsidy variables on the basis of the “inventory of corporate subsidies” released by Global Trade Alert (Evenett and Fritz, 2021).

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<sup>11</sup> “Consolidated version of the Treaty on the Functioning of the European Union - Part Three: Union Policies and Internal Actions - Title VII: Common Rules on Competition, Taxation and Approximation of Laws - Chapter 1: Rules on competition - Section 2: Aids granted by States - Article 107 (ex Article 87 TEC)”, Official Journal 115, 9 May 2008, <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12008E107&from=EN>.

<sup>12</sup> Ibid.

In this inventory, each subsidy is assigned a unique ID. Moreover, the database contains crucial information on each recorded subsidy scheme, such as the implementing country, the date of implementation, the date of removal and whether the subsidy was firm-specific or non-firm-specific. The inventory also adopts the taxonomy of the OECD such that each subsidy is categorized as either “Direct transfer of funds”, “Induced transfer”, “Tax revenue foregone” or “Transfer of risk to government”. Importantly, the database includes information on the industry sectors that benefit from the respective subsidy, using the United Nations Central Product Classification System, version 2.1 (CPC 2.1).

We calculated the relevant subsidy variables in several steps. First, we converted the CPC 2.1 to the North American Industry Classification System (NAICS) at the two-digit level. Then, we calculated the number of active subsidies per year, country and industry, conditional on subsidy characteristics.<sup>13</sup> For example, in 2009, Germany had 78 active subsidy schemes for the NAICS sector with the number 33, which refers to “metal manufacturing”. Of those 78 subsidy schemes, 75 were granted to specific firms, whereas 3 were implemented as non-firm-specific. With respect to the OECD taxonomy, of the 78 subsidy schemes for this specific sector, 2 were granted as a “Direct transfer of funds”, while the other 76 were granted as indirect subsidies. Then, we matched this information uniquely to the unit of analysis of our longitudinal data set, firm-country dyads, by considering the firm’s industry and the year.

Finally, for each firm-country dyad and year in our longitudinal data set we obtain several variables containing information on the active subsidies for the respective country and sector: *Subsidies* captures the total number of active subsidies per year (*t*), country (*ct*) and industry sector at the NAICS two-digit level. *Direct subsidies* captures the number of subsidy programmes classified as “Direct transfer of funds”, whereas the variable *Indirect subsidies* captures the number of subsidies not classified as “Direct transfer of funds”. *Non-firm-specific subsidies* counts the number of subsidies that are classified as non-firm-specific and thus available in principle to many firms. In contrast, *Firm-specific subsidies* measures the number of subsidies for which only specific companies are eligible. The variable *Indirect-NFS subsidies* counts the number of subsidies that are non-firm-specific and indirect, *Direct-NFS subsidies* tracks the number of subsidies that are non-firm-specific and direct, *Direct-FS subsidies* measures the number of firm-specific and direct subsidies, and *Indirect-FS subsidies* captures the number of firm-specific and indirect subsidies.

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<sup>13</sup> For those subsidy schemes in the database that lacked a removal date, we assumed that the schemes were still active at the end of the time period covered.

We control for several factors on the firm, host-country and country-dyad levels. At the firm level we included *Cash stock* because research has shown that in environments characterized by uncertainty, cash serves as a buffer (Kim and Bettis, 2014). We included both the return on assets (*ROA*) and the return on investment (*ROI*), since firms performing high on those metrics may have a higher propensity to conduct foreign investment (Henderson et al., 2012). We transformed both variables with the inverse hyperbolic sine because of their highly skewed nature in our sample (Sabel and Sasson, 2023). Similarly, we included *Leverage* and *Tobin's Q* as firm-level controls (Kim and Bettis, 2014) as well as *Firm size*. We included the variable *Colocation*, which captures localized knowledge spillovers in the home country (Lamin and Livanis, 2013) and the tendency of firms to invest in countries in which national peers are present (Zhu et al., 2022). In addition to the firm level, we included several variables for host-country characteristics. We included *GDP* (Blake and Moschieri, 2017), *GDP growth* (Blake and Moschieri, 2017), *Inflation rate* (Cuervo-Cazurra, 2008), endowment of *Natural resources* (Zilja et al., 2022), *Population* (Li and Vashchilko, 2010), and the *Worldwide Governance Indicators*, constructed by Daniel Kaufmann and Aart Kraay.<sup>14</sup> Following prior research, we also included the country-dyadic variable *Trade dependence* (Holburn and Zelner, 2010). For a complete overview of all variables and their operationalizations, see table 2.

**Table 2. Overview of all variables and their operationalizations**

Variable	Description	Measurement	Source
Subsidiaries	Number of subsidiaries per firm-country dyad	Discrete integers	LexisNexis Corporate Affiliations (acquired in November 2021)
Subsidies	Number of active subsidy schemes per firm-country dyad, broken down by industry at the two-digit NAICS level	Discrete integers	Global Trade Alert, Corporate Subsidy Inventory 2.1, <a href="http://www.globaltradealert.org/data_extraction">www.globaltradealert.org/data_extraction</a>
Cash stock	Cash and short-term investments divided by total assets	Continuous (ratio)	S&P Global Market Intelligence, Compustat Fundamentals, annual (last accessed 18 July 2022)
ROA	Net income divided by total assets; transformed with inverse hyperbolic sine	Continuous	S&P Global Market Intelligence, Compustat Fundamentals, annual (last accessed 18 July 2022)
ROI	Net income divided by invested capital; transformed with inverse hyperbolic sine	Continuous	S&P Global Market Intelligence, Compustat Fundamentals, annual (last accessed 18 July 2022)
Leverage	Sum of short- and long-term debt, divided by total assets. Transformed with the natural logarithm	Continuous	S&P Global Market Intelligence, Compustat Fundamentals, annual (last accessed 18 July 2022)

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<sup>14</sup> See <http://info.worldbank.org/governance/wgi> (accessed 29 September 2022).

**Table 2. Overview of all variables and their operationalizations** (Concluded)

Variable	Description	Measurement	Source
Tobin's Q	Firm value in relation to the replacement value of all assets	Continuous	S&P Global Market Intelligence, Compustat Fundamentals, annual (last accessed 18 July 2022)
Firm size	Natural log of number of employees	Continuous	S&P Global Market Intelligence, Compustat Fundamentals, annual (last accessed 18 July 2022)
Colocation	Number of United States firms with a headquarters in the same State as the headquarters of the focal firm that have at least one subsidiary in the host country	Discrete integers	LexisNexis Corporate Affiliations (acquired in November 2021)
Worldwide Governance Indicators	Estimate of governance quality; range: [-2.5 to 2.5]	Continuous	World Bank (2022b)
Population	Natural log of country's population	Continuous	World Bank (2022a)
GDP	GDP of host country in constant 2015 United States dollars; transformed with the natural logarithm	Continuous	World Bank (2022a)
GDP growth	GDP growth rate of host country in the respective year	Percentage points	World Bank (2022a)
Inflation rate	Inflation rate of host country in the respective year	Percentage points	World Bank (2022a)
Trade dependence	Host country's share of merchandise trade volume with the United States in relation to the country's total trade volume; transformed with the natural logarithm	Continuous	UNCTAD (2022a)
Natural resources	Natural log of total natural resources rents (per cent of GDP); transformed with the natural logarithm	Continuous	World Bank (2022a)

Source: Authors' compilation.

### 3.3 Empirical strategy

Since we are studying multiple units over several years and investigating changes within firm-country dyads, we apply a fixed-effects ordinary least squares model to explore the effects of subsidies on foreign investment decisions. Inherent in fixed-effects models is consideration of time-invariant fixed effects at the unit level. In our case, those are factors that do not change within firm-country dyads over time. As our dependent variable counts the number of subsidiaries per firm-country dyad, our primary independent variable is *Subsidies*, and we incorporate controls at the firm, country, and dyad levels. Our regression model can be presented as follows:

$$Subsidies_{ij,t} = \beta_0 + \beta_1 \times subsidies_{i,t-1} + \beta_2 \times firm\ controls_{i,t-1} + \beta_3 \times country\ controls_{j,t-1} + \beta_4 \times dyad\ controls_{ij,t-1} + Year_t + \varepsilon_{ij,t}$$

In this specification,  $Subsidiaries_{ij,t}$  is the number of subsidiaries per firm-country dyad  $ij$  in year  $t$ ;  $\beta$  is the vector of coefficients with  $\beta_0$  representing the intercept and  $\beta_1$  to  $\beta_4$  depicting the coefficients for the various sets of independent variables;  $subsidies_{j,t-1}$  is the number of subsidy schemes per country in year  $t-1$ ;  $firm\ controls_{i,t-1}$  is a vector of control variables on the firm level in year  $t-1$ ;  $country\ controls_{j,t-1}$  is a vector of control variables on the country level in year  $t-1$ ;  $dyad\ controls_{ij,t-1}$  represents our dyad controls.  $Year_t$  represents a vector of yearly fixed effects, and  $\varepsilon_{ij,t}$  is the error term.

Since international business research usually assumes that firms are heterogeneous and that their competitive advantage arises from specific firm characteristics which are often unobservable, endogeneity, and, consequently, biased estimates in empirical analyses are a considerable reason for concern in this field of research (Wolfolds and Siegel, 2019). This also applies to our study, where endogeneity might be an issue. Specifically, endogeneity arising from sample selection bias might be present in our analysis because firms are likely to have hidden preferences to invest in certain countries or latent preferences to explicitly avoid investing in particular countries. For example, strategizing managers might base their judgement and decision on their personal experience from their career (Crossland et al., 2014), which is often hidden to the researcher. In order to address this potential sample selection bias (Certo et al., 2016), we apply a two-stage Heckman model (Heckman, 1979), following established practice in previous research (Chen, 2015; Rubera and Tellis, 2014).

In the first stage, we estimate the probability of a firm investing in a country with a probit regression. We follow established practice in empirical research and inflated the data set by counterfactual information, as potential but unrealized investment in host countries needs to be considered (Albino-Pimentel et al., 2021; Georgallis et al., 2021). Thus, for each firm and year, there are 29 observations in our data set, resulting in more than 600,000 firm-year-country observations. Then, we calculate the inverse Mills ratio using the probit estimation results by dividing the probability density function by the normal cumulative distribution. This resulting parameter, often denoted as lambda (Wolfolds and Siegel, 2019), is then used as a control in the second-stage regression. Afterwards, in the second stage, we restrict our sample to observations in which firms have a commitment in the form of at least one subsidiary per year and country (i.e. the sample is restricted to observations that have a positive value in the dependent variable).

Using this empirical approach, we estimated four different model specifications. In the first specification, we used the aggregated number of subsidies per year and country as the main independent variable. In the second specification, we distinguished between direct and indirect subsidies as independent variables to test for their differential effect. In the third specification, we included both non-firm-specific and firm-specific subsidies as independent variables to test for their distinct effect.

Finally, in the fourth model, we break down the subsidy variables further to their four types. Thus, we distinguished between direct and firm-specific, direct and non-firm-specific, indirect and firm-specific, and indirect and non-firm-specific subsidies.

## 4. Results

Table 3 presents the descriptive statistics of the main sample, which is used in the second-stage regressions. The correlation matrix is presented in table 4. In the first-stage sample, 627,564 observations were artificially created through zero inflation, whereas this number drops to 42,584 observations in the restricted sample that considers only existing observations. The mean number of subsidiaries in the restricted sample is 2.23. The mean number of policy support schemes is 24 in the sample of the second stage.

Our regression results from the analysis of the effect of subsidies on investment location choice are presented in table 5.<sup>15</sup> Model 1 contains the estimates of the first-stage regression of our first model with the aggregated number of subsidies per year and country as the main independent variable. Since the first-stage results of the other models are very similar because only the main independent variables vary, we decided to restrict presentation of the first stage to the first model. The remaining columns contain the estimation results of the second-stage regressions. Although the main independent variables vary in each model, we used the same controls to ensure comparability. The inverse Mills ratio is highly significant throughout all models ( $p < 0.001$ ), indicating that a selection effect is present and has been accounted for.

In Model 2, we tested for the aggregate effect of subsidies on investment location choice (H1) with the main independent variable *Subsidies*. The coefficient of *Subsidies* is positive and significant ( $\beta = 0.021$ ,  $p < 0.001$ ), indicating that an increase in policy support by one unit leads to an increase in the number of subsidies per year and country by 0.021, on average. This provides support for hypothesis 1. In Model 3, we test for the difference of subsidies with respect to immediacy and distinguish between direct and indirect subsidies (H2). The coefficient of *Direct subsidies* is positive and significant ( $\beta = 0.027$ ,  $p < 0.001$ ) and larger than the coefficient of indirect policy support, *Indirect subsidies* ( $\beta = 0.017$ ,  $p < 0.001$ ).

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<sup>15</sup> The F-statistics of the main models ( $> 30$ ) show that each model individually includes coefficients that are jointly different from 0. This model fit does not decrease strongly when we split the subsidy variables in granular categories, indicating that each category has its distinct effect on the dependent variable. However, the R-squared of the model overall stays stable across models ( $\sim 0.14$ ), which means that splitting the subsidy variables does not help to explain more of the variation in subsidiary investment.

**Table 3. Descriptive statistics**

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Subsidiaries	42 584	2.227	3.044	1	65
Subsidiés	42 584	24.642	68.777	0	336
Direct subsidiaries	42 584	11.091	43.204	0	302
Indirect subsidiaries	42 584	13.551	51.589	0	330
Non-firm-specific subsidiaries	42 584	3.706	5.859	0	38
Firm-specific subsidiaries	42 584	20.936	65.764	0	330
Direct-NFS subsidiaries	42 584	1.981	4.303	0	33
Indirect-NFS subsidiaries	42 584	1.725	3.613	0	25
Direct-FS subsidiaries	42 584	9.110	42.949	0	298
Indirect-FS subsidiaries	42 584	11.826	51.382	0	328
Cash stock	42 584	0.149	0.136	0	0.968
ROA	42 584	0.044	0.103	-4.513	2.638
ROI	42 584	0.072	0.223	-5.009	5.224
Leverage	42 584	-1.641	1.173	-13.088	1.672
Tobin's Q	42 584	1.665	1.213	0.004	22.719
Firm size	42 584	2.466	1.661	0.693	14.648
Colocation	42 584	24.222	27.652	0	155
WGI Governance and Accountability	42 584	1.051	0.767	-1.701	1.690
WGI Political Stability	42 584	0.573	0.456	-0.657	1.461
WGI Government Effectiveness	42 584	1.286	0.541	-0.360	2.241
WGI Regulatory Quality	42 584	1.279	0.582	-0.289	2.051
WGI Rule of Law	42 584	1.287	0.681	-0.543	2.130
WGI Control of Corruption	42 584	1.268	0.795	-0.562	2.446
Population	42 584	17.311	1.474	13.118	21.062
GDP	42 584	27.658	1.318	23.665	30.233
GDP growth	42 584	1.989	3.172	-14.839	25.176
Inflation rate	42 584	1.449	1.204	-4.478	6.091
Trade dependence	42 584	-2.820	0.587	-4.809	-1.404
Natural resources	42 584	-1.446	1.377	-6.711	2.038

Source: Author's estimations.



**Table 4. Correlation matrix**

Number	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	
(1)	Subsidiaries	1.00																					
(2)	Subsidies	0.10	1.00																				
(3)	Cash stock	-0.09	0.01	1.00																			
(4)	ROA	0.03	-0.02	-0.01	1.00																		
(5)	ROI	0.03	-0.02	-0.02	0.61	1.00																	
(6)	Leverage	0.07	-0.02	-0.27	-0.03	0.00	1.00																
(7)	Tobin's Q	-0.05	0.00	0.32	0.25	0.16	0.03	1.00															
(8)	Firm size	0.17	-0.08	-0.17	0.31	0.23	0.18	-0.03	1.00														
(9)	Colocation	0.12	0.10	0.20	-0.08	-0.07	-0.10	0.08	-0.18	1.00													
(10)	WGI Governance and Accountability	0.02	-0.44	0.02	0.00	0.00	0.01	0.02	-0.01	0.06	1.00												
(11)	WGI Political Stability	-0.07	-0.30	0.01	0.03	0.02	0.01	0.00	0.07	-0.16	0.72	1.00											
(12)	WGI Government Effectiveness	0.08	-0.17	0.03	-0.02	-0.02	-0.03	0.01	-0.08	0.18	0.74	0.60	1.00										
(13)	WGI Regulatory Quality	0.08	-0.28	0.02	-0.03	-0.02	-0.01	0.02	-0.07	0.20	0.87	0.67	0.89	1.00									
(14)	WGI Rule of Law	0.07	-0.27	0.03	-0.02	-0.02	-0.02	0.01	-0.07	0.17	0.85	0.66	0.95	0.95	1.00								
(15)	WGI Control of Corruption	0.09	-0.18	0.03	-0.03	-0.02	-0.03	0.01	-0.09	0.20	0.78	0.60	0.96	0.93	0.96	1.00							
(16)	Population	0.13	0.49	0.01	-0.04	-0.04	-0.06	-0.01	-0.15	0.29	-0.67	-0.77	-0.40	-0.50	-0.50	-0.41	1.00						
(17)	GDP	0.18	0.44	0.02	-0.06	-0.05	-0.08	0.01	-0.20	0.41	-0.39	-0.61	-0.07	-0.18	-0.17	-0.08	0.92	1.00					
(18)	GDP growth	-0.01	0.21	-0.01	-0.01	-0.01	0.03	0.02	0.00	-0.04	-0.50	-0.23	-0.25	-0.29	-0.31	-0.26	0.24	0.12	1.00				
(19)	Inflation rate	0.00	0.08	-0.01	0.01	0.01	-0.07	-0.07	-0.03	0.06	-0.22	-0.14	-0.11	-0.10	-0.11	-0.09	0.20	0.15	-0.02	1.00			
(20)	Trade dependence	0.16	0.26	0.03	-0.06	-0.06	-0.05	0.01	-0.18	0.37	-0.18	-0.32	0.22	0.12	0.13	0.22	0.50	0.68	0.30	0.05	1.00		
(21)	Natural resources	0.00	0.11	0.01	0.00	0.00	-0.05	-0.05	-0.03	0.07	-0.41	-0.14	-0.19	-0.15	-0.22	-0.16	0.28	0.13	0.23	0.38	0.04	1.00	

Source: Authors' estimations.

Table 5. Main regression

Dependent variable	Model				
	(1)	(2)	(3)	(4)	(5)
	Probit	OLS	OLS	OLS	OLS
	Investment (1/0)		Subsidiaries		
Subsidiaries	0.002*** (0.000)	0.021*** (0.003)			
Direct subsidiaries			0.027*** (0.003)		
Indirect subsidiaries			0.017*** (0.002)		
Non-firm-specific subsidiaries				0.108*** (0.012)	
Firm-specific subsidiaries				0.017*** (0.002)	
Direct-NFS subsidiaries					0.081*** (0.010)
Indirect-NFS subsidiaries					0.216*** (0.027)
Direct-FS subsidiaries					0.012*** (0.002)
Indirect-FS subsidiaries					0.016*** (0.002)
Cash stock	0.423*** (0.046)	3.981*** (0.451)	3.891*** (0.423)	3.743*** (0.413)	3.717*** (0.404)
ROA	0.252** (0.095)	2.108*** (0.267)	2.075*** (0.255)	2.118*** (0.262)	2.087*** (0.257)
ROI	-0.032 (0.038)	-0.303*** (0.052)	-0.298*** (0.052)	-0.301*** (0.052)	-0.296*** (0.052)
Leverage	0.017** (0.006)	0.141*** (0.023)	0.137*** (0.022)	0.138*** (0.022)	0.137*** (0.022)
Tobin's Q	-0.003 (0.003)	-0.001 (0.014)	0.000 (0.014)	-0.000 (0.014)	0.001 (0.014)
Firm size	0.272*** (0.004)	2.760*** (0.280)	2.720*** (0.267)	2.726*** (0.270)	2.706*** (0.266)
Colocation	0.003*** (0.000)	0.050*** (0.006)	0.049*** (0.006)	0.049*** (0.006)	0.049*** (0.006)
WGI Governance and Accountability	0.464*** (0.044)	4.609*** (0.479)	4.906*** (0.498)	4.481*** (0.456)	4.809*** (0.491)
WGI Political Stability	-0.074* (0.030)	-0.549*** (0.119)	-0.589*** (0.120)	-0.587*** (0.121)	-0.659*** (0.125)
WGI Government Effectiveness	0.063 (0.051)	0.457*** (0.118)	0.337** (0.111)	0.244* (0.108)	0.151 (0.105)
WGI Regulatory Quality	0.113* (0.054)	1.442*** (0.178)	1.606*** (0.178)	1.656*** (0.189)	1.649*** (0.181)
WGI Rule of Law	-0.029 (0.060)	-0.782*** (0.125)	-0.842*** (0.125)	-0.800*** (0.123)	-0.919*** (0.130)

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**Table 5. Main regression** (Concluded)

Dependent variable	Model				
	(1) Probit	(2) OLS	(3) OLS	(4) OLS	(5) OLS
	Investment (1/0)		Subsidiaries		
WGI Control of Corruption	-0.108** (0.041)	-0.384* (0.180)	-0.363* (0.177)	-0.292 (0.175)	-0.337 (0.175)
Population	0.107** (0.040)	4.496*** (1.063)	4.664*** (1.070)	4.332*** (1.061)	4.044*** (1.022)
GDP	0.188*** (0.040)	0.851** (0.322)	1.054** (0.324)	0.890** (0.323)	1.135*** (0.338)
GDP growth	0.016*** (0.003)	0.120*** (0.016)	0.120*** (0.016)	0.123*** (0.016)	0.130*** (0.017)
Inflation rate	0.023** (0.009)	0.226*** (0.025)	0.236*** (0.025)	0.247*** (0.027)	0.257*** (0.027)
Trade dependence	0.168*** (0.025)	1.265*** (0.189)	1.193*** (0.173)	1.187*** (0.177)	1.157*** (0.170)
Natural resources	0.038*** (0.009)	0.245*** (0.053)	0.180*** (0.046)	0.236*** (0.051)	0.195*** (0.047)
Inverse Mills ratio		9.114*** (1.063)	8.960*** (1.008)	8.987*** (1.023)	8.914*** (1.004)
Constant	-12.648*** (0.487)	-158.647*** (21.525)	-166.850*** (21.812)	-156.298*** (21.414)	-157.709*** (20.717)
Observations	627 564	42 584	42 584	42 584	42 584
Firm-country dyads	110 544	7 729	7 729	7 729	7 729
Chi-squared	8 144	n/a	n/a	n/a	n/a
Loglikelihood	-30 137	n/a	n/a	n/a	n/a
Year dummies	No	Yes	Yes	Yes	Yes
Firm-country fixed effects	No	Yes	Yes	Yes	Yes
F-statistic	n/a	32.716	31.860	31.692	30.376
R-squared	n/a	0.141	0.142	0.141	0.142

Source: Authors' estimations.

Note: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ . n/a = the fit statistics are not applicable to this particular model.

We tested for statistically significant difference using a standard Wald test and found that this is indeed the case at the 1per cent level. This provides support for hypothesis 2.

In Model 4, we dissected subsidies according to their firm specificity (H3) and compared non-firm-specific with firm-specific subsidies. The coefficient of *Non-firm-specific subsidies* ( $\beta = 0.108$ ,  $p < 0.001$ ), is significantly larger than the coefficient of *Firm-specific subsidies* ( $\beta = 0.017$ ,  $p < 0.001$ ), as confirmed by the Wald test ( $p < 0.001$ ).

Finally, in Model 5, we tested for the differential effect of the four types of policy, combining the dimensions of immediacy and firm specificity. Thus, we used Wald tests to pairwise compare the coefficients of *Direct-NFS subsidies* ( $\beta = 0.081$ ,

$p < 0.001$ ), *Indirect-NFS subsidies* ( $\beta = 0.216$ ,  $p < 0.001$ ), *Direct-FS subsidies* ( $\beta = 0.012$ ,  $p < 0.001$ ) and *Indirect-NFS subsidies* ( $\beta = 0.016$ ,  $p < 0.001$ ). While the difference between *Direct-FS subsidies* and *Indirect-NFS subsidies* is only marginally significant ( $p = 0.0744$ ), all other pairwise comparisons yield significant differences at the 1 per cent level ( $p < 0.001$ ). Contrary to our hypothesizing, *Indirect-NFS subsidies* shows the largest effect and *Direct-FS subsidies* yields the lowest effect on investment location choice. Hence, we do not find empirical support for our hypotheses 4a and 4b. This alludes to the fact that these effects are not additive but may cancel each other out to some extent. Similar to prior studies on foreign subsidiary investments specifically (Zilja et al., 2022) and on foreign entry choices in general (Boustanifar et al., 2022), we are able to explain only a small part of firm-level investment, with an R-squared of approximately 0.14. This reflects the fact that market entry decisions are based on complex evaluations of firm-specific risks and opportunities (Blake and Moschieri, 2017), of which subsidies are just one aspect.

To increase confidence in our findings, we conduct several robustness tests with focus on the dependent variable, the estimation technique and the sample (table 6). First, we transformed our dependent variable with the natural logarithm to reduce the impact of outliers. Results for the direct effects and for the Wald tests for differences in coefficients remain significant (Models 1–4). Second, we exchanged our main estimation technique (fixed-effects ordinary least squares) with fixed-effects Poisson regressions, as distributional effects of the dependent variable may distort our results. The results remain consistent with this change (Models 5–8).

Third, we test our results within subsets of our sample, to check whether our effects cluster within specific countries. We observe that our results hold.<sup>16</sup> Excluding Germany (Models 9–12), the coefficients of indirect and direct subsidies are not statistically different. This observation may imply that the pronounced impact of direct subsidies can be attributed largely to Germany. Furthermore, we partitioned our sample into two time frames, 2009–2014 and 2015–2019. Our results remain significant when we confine the sample to the years 2009–2014 (Model 13). Conversely, in the subsequent period of 2015–2019, while all coefficients retain their positive direction, the statistical significance between the coefficients of direct and indirect subsidies diminishes (Model 14). This may suggest that the stronger effect of direct subsidies might be more relevant at the beginning of the decade. However, because we are studying the variation within firm-country dyads over time, splitting the sample this way may also obfuscate firms' past decisions in the more recent subsample and distort the coefficients downwards.

<sup>16</sup> We observe that our results hold when we exclude China, as the sole non-European Union country in the sample, or the United Kingdom and France as two of the three largest European Union economies during the sample time frame.

**Table 6. Robustness tests**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Corresponding main model	Model 2	Model 3	Model 4	Model 5	Model 2	Model 3	Model 4	Model 2	Model 3	Model 4	Model 5	Model 5	Model 5	Model 5
Robustness test	ln(DV)	OLS	ln(DV)	OLS	FE Pois	FE Pois	FE Pois	FE Pois	OLS	Germany OLS	Germany OLS	Germany OLS	Germany OLS	Germany OLS
Model	OLS	OLS	OLS	OLS	Poisson	Poisson	Poisson	Poisson	OLS	Germany OLS	Germany OLS	Germany OLS	Germany OLS	Germany OLS
Subsidies	0.004*** (0.000)				0.003*** (0.000)				0.018*** (0.002)					
Direct subsidies	0.006*** (0.001)				0.004*** (0.001)					0.023*** (0.003)				
Indirect subsidies	0.003*** (0.000)				0.002*** (0.000)					0.038*** (0.010)				
Non-firm-specific subsidies			0.022*** (0.002)				0.015*** (0.003)				0.099*** (0.013)			
Firm-specific subsidies			0.003*** (0.000)				0.003*** (0.000)				0.014*** (0.002)			
Direct-NFS subsidies				0.017*** (0.002)				0.012*** (0.002)				0.075*** (0.010)	0.081*** (0.023)	0.024* (0.010)
Indirect-NFS subsidies				0.035*** (0.005)				0.024*** (0.006)				0.202*** (0.028)	0.294*** (0.044)	0.042 (0.026)
Direct-FS subsidies				0.003*** (0.000)				0.003*** (0.001)				0.011*** (0.002)	0.013*** (0.003)	0.006* (0.003)
Indirect-FS subsidies				0.003*** (0.000)				0.002*** (0.000)				0.037*** (0.011)	0.014*** (0.003)	0.008* (0.003)
Observations	42 584	42 584	42 584	42 584	41 676	41 676	41 676	41 676	38 109	38 109	38 109	38 109	17 958	24 626
Firm-country dyads	7 729	7 729	7 729	7 729	6 821	6 821	6 821	6 821	6 911	6 911	6 911	6 911	5 454	6 620
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic	63.001	61.067	61.024	57.376	n/a	n/a	n/a	n/a	28.613	28.279	27.756	26.780	25.208	13.052
R-squared	0.218	0.218	0.218	0.218	n/a	n/a	n/a	n/a	0.132	0.134	0.133	0.134	0.130	0.052
Chi-squared	n/a	n/a	n/a	n/a	1 837	1 848	1 836	1 844	n/a	n/a	n/a	n/a	n/a	n/a
Loglikelihood	n/a	n/a	n/a	n/a	-40 576	-40 576	-40 576	-40 576	n/a	n/a	n/a	n/a	n/a	n/a

Source: Authors' estimations.  
Note: DV = dependent variable, FE = fixed effects, OLS = ordinary least squares. \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05. n/a = the fit statistics are not applicable to this particular model.

## 5. Discussion

Our research is based on the idea that the effect of subsidies on MNEs' investment location choices is based on the configuration of the subsidy scheme. Our empirical results indicate that firms respond to various types of subsidies in different ways, depending on their specific type. First, the results of our analysis demonstrate that host-country subsidies have a general positive effect on firms' investment location choices. Second, our results suggest that subsidies in the form of direct transfers have a larger effect on MNEs' likelihood to invest than host-country subsidies in the form of indirect transfers. Third, the empirical results demonstrate that the effect on MNEs' likelihood to invest is larger for non-firm-specific host-country subsidies than for firm-specific ones.

However, the last regression set comparing the four types of subsidies is somewhat puzzling. Our results suggest that non-firm-specific subsidies have a greater effect than firm-specific subsidies on investment in foreign subsidiaries. This is in line with our theorizing concerning the firm specificity of subsidies. However, in more nuanced models that address immediacy and firm specificity simultaneously, we find that indirect subsidies have a larger effect on foreign investment than direct subsidies. This contradicts our explorative hypotheses on the intricate effects of subsidies. Further investigation into this phenomenon is needed to resolve this puzzle. It might be that specific combinations of immediacy and firm specificity imply disparate effects on location choices that are distinct from the effects of those dimensions considered in the aggregate.

Our research makes multiple contributions. First, as our evidence is consistent with previous research on the effect of subsidies on firms' investment location choices (Georgallis et al., 2021), we confirm preceding theoretical advances. However, whereas Georgallis et al. (2021) analysed the effect of subsidies in one specific sector, we empirically show that this effect is also prevalent when considering a variety of sectors. Second, we demonstrate that the effects of subsidies depend substantially on the specific configuration of subsidy schemes along the dimensions of immediacy and firm specificity. Third, by offering this finer-grained picture of subsidy configurations, we provide a starting point for future research on policy support. This is not confined to research about investment location choice but includes other research streams in international business and global strategy. For instance, configurations of subsidies may explain variations in subsidiary performance, heterogeneity in entry modes and disparities in behaviour in State-owned and privately owned MNEs. Fourth, we provide insights and guidance for both managers and policymakers. On the one hand, we believe that managers benefit from our study as they have a better awareness of the landscape of subsidies and the various impacts that the different facets of subsidies have on their companies' costs and benefits. On the other hand, we supply policymakers with knowledge of variations

in subsidy programmes that draw in foreign investment. Both viewpoints are crucial since both politicians and managers face substantial costs associated with subsidies – administrative costs associated with establishing and running subsidy schemes in the case of policymakers and search costs associated with finding and evaluating subsidy schemes that underpin their strategy in the case of managers.

## 6. Limitations

Our study has limitations. We studied the effect of different types of subsidies on firms' investment location choices by using data from United States firms. Thus, it may be that firms from other home countries with different institutional settings, historical background and experience show a different behavioural pattern in response to subsidies. Also, the host countries we studied in our data set all have (arguably) trustworthy bureaucratic systems. Thus, it might be possible that the effect of subsidies on investment location choice differs substantially in countries that lack sound civil administrations. Also, further investigation into firm-level boundary conditions is needed. We know so far that firms hold more subsidiaries in countries where subsidies are more generous. We do not know whether this effect is due to more entry decisions, additional investments in countries where the focal MNE is already present or fewer divestments.

Finally, we rely on count data of subsidies for our empirical analysis, owing to data availability. Specifically, we calculated the number of subsidy programmes per year, country and industry. This specific operationalization of subsidies as a count variable does not take the generosity of subsidy schemes into account. Thus, the effects of specific subsidy programmes on location choice might very well differ with respect to their financial generosity. However, we believe that the scope of the study, in which we consider multiple industries, numerous countries and various subsidy schemes, provides valuable insights into the heterogeneous relationship between variations of subsidies and investment location choice. This is a starting point for further research. This includes discovering other dimensions by which to categorize subsidies to get a clear picture of the constructs and to explain further the heterogeneity in firm behaviour.

## 7. Conclusion and policy implications

Ultimately, given the increasingly interventionist role adopted by the State in the face of global challenges,<sup>17</sup> such as fighting the COVID-19 pandemic,<sup>18</sup> managing the energy transition to combat climate change (Ghuri et al., 2021), gaining

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<sup>17</sup> *The Economist*, "Business and the State: The new interventionism", 15 January 2022.

<sup>18</sup> *The Economist*, "Rich countries try radical economic policies to counter Covid-19", 26 March 2020.

strategic national independence from other regimes (Evenett, 2020), and dealing with populism and economic nationalism (Ghauri et al., 2021), our study is highly relevant. The role of the State in tackling those global challenges is also evident in the UNCTAD *World Investment Report*. The yearly report highlights, for instance, that investment policies specifically are key to address adverse consequences of the pandemic (UNCTAD, 2020) and to facilitate the transition towards clean energy (UNCTAD, 2023).

Cautious extrapolation of our results in light of current events, recent crises and challenges for policymakers suggests that subsidies should be designed in specific ways if governments are to attract foreign investment flows for specific purposes. Most importantly, our findings suggest that policymakers are well advised to design their subsidy schemes in a non-firm-specific way, i.e. governments should not “pick winners”. Second, because firms face liability of foreignness in foreign host countries and cash can be quickly allocated to relieve various barriers, subsidies should be designed to be direct. Yet, policymakers need to clearly outline the industry boundaries of subsidy schemes, to make them efficient in achieving their goals. In the case of the energy transition, for example, policymakers need to clearly delineate which type of industry is eligible for support, e.g. solar power versus wind power. In the process of defining the boundaries of eligible firms, policymakers should pay particular attention to integrating the Sustainable Development Goals. By doing so, they can make sure that government spending is encouraging investment inflows to ensure access to affordable and sustainable energy for all (SDG 7), for example. Finally, collaboration between developing and especially low-income countries and regional and international development banks should be encouraged to help those countries develop non-discriminatory, reliable and sound subsidy programmes.

Our study highlights the different effects that the various instruments of the policy toolkit have on the strategic management of companies. By adopting an institutional lens, we contribute to a more nuanced understanding of strategic firm behaviour at the interplay of the complex cross-country context with “the multiplicity of entities, multiplexity of interactions, and dynamism of the global economic system” that is characteristic of international business research (Eden and Nielsen, 2020). Our study contributes to the rich body of research investigating the interaction of host-country institutional settings (North, 1990; Williamson, 2000) and investment location decisions of MNEs (Delios and Henisz, 2003).



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# Exploring knowledge spillovers and GVC participation to understand double counting in GVCs: A case study of Japan\*

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## Abstract

As global value chain (GVC) participation and knowledge spillovers have arguably become more crucial for countries, it is still challenging to measure their real value for countries. The complexity comes from the trade in intermediate goods as part of GVCs and the inability to track their coupling with additional components and services. The result is double counting and lack of clarity about the real value of GVCs for countries. This paper assesses how GVC participation and knowledge spillovers influence double counting and transitively the innovation and value added growth in GVCs for the case of Japan. The empirical evidence suggests that expanding production fragmentation within GVCs and diversifying foreign suppliers in production stages foster innovation and maximize knowledge diffusion, leading to enhanced value added output. Thus, knowledge spillovers and feedback effects within and between countries at bilateral and multilateral integration levels affect the GVCs. The paper sheds light on the intricate nature of intermediate goods flows in GVCs and the link between double counting and knowledge spillovers in GVCs.

**Keywords:** double counting, global value chains, knowledge spillover, value added

**JEL classification codes:** E01, E16, F14, L14

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## 1. Introduction

As multinational companies expand globally, global value chain (GVC) participation becomes more crucial but challenging to measure. The complex nature of trade in intermediate goods and the inability to track their coupling with additional components and services hinder accurate measurement. Disaggregating integrations at the level of the enterprise or the production stage proves difficult because of the multidirectional trade flows of intermediate goods. The high volume of sector-country transactions raises questions about accurately tracing production value and origins because of the unavailability of data sources to show where the goods are coupled with additional components and services. Consequently, at the heart of GVC measurement challenges lies the issue of double counting, i.e. intermediate goods being repeatedly traded among countries during the production process, distorting traditional trade statistics. This double counting is leading to an overestimation of economic activity and a skewed perception of each country's actual contributions to GVCs (de Gortari, 2019; Johnson, 2018; Kee and Tang, 2016).

Intermediate product flows in GVCs present both double-counting challenges and opportunities for knowledge transfer among countries collaborating on and specializing in specific production stages for traded goods. Participation in GVCs, particularly through importing commodities, serves as a valuable avenue for knowledge exchange, facilitating the transfer of production techniques and fostering both imitation and innovation outcomes. Despite the possibility of some double counting in the production process, the concept of the knowledge spillover effect, driven by production stages achieved through vertical integration, underscores international production fragmentation as a means of knowledge transfer (Keller, 2010). For example, scholars have found compelling evidence of the integration between patent flows and value added production within GVCs (Zolas and Lybbert, 2022), resulting in significant international knowledge spillovers (Constantinescu et al., 2019; Piermartini and Rubínová, 2021).

The complexity of measurements in GVCs requires a novel approach to understanding GVC dynamics and value creation in international trade. This approach needs to take into account the intermediate product flow between countries and incorporate a perspective on vertical integration. Neglecting the double-counting issue in GVCs when estimating the optimal impact of production stages leads to biased estimates. Empirical estimates need to both address double-counting issues regarding direct contributions and emphasize the significance of knowledge spillovers in GVC participation. Thus, the main research question guiding this study is, how does the concept of knowledge spillovers address double-counting, influence GVCs and, in turn, affect the potential for innovation and value added growth in GVCs in the case of Japan?

To estimate the optimal value added (VA) and its spillover effect among sectors and sector-country pairs within GVCs, the study uses the Global Trade Analysis Project version 10 Multi-Region Input-Output (GTAP-MRIO) and the patent panel data sets derived from the United States Patent and Trademark Office. Incorporating additional information from a structured patent panel data set can enhance the analysis of technology diffusion, considering the vertical integration of subsequent production stages. This approach,<sup>1</sup> leveraging the GTAP-MRIO and patent panel data sets, provides more precise information than traditional input-output data, contributing to a better understanding of GVC involvement and its impact on knowledge transfer among sector-country pairs within GVC. Empirical evidence indicates that sector-country pair integration, measured by the trade among nations as spillovers, significantly contributes to VA while occasionally introducing double-counting issues, estimated at approximately 1.5 per cent.<sup>2</sup> Also, expanding production fragmentation within GVCs leads to increased innovation; thus, considering the knowledge spillover effect, tradable commodities being reexported or reimported in production stages, such as crossing borders at the initial stage or reaching their full potential within GVC, contribute from 2.5 per cent to as much as 154 per cent.

Accurate estimation of VA in GVCs requires developing robust accounting frameworks and methodologies to address double counting, as cross-border product flows with knowledge spillover effects significantly boost value added output. Also, empirical evidence emphasizes the role of countries with a global market concentration and diverse intermediate goods in the production process in driving knowledge accumulation. In essence, developing robust techniques, promoting GVC participation, strengthening trade relationships and facilitating knowledge exchange emerge as critical policy considerations for unlocking the potential of GVCs in driving value added growth. These policy measures empower economies to harness innovation, bolster productivity and enhance resilience, ultimately leading to sustainable value added output.

The paper contributes to the literature and practice in various ways. The research aligns with existing literature, highlighting the positive effects of technology spillover among nations during the production stages within GVCs (Alfaro et al., 2019). Firms engaged in GVCs often experience greater productivity, a phenomenon commonly

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<sup>1</sup> This paper draws inspiration from works such as Alfaro et al. (2019), de Gortari (2019) and Zolas and Lybbert (2022). For instance, Zolas and Lybbert (2022, p. 471) emphasize "...increasing the flow of intermediate and final goods and catalyzing knowledge spillovers across sectors and regions".

<sup>2</sup> The fragmentation of GVCs has concentrated activity in specific regions. "Factory East Asia", including Japan, contributes 38 per cent of global industrial output, followed by Factory North America (19 per cent) and Factory Europe (20 per cent) (Li et al., 2019). Notably, these findings are particularly relevant in the context of this paper, providing a nuanced understanding of the dynamics specific to the Japanese scenario within the broader GVC framework.

referred to as “GVC-driven innovation” (Pietrobelli and Rabellotti, 2011), resulting in productivity gains estimated at approximately 1.6 per cent (Constantinescu et al., 2019). To illustrate, the decoupling of GVCs through the removal of intermediate input trade can lead to output and welfare reductions ranging from 1 per cent to 70 per cent (Caliendo and Parro, 2015; Eppinger et al., 2021). These findings underscore the pivotal role of intermediate goods trade within the GVC framework. Moreover, by addressing this issue, policymakers can make well-informed decisions that promote resilience and drive sustainable value added output. This study delves into the complexities of measuring double counting in GVCs, presents examples of two-country and n-country models, and overcomes challenges through empirical analysis. Also, it explores vertical integration, uncovering spillover and feedback effects within and between countries at the levels of bilateral and multilateral integration. In doing so, the study sheds light on the intricate nature of intermediate goods flows in GVCs, revealing the link between double counting and knowledge spillovers in GVCs.

The rest of this paper is organized as follows: section 2 provides a review of the relevant literature; section 3 presents the empirical modeling and analysis for two approaches – double counting and knowledge spillovers in GVC; and the concluding section summarizes the key findings of this study, along with policy implications.

## 2. Literature review

GVC participation extends beyond traditional trade by encompassing the exchange of intermediate inputs and services across various production stages such as roundabout models (Caliendo and Parro, 2015), spider models (Antràs et al., 2017; Baldwin and Venables, 2013), snake models (Antràs and de Gortari, 2020), and hybrid “sniker” models (Antràs et al., 2023). A growing body of recent literature explores the trade channels of (i) knowledge transfer dynamics linked to imports and exports (Atkin et al., 2017; Buera and Oberfield, 2020) and (ii) value added double-counting in GVCs (Borin and Mancini, 2019; Hummels et al., 2001; Johnson and Noguera, 2012 and 2017).

Participation in GVCs necessitates collaboration and coordination among countries, each specializing in specific production stages for globally traded goods and services. This collaboration facilitates knowledge transfer and the exchange of know-how among GVC participants, encompassing mechanisms such as import-driven spillovers (Halpern et al., 2015; Nabeshima et al., 2018) and vertical specialization in productivity (Blalock and Veloso, 2007; Constantinescu et al., 2019). Notably, tradeable (intermediate) commodities, integrated into sector-country pairs, significantly drive value added output (Halpern et al., 2015; Keller, 2010), highlighting the positive impact of knowledge embedded in tradeable



goods on sectoral productivity (Tajoli and Felice, 2018; Zolas and Lybbert, 2022). Their findings also indicate a link between increasing knowledge flows and higher levels of value added output, underscoring the importance of knowledge flows in driving sectoral innovation and economic performance within GVCs.

Specifically, GVCs play a crucial role as channels for knowledge spillovers that drive innovation through strong interactions between foreign firms and domestic suppliers (Piermartini and Rubínová, 2021; World Bank, 2020) and efficient production of outsourced inputs, eventually consumed by foreign outsourcing firms (Baldwin and Lopez-Gonzalez, 2015). This is supported by research indicating that engaging in specific production stages within GVCs stimulates innovation (Alfaro et al., 2019; de Gortari, 2019; Tajoli and Felice, 2018) and that utilizing foreign intermediate inputs enhances plant productivity (Halpern et al., 2015). In this context, this paper integrates the concept of knowledge spillover effects within GVC participation to estimate the production stage and its impact on VA.

Nevertheless, the intricate dynamics of intermediate product flows in GVCs pose both opportunities for knowledge transfer among collaborating countries and double-counting challenges; thus, estimating the optimal impact of GVCs by production stages would result in biased estimates if the double-counting issue in GVCs is ignored. The literature on VA has explored various dimensions, including the location of VA creation (Koopman et al., 2014; Wang et al., 2013), the upstream effect of VA (Alfaro et al., 2019; Antràs et al., 2012; Fally, 2012), measuring of double-counting rates (World Bank, 2020), VA exchange rates (Bems and Johnson, 2017), factor content (Trefler and Zhu, 2010), international inflation spillover (Auer et al., 2019), and bias estimate of both domestic value added (DVA) and foreign value added (FVA) (Bems and Kikkawa, 2021; Johnson, 2018; Kee and Tang, 2016).

Koopman et al. (2014) and Wang et al. (2013) extended the gross export decomposition methodology introduced in Koopman et al. (2010) by introducing distinct definitions for “domestic value added in exports” and “domestic content in exports”. These differentiated measures provided a deeper understanding of the trade in value added concept. In addition, Johnson (2018) and Los et al. (2016) proposed analytical frameworks such as the GDP decomposition framework and the production of final goods decomposition framework. These frameworks enable the separation and analysis of fragmented production chains. Specifically, they shed light on the re-exportation of intermediate goods and their subsequent absorption in home countries, importers and third countries. These methodologies offer insights into the destinations of products and identify the countries and sectors participating in GVCs.

One limitation of these studies is that the double-counting estimates rely on two-way or three-way gross exports among n-way (Koopman et al., 2014; Los et al., 2016; Wang et al., 2013). GVC participation, when considering multi-country export content,

treats third parties as a single country and segments product portions on the basis of DVA and FVA. The literature lacks an approach that accounts for n-way (multinational) intermediate inputs trade within a multi-country setting. In addition, Blaum (2019) demonstrates that export-oriented firms tend to be more reliant on imports (Amiti et al., 2014). This implies that trade in DVA is overestimated in terms of GVC involvement because of the lack of consideration for heterogeneity in export-import intensity between firms within clustered sectors (Bems and Kikkawa, 2021).

In contrast, this paper highlights the complexities arising from the inclusion of aggregated third economies in trade beyond two- or three-way interactions. The integration of cross-border trade at a multilateral level is a complex process, and estimations of GVCs heavily rely on assumptions regarding the observation of foreign goods in destination or exporter countries, as noted by Borin and Mancini (2019) and Koopman et al. (2014). Consequently, the complex nature of these integrations in VA estimation manifests as seemingly simple mathematical equations that are inherently unpredictable, giving rise to what is referred to as the “paradox of intertwined trade”.

In summary, this study contributes to the deeper understanding of GVC dynamics by exploring the positive spillover effects of vertical integration within GVCs. Nonetheless, overlooking double counting in GVCs during the estimation of the optimal impact of production stages may introduce bias. Thus, this paper not only underscores the importance of accounting for double-counting effects in evaluating the impact of intermediate goods within GVCs but also delves into the intricate dynamics of knowledge flows within GVC networks (de Gortari, 2019; Pietrobelli and Rabelotti, 2011; Tajoli and Felice, 2018), elucidating the link between double counting and knowledge spillovers in GVCs. While drawing from previous works by Koopman et al. (2014) and Wang et al. (2013), this paper differentiates itself by utilizing the average of aggregate value added instead of separately derived DVA and FVA. This addresses the issue of undervaluation of downward GVC participation, as discussed in the literature (Bems and Kikkawa, 2021;<sup>3</sup> Johnson, 2018; Kee and Tang, 2016). Notably, this research advances GVC-related measurements by introducing a novel model that incorporates the vertical integration of production stages to calculate the optimal contribution of knowledge flow to overall outcomes within GVCs.

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<sup>3</sup> The researchers discovered that sectoral input-output tables introduce bias in value added (DVA and FVA) estimates owing to firm-level heterogeneities, leading to an undervaluation of downward GVC participation (for firm-level evidence in China, see Kee and Tang (2016)).

### 3. Empirical analysis

#### 3.1 Double counting in production stages

This subsection explores the impact of supply chain trade on cross-border production measures, building on the works of Antràs and Chor (2018), and Baldwin and Lopez-Gonzalez (2015). The issue arises with the potential double counting of VA, as tradeable commodities cross borders multiple times, resulting in measurement bias (Los et al., 2016; Johnson, 2018). The extent of this double counting and its effect on VA depends on a country's role as a hub for goods in process within GVCs. To address this, the study incorporates value added embodied in intermediate goods export, introducing complexity to VA integration and potentially leading to double counting from the perspective of final demand.

The analysis then delves into the phenomenon of re-exportation and reimportation of intermediate products within production activities, shedding light on the intricate challenge of bias estimation in GVCs. This investigation is motivated by the inherent complexities arising from the unavailability of a methodological framework and a reliable data source for tracking double counting. Specifically, the analysis focuses on the potential bias introduced in GVC estimation by the inability to systematically monitor the re-exportation and reimportation of intermediate goods in the assembly process.

#### 3.2 DVA and FVA in a multi-country setting

To simplify the understanding of DVA and FVA, we use a three-country set-up model, designating the countries as  $r$ ,  $s$  and the rest of the world  $I$ .<sup>4</sup> In this model, the Japanese market is considered as  $r$ , as the country of primary interest at the country level, taking into account its interactions with  $s$  and  $I$ . DVA in country  $r$ <sup>5</sup> can be written as follows:

<sup>4</sup> The algebras and calculated matrix are available upon request.

<sup>5</sup> In the context of the model, the subscripts  $r$  and  $s$  are used to index countries, where  $I \leq r, s \leq S$ . Similarly, the subscripts  $i$  and  $j$  are used to index industries, where  $I \leq i, j \leq J$ . When a pair of superscripts is used, the left superscript refers to the source or selling country-industry, while the right superscript refers to the destination or buying country-industry. By decomposing the Leontief inverse matrix ( $B = B^{rr} + B^{rs}$ ) into two components, namely (i) the domestic effect ( $D^{rr}$ ) and intra-country feedback effect ( $F^{rr} = B^{rr} - D^{rr}$ ), and (ii) the multilateral spillover effect ( $B^{rs}$ ) and bilateral spillover effect ( $L^{rs}$ ), we gain insights into the intricate interactions within GVCs. The feedback spillover effect from multilateral integration is represented by  $F^{rs} = B^{rs} - L^{rs}$ . The downstream effect shows how products in country  $r$  are stimulated by multilevel integration from country  $s$  ( $D^{rr}A^{rs}B^{sr} = \lambda^{rs}$ ), while the upstream effect reveals how products in country  $s$  are stimulated by multinational integration from country  $r$  ( $F^{rr}A^{rs}B^{sr} = \delta^{rs}$ ). Briefly,  $D^{rr} = (I - A_{ij}^{rr})^{-1}$  captures the local equilibrium conditions that each country satisfies. Also,  $L^{rs} \cong D^{rr}A^{rs}D^{ss}$  represents the matrix of the bilateral spillover effect. For more details, see Bijik (2022).

$$\begin{aligned}
DVA^r &= v^r B^{rr} E^{rs} + v^r B^{rr} \sum_{l \neq r, s}^S E^{rl} \\
DVA^r &= v^r [D^{rr} + F^{rr}] \left( \hat{Y}^{rs} + \sum_{l \neq r, s}^S \hat{Y}^{rl} \right) \\
&+ v^r \{ \lambda^{rs} + L^{rs} + \delta^{rs} + F^{rs} \} \left( A^{rs} X^{ss} + A^{rs} X^{sr} + \sum_{l \neq r, s}^S A^{rs} X^{sl} \right) \quad (1) \\
&+ v^r \left( \sum_{l \neq r, s}^S \{ \lambda^{rl} + L^{rl} + \delta^{rl} + F^{rl} \} \right) \left( \sum_{l \neq r, s}^S \left[ A^{rl} X^{ll} + A^{rl} X^{lr} + A^{rl} X^{ls} \right. \right. \\
&\left. \left. + \sum_{t \neq r, s, l}^S A^{rl} X^{lt^*} + \dots + \sum_{t \neq r, s, l}^S \sum_{v \neq r, s, l, t}^S \dots \sum_{x \in S} A^{lx} X^{x^*} \right] \right)
\end{aligned}$$

FVA in  $r$  can be written as follows:

$$\begin{aligned}
FVA^r &= v^s B^{sr} E^{rs} + \sum_{l \neq r, s}^S (v^l) \sum_{l \neq r, s}^S (B^{lr} E^{rl}) \\
FVA^r &= v^s (L^{sr} + F^{sr}) (\hat{Y}^{rs} + A^{rs} X^s) \quad (2) \\
&+ \left( \sum_{l \neq r, s}^S (v^l) \sum_{l \neq r, s}^S (L^{lr} + F^{lr}) \right) \left( \sum_{l \neq r, s}^S \hat{Y}^{rl} + \sum_{l \neq r, s}^S A^{rl} X^{l^*} + \sum_{l \neq r, s}^S \sum_{t \neq r, s, l}^S A^{rl} X^{lt} \right)
\end{aligned}$$

Where  $(\hat{Y}^{rs}$  and  $\sum_{l \neq r, s}^S \hat{Y}^{rl}$ ) final goods in  $r$  are exported to  $s$  and third partners (ROW)  $l$ . Note that the trade flows of intermediate goods have different processes. While  $(A^{rs} X^{ss})$  and  $(\sum_{l \neq r, s}^S A^{rs} X^{sl})$  intermediated goods in  $r$  are absorbed in  $s$  and  $l$ , intermediated products of  $(A^{rs} X^{sr})$  are processed and exported back to  $r$ , as a form of products embodied in the semi-final  $[A^{sr} X^r]$  or final products  $(\hat{Y}^{sr})$ . Likewise,  $\sum_{l \neq r, s}^S A^{rl} X^{lr}$  and  $\sum_{l \neq r, s}^S A^{rl} X^{ls}$  are processed and exported back to  $r$  and exported to  $s$  from  $l$ . This process is relatively straightforward because it involves the bilateral relationships between a single country and other countries.

The distribution of exports from third countries to partners ( $r$  and  $s$ ) and within their own borders is a crucial aspect to consider in the context of complex and continuous production processes of multi-level integration. The literature suggests that direct trade between third partners is often absent, as they tend to rely on aggregated third countries instead. However, this paper's extension introduces a novel perspective by considering the  $DVA^l$  of third countries in export content, thereby promoting continuous trade integration. Specifically, describing  $\sum_{l \neq r, s}^S A^{rl} X^{ll}$ , which represents intermediate goods domestically absorbed in  $l$ ,

presents a challenge that this research seeks to address. The challenge arises because the imported intermediate products undergo processing to produce semi-final and final products, which are then exported to  $r$  ( $\sum_{l \neq r, s}^S A^{rl} X^{lr}$ ),  $s$  ( $\sum_{l \neq r, s}^S A^{rl} X^{ls}$ ),  $l$  ( $\sum_{l \neq r, s}^S A^{rl} X^{ll}$ ), as well as distributed within trade partners ( $\sum_{l \neq r, s}^S \sum_{t \neq r, s, l}^S A^{rl} X^{lt}$ ) in  $t$ . The challenge lies in comprehending  $\sum_{l \neq r, s}^S \sum_{t \neq r, s, l}^S A^{rl} X^{lt^*}$ , which represents the processed and exported intermediate goods absorbed in (S-4) countries originating from  $l$  countries (S-3).

This concept highlights the paradox of intertwined trade in multi-country relations. It acknowledges the complex trade integration between countries, including  $r$ ,  $s$ ,  $l$ ,  $t$  and (S-4) countries, where each has trade connections with the others. This concept aligns with the findings of de Gortari (2019), Fally (2012), Alfaro et al. (2019) and Antràs et al. (2012), who emphasize the role of multiple production stages and vertical integration. Within this framework, intermediate commodities traverse sector-country pairs, eventually contributing to the production of final goods. These final goods are subsequently shipped and consumed in country  $x$ . Stated differently, this process is repeated until intermediate commodities complete their route to becoming final goods that are delivered and sold to final consumers in country  $x$  as  $\sum_{l \neq r, s}^S \sum_{t \neq r, s, l}^S \sum_{k \neq r, s, l, k}^S \dots \sum_{x \in S} A^{lx} X^{x^*}$  (box 1).

Whereas previous research (e.g. Borin and Mancini (2019) and Koopman et al. (2014)) explains methods to identify and eliminate double counting, this study is unable to provide a definitive estimation method to address the returning-home part, given the iterative nature of product movements across borders for assembly. Specifically, equations (1) and (2) highlight the challenge of identifying the origins of intermediate goods exports and their commodities in multi-country trade. Constructing comprehensive equations to explain the flow of intermediate goods across sector-country pairs is complex. However, a technique exists to address double counting in two-way global trade when intermediate goods cross borders twice, as demonstrated by the example of spider models in Baldwin and Venables (2013).

In sum, addressing double counting and determining the origins of intermediate goods in multi-country trade pose significant challenges. The paper aims to develop an optimal approach using an inverse matrix to empirically eliminate double counting based on the number of times goods return to their source economies. To be specific, this study evaluates the impact of sector-country integration on overall output and utilizes the spillover effect as a measure of products crossing international borders within GVCs.

### Box 1. Sector-country pairs in GVC participation

To estimate the stage of the production process, this paper modifies the integration of intermediate goods trade flow. It defines  $r$  as a country ( $r, s, \dots, x, \dots \in \mathcal{S}$ ),  $i$  as a sector ( $i, j \in \mathcal{J}$ ) and  $k$  as sector-country pairs  $\{k[r(i), s(j)] \in \mathcal{K}\}$ . The intermediate goods trade flow at sector-country pairs is denoted as  $\zeta^\dagger(k^{\dagger-1}, k^{\dagger-2}, \dots, k^1, x)$ , where inputs are sold from  $k^{\dagger-1}$  to the sequence  $k^{\dagger-2} \rightarrow k^{\dagger-3} \rightarrow \dots \rightarrow k \rightarrow x$ . This concept illustrates how intermediate goods flow at sector-country pairs, and it helps explain how many times inputs are sold from  $k^{\dagger-1}$  to  $x$ . For example, produced products in  $k^{\dagger-2}$  are sold to  $k^{\dagger-3}$ , and so on and so forth, until the products arrive at  $k^1$  and are put into final goods that are shipped and sold to final consumers in  $x$ . To illustrate sector-country pairs in GVC participation at bilateral integration in the last two stages, VA can be written as follows:

$$VA = \sum_{\dagger=2}^{\infty} \dots \sum_{k \in \mathcal{K}} VA^\dagger(k^{\dagger-1} | k^2, k, x)$$

However, the complexity increases when intermediate inputs flow within a multilateral integration setting. Theoretical frameworks of highly stylized sequential production do not characterize asymmetries across production stages (see Alfaro et al. (2019)). This is because the production activities of transactions among countries are not easily observed. Nevertheless, de Gortari (2019) suggests that this challenge can be addressed by specializing inputs, as exemplified by the roundabout model involving Canada, Mexico and the United States.

### 3.2.1 Data source

The input-output data set provides detailed information about sectoral and sector-country pair integration, allowing for the direct mapping of DVA and FVA. This paper utilizes input-output databases to examine GVC participation through an aggregated data set. The study develops a GTAP-MRIO table using the methodology of Walmsley et al. (2014) and the GTAP-MRIO version 10 database, released in 2019. This database covers 65 sectors in 141 economies, countries and regions, with 2014 as the reference year (Aguilar et al., 2019). The methodology can be adapted to various input-output tables, considering their specific data restrictions and advantages. The aggregated data analysis focuses on the Japanese market across four sectors to estimate the single-country variable  $r$  in the model set-up, as shown earlier (appendix table A1).

### 3.2.2 Results and discussion

The empirical analysis examines the optimal double-counting coefficients, which represent the percentage contribution of sectoral or total average output. By predicting sector-country pair integration using an empirical approach, the paper addresses the challenges by accurately disentangling double-counting elements in the vertical production stages, which could lead to estimation bias. The analysis sheds light on the impact of sectoral interconnections on overall output growth. The following paragraphs present the findings derived from the Japanese market.<sup>6</sup>

Table 1 shows that the interconnections within domestic industries have a significant impact on their respective sectoral outputs (see column 2, domestic effect). Industries with strong trade relationships with their partners exhibit a notable supplier effect through multilevel integration. For instance, in the Japanese context, the manufacturing sector benefits from bilateral integration as a direct effect, leading to a 3.13 per cent increase in its sectoral output as VA (see column 5, on bilateral effect). In addition, the feedback effect from multilevel integration as an indirect effect contributes an additional 0.56 per cent to the manufacturing sector's output

**Table 1. Contribution of sectoral integration to sectoral outcome in Japan (Percentage)**

Sector	Trade at bilateral and multinational levels					
	Within market			Spillover effect		
	Domestic effect	Feedback effect	Total effect	Bilateral effect	Feedback effect	Total effect
Agriculture	99.79	0.03	99.82	0.15	0.03	0.18
Mining	99.49	0.10	99.59	0.36	0.06	0.41
Manufacturing	95.65	0.66	96.31	3.13	0.56	3.69
Services	98.51	0.22	98.73	1.09	0.18	1.27
Sectoral average	98.18	0.28	98.46	1.32	0.23	1.54

Source: Author's estimation, based on GTAP-MRIO version 10 database.

Note: The Leontief matrix results at the multinational level are presented as *Within market* ( $B^w$ ) and *Spillover effect* ( $B^s$ ). *Within market* is divided into domestic effects ( $D^w$ ) and (intra-country) feedback effect ( $F^w = B^w - D^w$ ). The *Spillover effect* includes bilateral ( $L^s$ ) spillover effect and a feedback spillover effect from multilateral integration ( $F^s = B^s - L^s$ ). Detailed estimations of these matrices are available upon request

<sup>6</sup> The analysis is based on a three-country sample in our model framework, with a particular focus on the Japanese market. This estimation does not depend on the specific nature of Japan's relationships with China or other countries, as it controls for country-specific effects by estimating the weighted average spillover effect among countries.

(see column 6, on feedback effect). This implies that a significant increase in global trade would particularly benefit Japan's manufacturing industry, contributing to growth in output of 3.69 per cent ( $3.13 + 0.56$  per cent) (see last column, total effect).

The growing involvement of GVCs in regions such as East Asia and North America raises concerns about biased estimates in VA caused by the complex nature of international trade in production networks, such as the form of spiders or snakes (Antràs and de Gortari, 2020; Baldwin and Venables, 2013). Specifically, the issue arises when commodities cross a border multiple times or return to the source country, resulting in additional VA generated through interconnected trade. These interconnected trade flows can occur through both direct and indirect integration among countries (Antràs et al., 2023). The implications of these phenomena highlight the need for careful consideration when estimating VA to accurately capture the full impact of GVCs.

This research, consistent with previous studies (Bems and Kikkawa, 2021; Johnson, 2018; Kee and Tang, 2016), focuses on the overall or average contribution rather than on each sectoral contribution of DVA/FVA. The novelty of this subsection lies in its empirical estimates, which reveal that the double counting arising from the back-and-forth movement of intermediate products in trade contributes about 1.3 per cent at the bilateral level and 1.5 per cent at the multilateral level of integrations (see row 5, the sectoral average, in table 1). These findings align with the World Bank's (2020) forecast of a 1.7 per cent contribution in Germany, which serves as a representative developed country. These findings highlight the significance of accounting for double-counting effects when measuring the impact of intermediate goods in GVCs. By considering these calibrations, readers can gain valuable insights into the contribution of production stages to average growth, as well as the interplay of knowledge flows within GVC networks discussed in the next subsection, within the context of bilateral and multilateral interactions.

Overall, while some studies shed light on the re-exportation of intermediate goods and their subsequent absorption in home countries, importers and third countries (e.g. Koopman et al., 2014), this paper raises the challenge of where intermediate goods go within GVCs. Specifically, the presence of re-exported or reimported products between trading partners poses challenges in accurately disentangling double-counting elements within GVCs (de Gortari, 2019), leading to potential estimation bias (Bems and Kikkawa, 2021; Johnson, 2018; Kee and Tang, 2016). Accurate estimation of VA is crucial for understanding the impact of intermediate goods in GVCs. Addressing the challenges of double counting elements in the vertical production stages, consistent with the literature (Antràs et al., 2023; Baldwin and Venables, 2013), is essential to avoid estimation bias (de Gortari, 2019).



### 3.3 Knowledge spillovers and GVC participation

The intricate nature of intermediate product flows in GVC challenges related to double counting, as elucidated earlier. Simultaneously, these complexities create opportunities for knowledge transfer among collaborating countries that specialize in specific production stages for traded goods. This subsection further contributes to a deeper understanding of GVC dynamics by delving into the positive spillover effects of vertical integration within GVCs, adding a nuanced perspective to the scholarly discourse.

This paper adopts a two-step approach to analyse the dynamics of knowledge flow within GVCs. The first step involves the introduction of a knowledge flow model that captures the exchange and diffusion of knowledge among sector-country pairs participating in GVCs. In the second step, the knowledge flow model with sector-country pair integration is integrated, represented in a matrix form. This combination enables us to assess the impact of knowledge flows on sector-country pair interconnections and their contributions to value added output.

In the first step, the knowledge flow model based on the work of Bottazzi and Peri (2003), is represented by equation (3):

$$\sum \eta_{ij}^{rs} = \sum X_{ij}^{rs} \prod_{s \neq r} IMP_{ij}^{rs} \quad (3)$$

where  $\eta_{ij}^{rs}$  represents the knowledge flow, which is influenced by the distribution probability of importing and exporting,  $IMP_{ij}^{rs}$  is the international knowledge spillovers embodied in tradable goods and  $X_{ij}^{rs}$  is the other variables that have an impact on knowledge flow in regions, such as distance and languages.

Equation (3) plays a vital role in shaping the concept of knowledge flow within the production process among sector-country pairs in multilateral integration. I assume that the distributional impact of knowledge flow is jointly determined by the production stages of continuous inputs. I represent this effect as a percentage contribution<sup>7</sup> denoted by  $\zeta_{r(i)s(j)}^{\dagger}$ , which accounts for the products that are being re-exported or reimported multiple times between economies to be assembled.

$$\zeta_{r(i)s(j)}^{\dagger} = \left[ \begin{array}{cc} \sum_{\dagger \neq 1}^{\infty} (\eta_{ij}^{rs})^{\dagger-1}, & \sum \eta_{ij}^{rs} \neq 0 \\ 1, & \sum \eta_{ij}^{rs} = 0 \end{array} \right] \quad (4)$$

<sup>7</sup> This logic aligns with the findings regarding the relationship between the logarithm of patent citations and import value, as illustrated later.

The distribution of the joint probability<sup>8</sup> is formulated as  $(\eta_{ij}^{rs})^1 + (\eta_{ij}^{rs})^2 + \dots + (\eta_{ij}^{rs})^{\dagger-1} + 1$ , where  $\dagger - 1$  accounts for the number of times a product crosses a border during the production process across sector-country pairs (box 1).  $\zeta_{r(i)s(j)}^\dagger = 1$  signifies products that fully complete their GVC participation within the destination country and have no direct impact on export content or production chain in export. Thus, under the assumption of symmetry in country characteristics, the sum of the  $\zeta_{r(i)s(j)}^\dagger$  is equal to  $1 + (\dagger - 1)x(\eta_{ij}^{rs})$ , which can be interpreted as the maximum potential of knowledge flow reaching 100 per cent within GVC. This formulation captures the cumulative effect of knowledge spillover as it propagates through sector-country pairs (Baqaee and Farhi, 2019).

In the second step, the knowledge flow model was integrated with GVC participation using the approach proposed by Koopman et al. (2010) and Trefler and Zhu (2010). To achieve this, equations (1) and (2) were adjusted by introducing the term  $\zeta_{r(i)s(j)}^\dagger$ , represented by an n-by-n diagonal matrix, and combining it with both sides in equation (5). This function describes the knowledge flow coefficients in a location that makes it inherently sequential.

$$\zeta^\dagger T_v^E = \begin{bmatrix} \zeta_r^\dagger & 0 & \dots & 0 \\ 0 & \zeta_s^\dagger & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \zeta_n^\dagger \end{bmatrix} \begin{bmatrix} v^r B^{rr} E_{k^*}^r & v^r B^{rs} E_{k^*}^s & \dots & v^r B^{rn} E_{k^*}^n \\ v^s B^{sr} E_{k^*}^r & v^s B^{ss} E_{k^*}^s & \dots & v^s B^{sn} E_{k^*}^n \\ \vdots & \vdots & \ddots & \vdots \\ v^n B^{nr} E_{k^*}^r & v^n B^{ns} E_{k^*}^s & \dots & v^n B^{nn} E_{k^*}^n \end{bmatrix} \tag{5}$$

$$= \begin{bmatrix} \zeta_r^\dagger v^r B^{rr} E_{k^*}^r & \zeta_r^\dagger v^r B^{rs} E_{k^*}^s & \dots & \zeta_r^\dagger v^r B^{rn} E_{k^*}^n \\ \zeta_s^\dagger v^s B^{sr} E_{k^*}^r & \zeta_s^\dagger v^s B^{ss} E_{k^*}^s & \dots & \zeta_s^\dagger v^s B^{sn} E_{k^*}^n \\ \vdots & \vdots & \ddots & \vdots \\ \zeta_n^\dagger v^n B^{nr} E_{k^*}^r & \zeta_n^\dagger v^n B^{ns} E_{k^*}^s & \dots & \zeta_n^\dagger v^n B^{nn} E_{k^*}^n \end{bmatrix}$$

Briefly, equation (5) provides insights into the location of knowledge spillover and its interaction with production activities that directly affect exports. An accurate assessment of the contribution of knowledge spillover to value added in exports can be achieved by calibrating the technological influence of sector-country pairs. The primary goal of this approach is to utilize the global input-output matrix to effectively determine the dissemination of know-how through the intermediate goods utilized in various production stages. In this regard, modifications have been applied to DVA and FVA regarding the disaggregated export value of

<sup>8</sup> The jointly cumulative effect aligns with sectoral value-added propagation length through vertical integration in supplier and consumer relationships (see Antràs et al. (2012) and Dietzenbacher et al. (2005) for further details on average propagation lengths).

$$\sum_{S \neq r}^S \sum_{i,j=1}^J \sum_{f=1}^F E_{i,j,f}^{rs} = \left[ \sum_{S \neq r}^S \sum_{i,j=1}^J \sum_{f=1}^F (\hat{Y}_{i,j,f}^{rs}) + \sum_{S \neq r}^S \sum_{i,j=1,1}^J (A_{i,j}^{rs} X_j^s) \right].^9$$

This modification considers the diversity of products involved in the production process across different sector-country pairs. DVA and FVA can be written as follows:

$$\begin{aligned} DVA^r = v^r [D^{rr} + F^{rr}] & \left( \sum_{S \neq r}^S \sum_{i,j=1}^J \sum_{f=1}^F (\zeta_{r(i)S(i)}^\dagger) (\hat{Y}_{i,j,f}^{rs}) + \sum_{l \neq r,S}^S \sum_{i,j=1}^J \sum_{f=1}^F (\zeta_{r(i)l(i)}^\dagger) (\hat{Y}_{i,j,f}^{rl}) \right) \\ & + v^r \{ \lambda^{rs} + L^{rs} + \delta^{rs} + F^{rs} \} \left( \sum_{i,j=1,1}^J (\zeta_{r(i)S(i)}^\dagger) [A_{i,j}^{rs} X_j^{ss}] + \sum_{i,j=1,1}^J (\zeta_{r(i)S(i)}^\dagger) [A_{i,j}^{rs} X_i^{sr}] \right. \\ & \left. + \sum_{l \neq r,S}^S \sum_{i,j=1,1}^J (\zeta_{r(i)S(i)}^\dagger) [A_{i,j}^{rs} X_j^{sl}] \right) \\ & + v^r \left( \sum_{l \neq r,S}^S \{ \lambda^{rl} + L^{rl} + \delta^{rl} + F^{rl} \} \right) \left( \sum_{l \neq r,S}^S \sum_{i,j=1,1}^J (\zeta_{r(i)l(i)}^\dagger) [A_{i,j}^{rl} X_j^{ll}] \right. \\ & + \sum_{l \neq r,S}^S \sum_{i,j=1,1}^J (\zeta_{r(i)l(i)}^\dagger) [A_{i,j}^{rl} X_j^{lr}] + \sum_{l \neq r,S}^S \sum_{i,j=1,1}^J (\zeta_{r(i)l(i)}^\dagger) [A_{i,j}^{rl} X_j^{ls}] \\ & + \sum_{l \neq r,S}^S \sum_{t \neq r,S,l}^S \sum_{i,j=1,1}^J (\zeta_{r(i)l(i)}^\dagger) [A_{i,j}^{rl} X_j^{lt}] \dots \\ & \left. + \sum_{l \neq r,S}^S \sum_{t \neq r,S,l}^S \sum_{v \neq r,S,l,t}^S \dots \sum_{x \in S} (\zeta_{l(i)x(i)}^\dagger) [A_{i,j}^{lx} X_j^{x^*}] \right) \end{aligned} \quad (6)$$

$$\begin{aligned} FVA^r = v^s (L^{sr} + F^{sr}) & \left( \sum_{f=1}^F \zeta_{s(j)r(i)}^\dagger (\hat{Y}_f^{rs}) + \sum_{i,j=1,1}^J \zeta_{s(j)r(i)}^\dagger [A_{i,j}^{rs} X_j^s] \right) \\ & + \left( \sum_{l \neq r,S}^S (v^l) \sum_{l \neq r,S}^S (L^{lr} + F^{lr}) \right) \left( \sum_{l \neq r,S}^S \sum_{f=1}^F \zeta_{l(j)r(i)}^\dagger (\hat{Y}_f^{rl}) + \sum_{l \neq r,S}^S \sum_{i,j=1,1}^J \zeta_{l(j)r(i)}^\dagger [A_{i,j}^{rl} X_j^{lr}] \right. \\ & \left. + \sum_{l \neq r,S}^S \sum_{t \neq r,S,l}^S \sum_{i,j=1,1}^J \zeta_{l(j)r(i)}^\dagger [A_{i,j}^{rl} X_j^{lt}] \right) \end{aligned} \quad (7)$$

To summarize, this research aims to enrich our understanding of GVC participation by investigating the effect of knowledge spillovers in vertical interactions. By thoroughly analysing continuous trade and its spillover effects within GVCs, it provides valuable insights into estimating tradable intermediate products and

<sup>9</sup> This represents the sum of the (aggregated) gross export in country  $r$  of (i) final goods  $\sum_{S \neq r}^S \sum_{i,j=1}^J \sum_{f=1}^F (\hat{Y}_{i,j,f}^{rs})$ , which account for the sum column of households, governments and investments, and (ii) intermediate goods  $\sum_{i,j=1,1}^J (A_{i,j}^{rs} X_j^s)$ , which accounts for the sum column of n-by-n industries.

their technological spillover impact on sector-country pair interconnections at the national and international levels. Importantly, the study emphasizes the diversity and heterogeneity of input products, leading to distinct knowledge spillover effects on trade in both bilateral and multilevel integrations. Overall, the model significantly contributes to comprehending global trade dynamics and the critical role of knowledge flows within GVCs.

### 3.3.1 Data source and econometric model

The number of patent citations is commonly used as a reliable indicator of knowledge flow (Nabeshima et al., 2018). In this study, to estimate the knowledge flow coefficient, patent citation data between 2001 and 2010 were collected from the United States Patent and Trademark Office.<sup>10</sup> In addition, import trade data at the 4-digit level of the International Standard Industrial Classification was obtained from the United Nations Comtrade database.<sup>11</sup> To quantify the spatial information of Japanese trading partners, variables such as distance, language and border were acquired from CEPII GeoDist.<sup>12</sup> To establish the connection between patent knowledge flow and trade goods industries, I merged the knowledge flow classification of patents with the industry classifications of trade goods. This merging process was based on the concordance table documented by Schmoch et al. (2003).

To ensure the consistency of the technological spillover effect, the trade data are linked with patent citation data. In addition, my research aligns with Bottazzi and Peri (2003), who established that knowledge spillovers tend to decrease with distance. To examine these dynamics, the data set comprises trade and patent citation information from 14 Asian economies: Brunei Darussalam, Cambodia, China, Hong Kong (China), Indonesia, Japan, the Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, the Republic of Korea, Singapore, Thailand and Viet Nam. These countries were selected on the basis of data availability and the presence of significant trade flow and industrial networks within the region.<sup>13</sup> Knowledge diffusion is estimated for Japan as a single-country analysis.

This research adopts the empirical approach proposed by Nabeshima et al. (2018) to investigate the connection between patent citations and import values. By solving the log linearizing system in equation (3), an approximate relationship between patent citations and import values can be derived, as follows:

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<sup>10</sup> "Patent application data", Bulk Data Storage System, <https://bulkdata.uspto.gov> (accessed 14 April 2019).

<sup>11</sup> <https://comtradeplus.un.org> (accessed 10 February 2020).

<sup>12</sup> [http://www.cepii.fr/CEPII/en/bdd\\_modele/bdd\\_modele.asp](http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp) (accessed 20 February 2020).

<sup>13</sup> Unbundling in GVCs has concentrated GVC involvement in specific regions, leading to more efficient knowledge transfer within specific regions (Piermartini and Rubínová, 2021).

$$\ln\left(\sum \eta_{ijt}^{rs}\right) = \beta_0 + \beta_1 \ln(\text{IMP}_{ijt}^{rs}) + \beta_2 \mathbf{X}_{ijt}^{rs} + \delta_i + \lambda_t + \varepsilon_{ijt}^{rs} \quad (8)$$

$$\ln\left(\sum \eta_{ijt}^{rs}\right) = \exp[\beta_0 + \beta_1 \ln(\text{IMP}_{ijt}^{rs}) + \beta_2 \mathbf{X}_{ijt}^{rs} + \delta_i + \lambda_t] + \varepsilon_{ijt}^{rs} \quad (9)$$

where  $\ln\left(\sum \eta_{ijt}^{rs}\right)$  represents the natural logarithm of the number of patent citations, representing the knowledge flow from country  $r$  to country  $s$  in an industry  $i$  to  $j$  for a specific year  $t$ , as a percentage of knowledge flow. Similarly,  $\ln(\text{IMP}_{ijt}^{rs})$  denotes the natural logarithm of bilateral trade flow of imports. The control variables,  $\mathbf{X}_{ijt}^{rs}$ , account for the logarithm of the distance between each country's capital, along with dummy variables for language and border (appendix table A2). Sector-fixed effect  $\delta_i$  and year-fixed effect  $\lambda_t$  are also considered. Lastly, the error term  $\varepsilon_{ijt}^{rs}$  accounts for unobserved factors.

In the analytical framework, the study employs a set of models for rigorous analysis. Panel data analysis involves random-effects, fixed-effects, Poisson random-effects and Poisson fixed-effects models. For pooled data, ordinary least squares, negative binomial regression and Poisson pseudo-likelihood regression with multiple levels of fixed effects are employed. These models, selected based on the non-negative nature of patenting data, ensure a comprehensive understanding of the intricate relationships between patent citations and imports across diverse sector-country pairs.

### 3.3.2 Results and discussion

Empirical research has demonstrated that international trade facilitates the exchange of knowledge across borders, particularly in production techniques, leading to improved productivity outcomes (Nabeshima et al., 2018). This study, centered on the Japanese market as a representative single economy, examines the knowledge flow embodied in imported goods between trading partners. Since the dependent variable (patent citations) is expressed in logarithms, the coefficients obtained correspond to elasticities, representing the percentage changes in productivity resulting from learning-by-exporting or -importing.

Table 2 provides panel and pooled data analysis for the relationship between patent citations and imports (refer to equation 9), with heteroskedasticity-robust standard errors and fixed effect. The coefficients denote the knowledge flow, expressing the percentage increase in knowledge associated with a corresponding percentage increase in imports. Columns 1 to 4 present the analysis for all sectors, while columns 5 to 7 focus on agriculture, mining and manufacturing, respectively. The coefficient estimates for imports are statistically significant and positively associated with knowledge flow.

**Table 2. Japanese knowledge diffusion (Percentage)**

Panel result							
Estimator	All sectors				Agriculture	Mining	Manufacturing
	RE (1)	FE (2)	Poisson RE (3)	Poisson FE (4)	RE (5)	RE (6)	RE (7)
In(Import+1)	0.547*** (0.051)	0.530*** (0.075)	0.314 (0.470)	0.259*** (0.021)	0.372*** (0.032)	0.317 (0.000)	0.580*** (0.054)
Constant	39.064*** (2.381)	0.354 (0.222)	8.836 (59.702)		23.957 (16.459)	35.880 (0.000)	40.718*** (2.281)
Observations	5 280	5 280	5 280	2 060	240	120	4 800
R <sup>2</sup>	0.034	0.617	0.000	0.000	0.031	0.005	0.038
Pooled result							
Estimator	OLS (1)	PPML (2)	PPML (3)	NBReg (4)	NBReg (5)	NBReg (6)	NBReg (7)
In(Import+1)	0.574*** (0.056)	0.415*** (0.029)	0.340*** (0.024)	0.615*** (0.036)	0.561*** (0.178)	1.016 (0.000)	0.619*** (0.036)
Constant	36.645*** (2.223)	8.286*** (0.818)	10.458*** (0.765)	6.209*** (0.883)	15.786 (9.796)	7.705 (0.000)	6.054*** (0.892)
Observations	5 280	5 040	5 280	5 280	240	120	4 800
R <sup>2</sup> /Pseudo R <sup>2</sup> /chi <sup>2</sup>	0.561	0.555	0.486	0.107	0.158	0.207	0.109
Year dummy	Yes	Yes	No	No	No	No	No
Sector dummy	Yes	Yes	No	No	No	No	No
X (Control variables)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster/Robust	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's estimations.

Note: The empirical distribution of dependent and independent variables is based on  $\ln(\text{citations}+1)$  and  $\ln(\text{import}+1)$ . This is because the data distribution exhibits a prevalence of 0 values; to avoid omitted observations, as  $\ln(0)$  is undefined, 1 is incorporated to ensure  $\ln(1)$  equals 0. Panel data analysis includes RE, FE, Poisson RE and Poisson FE models. Pooled data analysis involves OLS, PPML and NBReg (see columns 1 to 7). The control variables (X) are distance, language and border. Sector-classified product codes 1-2 for agriculture, 9 for mining, 3-8 and 10-44 for manufacturing and 5 for service are not presented as the relationship between patent citations and imports for the services sector in Japan could not be estimated, because of the standard deviation of 0 (min and max 0). \*\*\*, \*\*, \* represent significance at the 1 per cent, 5 per cent and 10 per cent level, respectively. Standard errors in parentheses. FE = fixed effects, NBReg = negative binomial regression, OLS = ordinary least squares, PPML = Poisson pseudo-likelihood regression with multiple levels of fixed effects, RE = random effects.

In the panel data, coefficients for all sectors range from 0.259 per cent to 0.547 per cent (see columns 4 and 1). In the pooled data, coefficients for all sectors range from 0.340 per cent to 0.615 per cent (see columns 3 and 4). Breaking down by sector, agriculture, mining and manufacturing show coefficients of 0.561 per cent, 1.016 per cent (insignificant result) and 0.619 per cent, respectively (see columns 5 to 7 in the pooled data result). Notably, the representative model for Japan reveals an overall knowledge flow coefficient of 0.615 per cent. These results emphasize the pivotal role of imports as a significant channel for knowledge exchange.

Using the two-step approach (explained in subsection 3.2), the knowledge flow is calculated in production stages, capturing the cumulative effect of knowledge spillovers. Subsequently, this knowledge flow is combined with sector-country pair interconnections to assess its contribution to VA as a potential GVC impact. The key findings of the study reveal that products that undergo the final stages of production in destination countries and subsequently across borders as final goods make a significant contribution to value added output. The estimated contributions range from 2.5 per cent to as much as 154 per cent,<sup>14</sup> depending on factors such as crossing borders at the initial stage or reaching their full potential within the GVC. These findings highlight the vital role of intermediate goods trade within GVCs, where these goods cross international borders multiple times to be assembled, assuming various forms, as exemplified by the spider, snake and hybrid “sniker” models (Antràs et al., 2017; Antràs et al., 2023; Baldwin and Venables, 2013).

The findings of this study align with established theoretical frameworks and empirical evidence. Firms operating within GVCs have exhibited increased productivity, often referred to as “GVC-driven innovation” (Baldwin and Yan, 2014; Piorelli and Rabelotti, 2011). Constantinescu et al. (2019) highlight the significant impact on average productivity of using imported inputs for export production, with gains of approximately 1.6 per cent. Also, Alfaro et al. (2019) found that more-productive firms tend to integrate a higher number of inputs within GVCs. Although the methodological approach differs in terms of estimating the direct and indirect effects of intermediate goods trade on output, for example, the concept of decoupling GVC, explored in roundabout models (Caliendo and Parro, 2015), demonstrates that no-intermediate-input trade can lead to reduced output and welfare, with impacts ranging from 1 per cent to 70 per cent (Eppinger et al., 2021).

In summary, this subsection explored the optimal contribution of re-exported or reimported products within GVCs. It highlighted their significant impact on knowledge flow and output growth, underlining the importance of knowledge spillovers through sector-country pair integration and international trade for driving economic output within GVCs.

<sup>14</sup> Note that the coefficient of 0.615% accounts for knowledge flow ( $\eta_{ij}^{rs}$ ) for the Japanese market. In the first step, the term  $\zeta_{r(i)s(j)}^{\dagger}$  represents the cumulative effect of knowledge spillovers in production stages, calculated as  $1 + (0.615)^1 + (0.615)^2 + \dots + (0.615)^{t-1}$  (see equation (4) in subsection 3.2). We can interpret this as the knowledge flow crossing borders at the initial stage, denoted as  $1 + (0.615)^1 = 1.615\%$ , or reaching its full potential, denoted as  $(0.615)^1 + \dots + (0.615)^{t-1} + 1 = (t-1) \times (0.615) + 1 = 100\%$ . By merging the two-step approach – the knowledge spillover with sectoral integration, expressed as  $\sum_{r \neq s} \sum_{i,j=1,1}^{\dagger} (\zeta_{r(i)s(j)}^{\dagger} B_{ij}^{rs})$  (see subsection 3.2) – tradable commodities in the production stages can contribute from 2.5% ( $1.615 \times 1.54$ ) to 154% ( $100 \times 1.54$ ) to overall output (see tables 1 and 2 for 1.54 and 0.615%, respectively).

## 4. Conclusions and policy implications

This study offers two significant contributions to literature. First, it unravels the double-counting mystery by elucidating production fragmentation through re-exported or reimported intermediate inputs. Second, it emphasizes the importance of knowledge spillover effects and introduces optimal GVC participation strategies. In short, the research shows that considering different forms of value added with knowledge flow effects provides more accurate integration information at the sectoral and regional levels, along with an optimal estimation technique.

The research highlights country-sector pairs benefiting from production fragmentation in GVCs, emphasizing the importance of accurate value added estimation. More specifically, the findings indicate that integration among country-sector pairs, represented by the export/import coefficient, significantly contributes to VA while occasionally causing double-counting issues, estimated at approximately 1.5 per cent at the country level. Furthermore, considering the knowledge spillover effect, tradable commodities being re-exported or reimported in production stages, such as crossing borders at the initial stage or reaching their full potential within GVCs, significantly contribute to value added output, in a range from 2.5 per cent to as much as 154 per cent.

The paper also has important policy implications. Overall, developing robust methods for analysis is important for developing robust policy recommendations. Promoting GVC participation requires strengthening trade relationships between different countries and regions. At the same time, fostering knowledge exchange is a pivotal policy consideration for unlocking the potential of GVCs to drive knowledge spillover and value added growth. In line with this paper's contribution, the paper calls for the development of robust accounting frameworks and methodologies to address double-counting effects in trade, ensuring accurate estimation of VA in GVCs. This is vital for informed policymakers who are striving to promote resilience and sustainable value added growth. Second, it underscores the paramount importance of recognizing the potential of GVC participation in driving VA growth. By embracing GVCs and actively engaging in global trade networks through processing trade policies,<sup>15</sup> countries can gain access to new markets, harness technological advancements and foster knowledge exchange (Pietrobelli and Rabellotti, 2011).

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<sup>15</sup> Prioritizing initiatives to promote bilateral integration and strengthen multilateral trade relationships enhances supplier effects, enables the smooth movement of intermediate goods, and fosters overall VA (Constantinescu et al., 2019; Razeqa, 2022). In GVCs, reducing trade costs, especially tariffs, is crucial since components often cross borders multiple times, magnifying the impact of trade costs on final prices.



Adopting more tailored trade policies becomes crucial for ensuring that GVC participation leads to higher value capture (Baldwin and Lopez, 2015; Pietrobelli et al., 2021; Van Assche and Gangnes, 2019). Policymakers should prioritize efforts to reduce cross-border transaction costs for local firms, enhance connectivity and attract GVC partners. For instance, studies by Nabeshima and Obashi (2021) and Nabeshima et al. (2021) show that differences in regulations can result in decreased bilateral trade volume and reduced diversity of traded goods. Streamlining regulations, promoting harmonization or achieving mutual recognition of regulations among major trading partners through plurilateral agreements may be ways to reduce the transaction costs to firms of complying with varying regulations, thereby facilitating greater participation by firms in GVCs.

There is concern about market concentration, where a few superstar firms often reap outsized benefits from intangible-related advancements (Autor et al., 2020), underscoring the negative impacts of globalization on certain groups, especially in smaller cities and among unskilled workers (Côté et al., 2020). But the rise of GVCs has produced an intricate trade policy landscape, with the COVID-19 pandemic underscoring the extensive impacts of global supply chain disruptions (Antràs et al., 2023; Eppinger et al., 2021; Van Assche and Brandl, 2021), thereby emphasizing the necessity for supranational reforms in GVCs. Thus, countries should prioritize GVC-oriented policies aligned with market facilitation, connectivity and sector-specific strategies. A key policy implication is that tailoring strategies to their unique contexts and objectives is essential, as a one-size-fits-all approach will not suffice. Policymakers should analyse their industry structures and GVC capabilities so as to design customized policies that leverage strengths and opportunities, promoting economic growth, job creation and innovation. In addition, fostering a collaborative approach through international cooperation, policy coordination and partnerships among governments, businesses and civil society is crucial for effective GVC participation.

The study acknowledges limitations, such as challenges in quantifying foreign-owned firms' participation and potential estimation bias. These important points should be taken into consideration for further research. Moreover, considering the increasing significance of digital technologies in the global economy and the evolving role of services within GVCs, particularly in light of the impact of service digitization on global production networks, investigating the influence of such technologies on the structure and functioning of GVCs emerges as a crucial domain for future research.

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## Appendix

**Appendix table A1. GTAP-MRIO Data: Sectors and economies, countries or regions**

<b>Sectors</b>	
<b>Agriculture</b>	Paddy rice; wheat; cereal grains, nec; vegetables, fruit, nuts; oilseeds; sugar cane, sugar beet; fish; sugar; plant-based fibers; fish; vegetable oils and fats; dairy products; crops, nec; bovine cattle, sheep and goats, horses; animal products, nec; raw milk; wool, silkworm cocoons; forestry.
<b>Mining</b>	Coal; oil; gas; mineral products, nec; petroleum, coal products.
<b>Manufacturing</b>	Metal products; manufacturers, nec; textiles; motor vehicles and parts; transport equipment, nec; machinery and equipment nec; bovine meat products; meat products, nec; processed rice; ferrous metals; metals, nec; food products, nec; beverages and tobacco products; wearing apparel; leather products; computer, electronic and optical products; electrical equipment; wood products; paper products, publishing; chemical products; basic pharmaceutical products; rubber and plastic products; bovine meat products; meat products, nec; vegetable oils and fats; dairy products; processed rice; sugar; food products, nec; beverages and tobacco products; other extraction (formerly other manufacturing) minerals, nec.
<b>Services</b>	Gas manufacture, distribution; construction; trade; accommodation, food and service activities; real estate activities; business services, nec; insurance; warehousing and support activities; transport, nec; communication; water transport; air transport; financial services, nec; electricity; water; recreational and other services; public administration and defense; education; human health and social work activities; dwellings.groups. The groups available for organizations to select were Children, Migrants, Women, Refugees and Other vulnerable populations.

### **Economies, countries or regions**

**Africa:** Central Africa (Central Africa), East Africa (the Democratic Republic of the Congo, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Uganda, the United Republic of Tanzania, Zambia, Zimbabwe, rest of East Africa), North Africa (Egypt, Morocco, Tunisia, rest of North Africa), South African Customs Union (Botswana, Namibia, South Africa, rest of the South African Customs Union), West Africa (Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, rest of West Africa)

**Americas:** North America (Canada, Mexico, United States of America, rest of North America), South America (Argentina, the Bolivarian Republic of Venezuela, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, the Plurinational State of Bolivia, Uruguay, rest of South America), Central America (Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, rest of Central America), Caribbean (the Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, rest of the Caribbean)

**Asia:** East Asia (China, Hong Kong (China), Taiwan Province of China, Japan, Mongolia, the Republic of Korea, rest of East Asia), South Asia (Bangladesh, India, Nepal, Pakistan, Sri Lanka, rest of South Asia), South-East Asia (Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, the Philippines, Singapore, Thailand, Viet Nam, rest of Southeast Asia), Western Asia (Armenia, Azerbaijan, Bahrain, Georgia, the Islamic Republic of Iran, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Türkiye, the United Arab Emirates, rest of Western Asia)

**Europe:** East Europe (Albania, Belarus, the Russian Federation, Ukraine, rest of East Europe), European Free Trade Association (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Kingdom of the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, Norway, rest of the European Free Trade Association), rest of Europe, former Soviet Union (Kazakhstan, Kyrgyzstan, Tajikistan, rest of Former Soviet Union)

**Rest of the world:** Oceania (Australia, New Zealand, rest of Oceania), rest of the world

*Source:* Author's aggregation, based on the GTAP-MRIO version 10 database.

*Note:* For more information on the geographic and sectoral coverage details in GTAP, see Aguiar et al. (2019, pp. 22–24).

**Appendix table A2. Summary statistics for key variables in patent panel data**

<b>Variable</b>	<b>Number of observations</b>	<b>Mean</b>	<b>Standard deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<i>Log of Patent citation</i>	68 060	0.432	2.076	0.000	19.873
<i>Log of Import value</i>	68 060	2.042	2.239	0.000	10.544
<i>Log of Distance</i>	68 060	7.672	0.616	5.754	8.664
<i>Language</i>	68 060	0.116	0.320	0.000	1.000
<i>Border</i>	68 060	0.148	0.356	0.000	1.000

*Source:* Author's estimations.

*Note:* Countries listed in the summary report include Brunei Darussalam, Cambodia, China, Hong Kong (China), Indonesia, Japan, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, the Republic of Korea, Singapore, Thailand and Viet Nam.





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## FOCUSED SECTION

# World Investment Forum 2023: Key issues and elements of a forward-looking research agenda

## Introduction

UNCTAD's eighth World Investment Forum 2023 (WIF23) provided the opportunity to tap into the latest research and academic thinking to strengthen the support and advice to Member States. The forum had more than 150 sessions and 8,000 attendees, including more than 1,100 speakers. Heads of state and government, ministers and international organization representatives attended, as well as policymakers and legislators, parliamentarians, heads of investment promotion agencies, treaty negotiators, regulators, chief executive officers and other executives of multinational enterprises (MNEs), academics and civil society.

All sessions, from high-level panels to academic presentations, addressed the most important challenges facing sustainable investment in developing countries – including high risk ratings and capital costs due to debt distress, the deteriorating international investment climate, tight financing conditions, difficult business environments, and institutional and infrastructure shortcomings. The forum's outcomes identified investment priorities, such as renewable energy and energy infrastructure; agriculture and agrifood systems to improve food security, resilience and biodiversity; water management; and health care. We are now at the midpoint of the 2030 global development agenda, with a risk of slowing the progress achieved in various sectors. For example, UNCTAD's *World Investment Report 2023* shows that although international investment in sectors relevant to the Sustainable Development Goals in developing countries increased in 2022 – with higher project numbers in infrastructure, energy, water and sanitation, agrifood systems, health and education – when compared with 2015 progress remains very modest. In agrifood systems, which are critical for future food security, international investment is lower today than when the Goals were adopted.

### **The academic track**

For more than three decades, UNCTAD's Division on Investment and Enterprise has contributed to advancing research, policy analysis and technical assistance on foreign direct investment (FDI), the activities of MNEs and international production, most notably through its annual World Investment Report. It has done so in close collaboration with the academic community.

UNCTAD organized the academic track of the forum in partnership with the Academy of International Business (AIB), the Graduate Institute of International and Development Studies, the United Nations University World Institute for Development Economics Research (UNU-WIDER), New York University–Abu Dhabi and Middlesex University–Dubai, as well as other universities and institutions.

In the academic track, more than 100 speakers, including world-renowned scholars and doctoral students, participated in the series of thematic events integrating research and ideas from scholars, researchers, executives from global companies and senior policymakers. The events covered a broad spectrum of issues related to foreign investment, MNEs and development, including themes such as the energy transition, sustainable infrastructure, FDI and women's empowerment, SME internationalization, investment in Industry 4.0 and the future of global investment.

An innovation of the 2023 academic track was that leading scholars ran the discussions in core sessions of the forum, creating synergies between academia and the multi-stakeholder community and generating cross-fertilizing debates. This provided a unique opportunity to hear about the latest research emerging in the field, to reflect on the core issues and themes discussed across the forum, and to influence the future research agenda on investment for development.

The track also featured an Academic–Practitioner's Dialogue on Sustainable Finance and Business, and the High-level International Investment Agreements Conference 2023. The Conference covered key themes: making investment policy and international investment agreements (IIAs) consistent with national, regional and global climate commitments; ensuring that IIA commitments safeguard the right of states to regulate in the public interest; enhancing the effectiveness of environmental clauses in IIAs, investor obligations and responsibilities; and strengthening regional and global forums for continued dialogue and coordination on comprehensive IIA reform.

For the first time, an Investment for Development Research Square was organized at the Investment Village, in collaboration with the WIF23 academic partners. It provided a platform for discussions and exchange of ideas between policymakers, academics, business representatives and professionals from diverse backgrounds about current policy, industry and academic thinking in relation to the role of international investment and the achievement of the Sustainable Development Goals. The Square also featured exhibition booths as an outlet for research and publication, including award-winning papers and videos on investment-related topics from investment promotion agencies, leading companies and experts from the United Nations and other international organizations.

A highlight of the Investment for Development Research Square were the daily high-profile “fireside chats” between senior policymakers, practitioners, scholars and

other stakeholders on issues relating to international investment and development. To enrich the multidisciplinary research agenda, a special session was held to facilitate research dialogue between scholars and academic journal editors.

## **The future research agenda**

Traditionally, UNCTAD has used the academic track in the WIF to help refresh the research agenda on investment for development (Zhan et al., 2021). Following the events and discussions in the numerous sessions of WIF23, prominent issues and challenges emerged to guide the focus for future research and opportunities with UNCTAD partners in investment for development. Some of the emerging topics for future research include the sustainability imperative, notably the energy transition and the need for climate resilience and adaptation, with a call for more research on the incentives and economics of investing in clean sources of energy, and the incentives and barriers to decommissioning fossil fuel assets; investment in biodiversity, agrifood systems and food security; FDI and gender equality, with more prominent roles for investment facilitation and stakeholder collaboration; the role of market infrastructure, particularly stock exchanges and their regulators; and the reconfiguration of global value chains, notably for supply chain resilience and a more inclusive trading system for low-income and vulnerable countries; and new insights on how developing economies, including the least developed countries, could finance adaptation investment needs. The short perspective papers in this focused section reflect some of the key issues and topics for that agenda through the lens of academia and highlight avenues for future research.

First, Kunal Sen's paper looks at the role of investment and domestic savings for development, focusing on sub-Saharan Africa. The note argues that institutional quality is the key driver of the type of investment that is necessary for structural transformation. It concludes that policymakers can support the growth of pension and capital markets, and the fintech sector, through appropriate reforms and through re-orienting sovereign wealth funds towards more developmental purposes.

Paul M. Vaaler focuses on the discussions of green investment and sustainable development at WIF23, including how to effectively facilitate collaboration by leaders across sectors to achieve sustainable development. Topics addressed in this thought piece include critical reflections on IIAs, investor–State dispute settlement and the role of investment projects based on public-private partnerships in investment regimes to achieve the SDGs.

Ari Van Assche addresses one of WIF23's main messages: the urgent need for innovative solutions to facilitate the integration of LDCs in the global investment and trading system, focusing on the Global Value Chains for LDCs Initiative.

The paper suggests that the initiative could be an integral part of such a solution package for LDCs, including by encouraging corporate engagement in incorporating LDCs in their supply chains.

Finally, the perspective paper by Rudolf R. Sinkovics, Denanjalee Gunaratne and Noemi Sinkovics addresses two core issues at WIF23: the role of innovative business models as game changers and the use of Industry 4.0 technologies to tackle the grand challenges for sustainable development. Exploring innovative business models in the agrifood sector, the paper highlights the importance of collaboration between policymakers, business leaders and researchers to promote and scale up game-changer business models that create economic, social and environmental innovations.

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# The drivers of investment and savings rates: An exploratory note\*

Kunal Sen<sup>a</sup>

## Abstract

This note explores the literature on the determinants of foreign direct investment and domestic savings. With respect to foreign direct investment, it argues that institutional quality is the key driver of the type of investment that is necessary for structural transformation. With respect to domestic savings, focusing on sub-Saharan Africa, which lags behind other regions in savings rates, it suggests that there needs to be a stronger emphasis on long-term capital needs of the region. Policymakers can support the growth of pension and capital markets and the fintech sector through appropriate reforms and through re-orienting sovereign wealth funds towards more developmental purposes.

**Keywords:** capital markets, fintech foreign direct investment, pension funds, savings

**JEL classification codes:** E21, E22, O40

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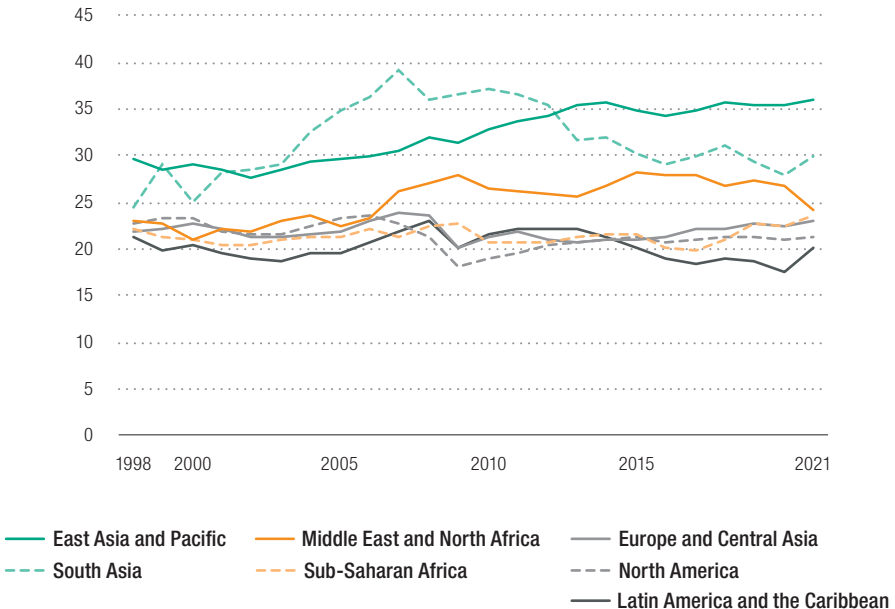
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### 1. Introduction

The vast empirical literature on economic growth has found that investment is a key determinant of growth (Barro, 1991). Investment rates (gross capital formation as a percentage of gross domestic product (GDP) differ greatly across regions (figure 1). For example, the average investment rate in East Asia in 2010–2021, at 35 per cent, was 13 percentage points higher than that of sub-Saharan Africa for the same period. This explains to a large extent why average economic growth rates in East Asia are substantially higher than in sub-Saharan Africa. What explains why some regions have higher investment rates than other developing regions? Investment is composed of foreign direct and domestic investment. The latter is almost completely determined by domestic savings, as noted by Feldstein and Horioka (1980). To understand why investment rates differ greatly across regions, we need to understand the drivers of foreign investment and domestic savings separately, drawing from a recent project by UNU-WIDER, “The Domestic Savings Shortfall in Sub-Saharan Africa: What Can Be Done About It?”. The note contributes to the literature on investment and savings, and especially, the determinants of domestic savings.

**Figure 1. Investment rates, by region, 1998–2021** (Domestic capital formation as percentage of GDP)



Source: Author’s calculations, based on the World Bank’s World Development Indicators (accessed 30 November 2023).

A particular challenge that policymakers in Africa face is mobilizing long-term capital for investment needs, given the underdeveloped nature of stock and bond markets in the continent. The interest in developing capital markets was reflected in two sessions that were held as part of the World Investment Forum held in Abu Dhabi in October 2023.<sup>1</sup>

The rest of the note is in three sections. Section 2 briefly discusses the role of institutional quality in determining foreign direct investment (FDI). Section 3 focuses on the determinants of domestic savings. Section 4 concludes.

## 2. The determinants of foreign direct investment

There is a large literature on the determinants of FDI.<sup>2</sup> Earlier literature has focused on resource endowments, the product cycle and market size of host countries (Dunning, 1970; Vernon, 1966). More recent literature has examined the role of institutional quality in explaining cross-country variations in FDI inflows (e.g. Altomonte, 2000; Bevan and Estrin, 2004). For example, Sen and Sinha (2017) look at the institutional determinants of both within- and across-country variations in United States FDI flows over time. They argue that in countries with high-quality contract enforcement, multinationals are more likely to invest in industries where by their very nature investments are relationship specific. Conversely, in countries with low-quality contract enforcement, multinationals are more likely to invest in industries where investments to a large degree are not relationship specific. Using three-dimensional panel data for United States FDI flows to 50 countries and 6 sectors for the period 1984–2010, they find strong support for their core hypothesis. Their findings suggest that countries that want to attract United States FDI in sectors that are highly intensive in technology and institutions such as transportation and electronics should improve their property rights and contracting environment. This suggests that institutional quality plays a key role in attracting foreign direct investment, especially in sectors such as manufacturing and tradable services which are key to productive structural transformation (Sen, 2023). In contrast, in countries where institutional quality is weak, and where resources such as oil and gas are abundant, FDI is more likely in sectors such as mining, where there are limited possibilities of spillover effects to domestic firms.

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<sup>1</sup> See <https://worldinvestmentforum.unctad.org/session/sovereign-and-public-investors-dialogue> and <https://worldinvestmentforum.unctad.org/session/sustainable-finance-and-business-academic-and-practitioner-dialogue>.

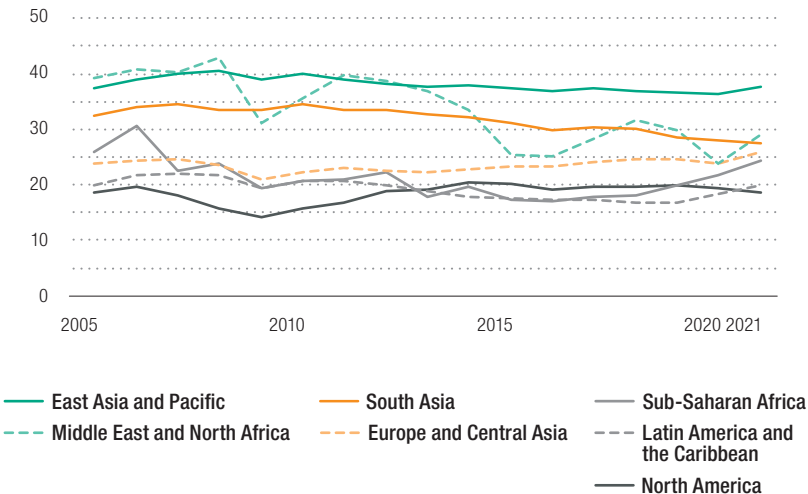
<sup>2</sup> See Helpman (2006) and Sinha and Sen (2016).

### 3. The drivers of domestic savings

Similar to investment rates, savings rates differ widely across regions (figure 2). Among developing regions, sub-Saharan Africa has one of the lowest rates of savings, an average of 19 per cent in 2010–2021. In the same period, in East Asia the savings rate was 37 per cent, which explains to a large extent why East Asia has the highest investment rates among developing regions. In the period 2000–2017, the average savings rate in sub-Saharan Africa was 22 per cent as compared with 34 per cent in East Asia and 27 per cent in South Asia. Of more concern is the fact that the savings rate in sub-Saharan Africa has fallen from a high of 27 per cent in 2006 to 19 per cent in 2017. Clearly, for economic growth to increase in the region, a major policy impetus should be to increase domestic savings rates.

Here, we examine the drivers of savings rates in sub-Saharan Africa, drawing from a recent project by UNU-WIDER, “The Domestic Savings Shortfall in Sub-Saharan Africa: What Can Be Done About It?”. The project aims to increase knowledge about (i) the key drivers of domestic saving rates in sub-Saharan Africa; (ii) whether alternative approaches, such as pension funds or fintech, could provide new solutions to increase domestic savings; (iii) lessons learned from the experiences so far in different countries in sub-Saharan Africa and; (iv) what sub-Saharan Africa can learn from the experience of regions that have been more successful in raising savings rates.

**Figure 2. Savings rates, by region, 2005–2021** (Gross savings as percentage of GDP)



Source: Author’s calculations, based on the World Bank’s World Development Indicators (accessed 30 November 2023).



One important development in developing countries in the past two decades has been the way technology and innovation have revolutionized financial markets. Financial technology (fintech) has changed the way banking services are provided, the way banks work, how capital is raised and how payments, including retail payments, are conducted. Ndung'u (2022) traces the development of fintech in sub-Saharan Africa and how it may have led to financial inclusion for underserved and unserved parts of the population in the continent. The author notes that fintech has vast potential to mobilize financial savings in sub-Saharan Africa and suggests options for policymakers to take to increase the rapid uptake of fintech products.

Njenga et al. (2022) review the state of progress in the development of capital markets in sub-Saharan Africa. The authors argue that policymakers need to stabilize capital markets in the continent by building investor confidence through strict enforcement of rules and regulations, having a stable macroeconomic environment and supporting the growth of micro, small and medium enterprises to enhance their attractiveness for being listed in bond and stock markets.

Pension systems are also a potential source of long-term investible funds, as is clear from the East Asian experience. Pensions also provide an important form of social protection for the elderly. Nyang'oro and Njenda (2022) discuss the experience with pension funds in sub-Saharan Africa, noting the low coverage and high costs of joining pension schemes, and that these schemes mostly cover formal sector employees. The authors argue for a targeted universal pension system funded by public resources and that the move to universal coverage needs to be gradual, so as not to lead to fiscal strain.

In many developed (as well as developing) countries, sovereign wealth funds (SWFs) play an increasingly important role in fiscal stabilization, productive investment and intergenerational saving. Addison and Lebdioui (2022) assess the potential role that SWFs can play in Africa in mobilizing savings for investment. African SWFs hold \$8 trillion in assets, making them global financial players. Addison and Lebdioui argue that in addition to fiscal stabilization and intergenerational savings roles, African SWFs should act as development funds in financing productive investment in long-term structural transformation.

Many countries in Africa implemented financial sector reforms as part of structural adjustment programmes in the 1980s and 1990s. The debate on whether financial liberalization leads to an increase or decline in savings is unresolved in the African context. Asiedu et al. (2022) assesses the impact of financial liberalization on private savings in sub-Saharan Africa using cross-country panel data and finds no discernible effect of financial reforms on private savings in the continent.

Athukorala and Suanin (2022) examine the experience in Asia, which has done better than other developing regions in having high domestic savings rates.

They argue that there is no evidence that a prior phase of promoting savings through specific policy initiatives was critical to Asia's success in mobilizing savings and that rapid economic growth was a primary factor in initiating the savings transition in the region.

The WIDER project on domestic savings in sub-Saharan Africa provides four implications for policymakers.<sup>3</sup> First, to exploit the vast potential of fintech in mobilizing financial savings in the subregion, there is a need to create a competitive ecosystem and infrastructure that facilitate entry, develop robust consumer protection regulations to provide an enabling and innovative environment, and build capacity to monitor and prevent cybercrime, especially in terms of office-level surveillance.

Second, interventions are needed to accelerate capital market development. They include sustaining efforts to ensure the stability of the capital markets to build investor confidence through strict enforcement of the laws, regulations and rules governing them; having a constantly stable and conducive macroeconomic environment to incentivize investments; developing and implementing focused policies to support the growth of micro, small and medium-sized enterprises so as to enhance their listing attractiveness; implementing prudent and comprehensive policies that support the development of capital markets and their timely review; and growing a vibrant private sector, which is necessary to support the development of capital markets, by designing effective approaches to exploit the benefits anticipated from trade agreements.<sup>4</sup>

Third, to grow and develop pension systems in sub-Saharan Africa, necessary interventions include putting in place a universal non-contributory pension scheme that meets the needs of the unemployed among the working-age population and workers in the informal sector; offering incentives such as a matching contributions or some guaranteed insurance cover if a certain level of contribution is reached by a member in a given period, to motivate members to save more for old age; and instituting a well-structured legal and regulatory framework to streamline the management of pensions funds and minimize costs of administration, especially for private pensions.

Finally, SWFs should act as national development banks to effectively finance productive investments for long-term structural transformation. An enabling

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<sup>3</sup> For further details, see Ngugi and Sen (forthcoming).

<sup>4</sup> In addition, as UNCTAD (2023) notes, institutional investors, pension funds and SWFs are ideally placed to help finance clean energy in developing countries. But they often lack access to investment opportunities in developing countries (especially in Africa) because they are prevented from financing non-investment-grade projects. Therefore, enhancing exposure to developing countries and addressing concerns surrounding greenwashing are key priorities for the sustainable finance market.

environment needs to be created for such development funds, which involves full transparency, strong governance and the necessary analytical capacity to ensure that investments contribute to structural transformation.

#### **4. Summary and conclusions**

In this note, we discussed the determinants of investment and savings, focusing on domestic savings. In particular, we noted that domestic savings rates in sub-Saharan Africa lag behind those of other comparable regions. This is in large part because of the lack of well-developed capital markets and pension funds. Yet although sub-Saharan Africa has lagged behind other regions in mobilizing domestic resources for investment needs, there is large potential for policymakers in the region to enhance the rate of domestic savings so as to provide the necessary resources needed for financial independence, sustained economic growth, and the attainment of the Sustainable Development Goals.

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## Discussion, debate and dissent about investment and sustainable development at the 2023 World Investment Forum\*

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### Abstract

The recently completed 2023 World Investment Forum in Abu Dhabi saw a rare confluence of leaders from public, private and civil society sectors gathering at dozens of scheduled and dozens more impromptu meetings aimed at building better cross-sector relationships and a common understanding about current best practices and near-term trends in sustainable development around the world. Here is what I took away from those meetings: (1) discussions there were building an investment regime to guide leaders within and across sectors who are trying to achieve the Sustainable Development Goals, leading to faster economic development and better environmental, social and governance practices; (2) debates there were focusing on how and how quickly to build that regime and reach those goals with investment projects based on public-private-partnerships; and (3) occasional dissent there about how to build that regime and reach those goals reminded some about inconvenient evidence-based truths about investor-State dispute settlement clauses in bilateral investment treaties and foreign direct investment. I elaborate on those points and conclude with some personal reflections and suggested additions to future meetings aimed at building that investment regime and advancing towards those development goals.

**Keywords:** economic development, environment, sustainability, foreign investment, institutions

**JEL classification codes:** O44, P18, P48

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Views articulated in this article are mine alone and represent neither the United Nations nor the University of Minnesota. All errors are mine.

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## **1. Hammering out an investment regime that supports sustainable development**

Good policy is hammered out on the anvil of vigorous discussion, debate and dissent. I saw and heard all three at the recently concluded WIF23 in Abu Dhabi. As a university professor attending my first WIF, I experienced more than a little awe at the sight of so many senior officials and executives from public, private and civil society sectors rubbing elbows with academics more at home in their ivory towers. With the awe, I also found the opportunity to explore some of the 150,000 square meters of the Abu Dhabi National Exhibition Center (ADNEC) – I easily got my 10,000 steps in each day – and sit in on conversations about how and how fast leaders from different sectors could work together to build an investment regime supporting sustainable development.

By regime, I mean the notion of Stephen Krasner (1982) that international actors can establish principles, norms, rules and decision-making procedures around which expectations can converge in a given area of international policy. Here, the international policy area is development – that is, how to explain and enhance economic growth and poverty alleviation. The principles, norms, rules, and procedures address development sustainability and its underlying environmental, social and governance (ESG) dimensions: principles help define those ESG dimensions; norms help assess progress toward them; rules and procedures help evaluate investment projects consistent with those principles and norms. Expectations converge with repeated discussion, robust debate and a healthy level of constructive dissent.

That is what I saw and heard in my wanderings about the ADNEC last October. It might have been a session on developing sustainable power projects, a presentation of provisional ESG standards for corporate accounting and reporting, or a statistical analysis of infrastructure investment and gender equity in Latin American countries. No matter the session, there were similarly themed discussions prompting shared understanding, expectations convergence and coordinated action among public, private and civil society leaders about the need for an investment regime that supports sustained development. Hammers were loudly clanking away on the policymaking anvil in Abu Dhabi.

Other hammers were clinking quietly. I lost count of how many times my UNCTAD hosts would appear briefly and then suddenly disappear from scheduled sessions. At first, I attributed those disappearances to the usual host concerns about assuring the timely launch of future sessions –panel chairs and wireless microphones often fail to appear on their own. But over the week, I noticed several instances of UNCTAD representatives and country representatives huddled together in conversation in the ADNEC hall or heading to and from some smaller ADNEC meeting room.



During conversations with academics attending their *n*th rather than first WIF, I learned more about the purpose of those meetings. They were important private discussions aimed at persuading country officials to “sign up” for some or all of the policies supporting UNCTAD’s emerging investment regime for sustainable development.

## **2. Debating the effectiveness of public-private partnerships**

It is hard to argue with the general proposition that development policy should emphasize sustainability. It is easier to argue about how to emphasize that. Investment based on public-private-partnership (PPP) was a popular topic at several panel sessions, but notions about how best to structure the ownership of those PPPs differed. Some advocated for approximately equal ownership shares in infrastructure investment projects. Others argued for majority State ownership in such PPPs.

My own research-based view is that “less can be more” when it comes to host-country State ownership in power, water, transportation, telecommunication and other infrastructure investment projects. My view begins with the assumption that government’s natural role in any investment project is as a regulator rather than a partial owner, but in some developing countries there is no regulatory agency to look out for the public interest or if there is such an agency, it is understaffed and underfunded. Regulatory agencies take time to develop, but investment project opportunities sometimes cannot wait. So, if the regulatory rules of the investment game seem a little less reliable to private foreign investors, then host-country governments may need to provide second-best assurances.

Host-country government co-ownership of investment projects might serve that end. I say “might” because those same private foreign investors usually want to retain day-to-day control over investment project construction and operation. Host-country governments can accommodate that preference by taking a substantial but non-controlling minority ownership interest. That would signal stability in the regulatory environment affecting investment project revenues and expenses. The host-country government also suffers losses if those regulatory arrangements change suddenly and adversely. Minority ownership signals the host-country government’s interest in having a voice in broader governance while letting private foreign investors and operators take the leading role in day-to-day construction and operation of the investment project.

There is a broad base of empirical support for these “minority rules” for governing PPPs. Banks are more willing to lend to developing-country investment projects in power, water, telecommunication, transportation and other sectors when host-country State co-ownership is, say, in the range of 20–30 per cent (James and Vaaler, 2018). Those same investment projects with the same substantial but non-controlling State co-ownership close on financing and move to construction faster,

especially for wind, solar and other renewable power projects (James and Vaaler, 2022). Less can be more when it comes to host-country State ownership and investment project governance and related performance.

A great example of this approach to PPPs is in Colombia, where national and local government agencies have taken small co-ownership shares and then partnered with multilateral lenders such as the Inter-American Development Bank, private lenders like Scotiabank, foreign development agencies such as the United States Agency for International Development, and private owner-operators such as Isagen-Brookfield, which is building and operating hydroelectric and other renewable power projects in more remote, underserved regions such as La Guajira. These PPPs incorporate training and employment for indigenous groups as well as equitable allocation of project benefits across stakeholder groups. They serve Colombia's broader strategy of shifting to renewable energy generation and inclusive development consistent with the United Nations Sustainable Development Goals as well as Isagen's commitment to the goals of the United Nations Global Compact and the Dow Jones Sustainability World Index.<sup>1</sup> Less can also be more when it comes to host-country State ownership and investment project social inclusiveness.

There is no time to lose in bringing this type of PPP structure to other regions in the developing world. In Southeast Asia, Indonesia is on a spree of having private foreign investors build and own coal-fired power plants in remote regions of the archipelago, where nickel mining is on the rise.<sup>2</sup> Ironically, nickel extracted with this "dirty" non-renewable power is a key input into battery technologies critical to the production of "clean" electric-powered automobiles. Earlier this year, the national government decided to exclude these private power projects when reporting progress toward Just Energy Transition Partnership targets.<sup>3</sup>

We can do better. Giving local and national governments some minority co-ownership of investment projects would almost certainly strengthen their voice in how to bring renewable power technologies into the project mix faster. Including multilateral and private lending institutions with a strong track record of social inclusiveness would almost certainly improve equitable allocation of project benefits, particularly for surrounding Indigenous communities. These and other PPP structures can improve ESG dimensions of investment projects without hindering projects' day-to-day commercial performance.

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<sup>1</sup> Brookfield Asset Management, "A Leading provider of renewable power generation in Colombia", [www.brookfield.com/news-insights/leading-provider-renewable-power-generation-colombia](http://www.brookfield.com/news-insights/leading-provider-renewable-power-generation-colombia) (accessed 4 December 2023).

<sup>2</sup> Hans Nicholas Jong, "Captive to coal: Indonesia to burn even more fossil fuel for green tech", 10 August 2023, <https://news.mongabay.com>.

<sup>3</sup> Gayatri Suroyo and Fransiska Nangoy, "Exclusive: Indonesia to omit private coal power plants from its JETP investment plan", Reuters, 30 October 2023.

### 3. Dissent about disputes

Good policy comes from robust discussion, debate *and* dissent. I saw and heard that, too, in certain WIF sessions. One session saw a large roundtable discussion about international investment agreements (IIAs) and their investor–State dispute settlement (ISDS) provisions. That roundtable was helmed by senior UNCTAD staff and included several senior officials from country investment and economic development agencies as well as a smattering of academic researchers. The 5- to 10-minute commentaries from the investment and economic agency officials touched on similar points. Their countries presented great opportunities for foreign investors. Their agencies stood ready to assist those investors. And if there were any disputes between foreign investors and host-country governments, they could and should be resolved quickly and amicably without need for “confrontation” in international arbitration panels.

Some of these commentaries came with anecdotes about the perils of negotiating IIAs with broad-ranging access to binding arbitration. National legislatures would be loathe to confirm them. They would poison host-country government relationships with current foreign investors and create disincentives for future foreign investors. Better to have less confrontational mediation or conciliation before host-country government agency officials specializing in amicable dispute resolution.

Near the end of the session, a legal academic at the roundtable offered what I thought to be a diplomatically formulated dissent. He began by pointing out that host-country governments rarely prefer to give up sovereign power when addressing foreign investor grievances running from small adverse changes in tax rates on their project profits to much larger threats of temporary project shutdown or outright project nationalization. Then came the dissenting challenge. He reminded all that credible commitments by host-country governments to *waive* such sovereign power and grant wide-ranging access to binding arbitration of disputes reassure private foreign investors who promise new capital, technology and employment. IIAs with strong ISDS provisions signal commitment to protecting contract and property rights of private foreign investors. They signal confidence in the settlement of disputes through timely presentation before and adjudication by impartial tribunals following international rule of law principles rather than national politics. Waiving some sovereignty in disputes prompts greater respect for those sovereign States and attracts more private foreign investment.

Recent empirical evidence based on careful analysis of IIA data housed at UNCTAD backs up this dissenting challenge. A November 2022 study by the chief economist of the United States International Trade Commission, Saad Ahmad, with Benjamin Liebman and Heather Wickramarachi (2022), analyzes the inward foreign direct investment (FDI) impact of ISDS chapters in thousands of bilateral investment treaties and other types of IIAs. UNCTAD evaluates the strength of

those ISDS provisions on several dimensions related to their range of application in different industrial sectors and the number of exceptions to the binding nature of international dispute arbitration. ISDS provisions deemed “strong” by UNCTAD have wide-ranging application with very few, if any, exceptions to their binding nature. Nearly 80 per cent of IIAs in force from 1980 to 2011 had such strong ISDS provisions.

A set of cleverly implemented panel data analyses yields these two important findings: IIAs with strong ISDS provisions increased inward FDI by as much as 22 per cent, and IIAs concluded with weaker ISDS provisions saw much smaller inward FDI increases or even decreases. Waiving some sovereignty in disputes prompts greater respect for those sovereign States and attracts more private foreign investment, often billions of United States dollars more.

Ahmad et al.’s (2022) findings are still preliminary, and their study awaits academic journal submission and rigorous peer review that will no doubt point to previous studies suggesting different relationships. Still, their findings constitute an empirical inconvenience for many WIF attendees. For those country investment and economic development officials, the findings challenge assumptions and anecdotes about private foreign investment preferences for informal national mediation or conciliation. For UNCTAD staff seeking to enlist those ministers in a sustainable investment regime, the findings may mean coaxing reconsideration of ISDS provisions that seemingly uphold home-country government sovereignty but actually undercut private foreign investor confidence in that government. Dissent is rarely popular, but it is occasionally necessary when hammering away on the policymaking anvil.

#### **4. Lessons and invitations for the future**

I found the WIF energizing for my academic research and related teaching and community engagement. I have been studying the commercial behaviour and performance of infrastructure investment projects in developing countries for nearly 20 years. I came to the WIF thinking I would be saying more than listening to others about how those projects advance and what helps them survive and be successful. Wow, was I wrong. In sessions I attended and sessions I contributed to as a panelist, there were so many others who brought new and novel insights based on their professional and policy experience or their own academic research experience.

On the last day of the WIF, I was honored to participate as the sole academic on a high-level panel discussing PPP structure and sustainable development trends. The other government ministers, business executives and international organization professionals on that panel brought years of hands-on, practical experience with

organizing, financing, building, operating and resolving disputes in sustainable investment projects. I may have known something more about how to run statistical analyses about broader project trends, but they knew the individual projects and their own particular challenges. I came away resolved to be more of an “engaged” scholar with deeper knowledge from fieldwork taking me to the project solar array, the desalination plant, the high-speed rail depot and the deepwater port. I came away from the WIF determined to get out of my ivory tower.

As I finish my commentary, I am also following developments at the 2023 United Nations Climate Change Conference in Dubai (COP28). It is easy to see how the two United Nations-sponsored meetings are linked by common goals of developing a sustainable investment regime to foster both economic growth and poverty alleviation in the developing world and to fight the climate change threatening the whole world.

If I could, I would hand out invitations to some COP28 attendees I thought underrepresented at the WIF: private lending and investment institutions, including private equity and hedge fund firms. The New Jersey-based investment arm of Prudential Insurance, Prudential Investment Management (PGIM), has more than \$1.5 trillion under management with nearly \$100 billion in “alternative” credit and investment around the world. The Netherlands-based Triodos Investment Management bank has €5.7 billion under management and hundreds of investments in renewable energy projects in developing countries. Both highlight their commitment to ESG-based investing and broad stakeholder engagement. PGIM, Triodos and so many others like them in the private sector are critical to scaling up the sustainable investment regime UNCTAD is fostering. There are definitely places for leaders from those organizations at the next WIF. And I cannot wait to meet and learn from them.

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# Why it is time for a “Global Value Chains for Least Developed Countries Initiative” \*

Ari Van Assche<sup>a</sup>

## Abstract

A central message that came out of the 8<sup>th</sup> UNCTAD World Investment Forum was the urgent need for innovative solutions to facilitate the integration of least developed countries (LDCs) in the global trading system. In this article, I suggest that the international community should consider implementing a “Global Value Chains for LDCs Initiative” as an integral part of such a solution package. This initiative proposes to make the value added exports of LDCs exempt from duties throughout their entire journey along global value chains. I discuss the mechanisms through which this initiative enhances the attractiveness of integrating LDCs into global value chains. Furthermore, I elaborate on how it can foster the creation of new metrics related to Sustainable Development Goals, encouraging corporate engagement in incorporating LDCs in their supply chains. Overall, the initiative proposes new pathways through which the global trading system can boost the involvement of LDCs in the global economy.

**Keywords:** global value chains, least developed countries, sustainable development goals, trade costs, trade facilitation, value added trade

**JEL classification codes:** F13, F15, F63, F68, O14, O24

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## 1. Introduction

How can the international community promote fair and sustainable globalization that does not leave least developed countries (LDCs) behind? This was a key subtheme deliberated by members of the global investment and development community during the 8<sup>th</sup> UNCTAD World Investment Forum, held in Abu Dhabi from 16 to 20 October 2023. Discussions ranged from the need to support LDCs in their efforts to attract foreign direct investment (FDI) to the importance of debt relief to provide LDCs with the fiscal space for greater spending on clean energy, and the need to avoid that LDC countries become carbon havens. A recurring message during the discussions was that the status quo in terms of international business policies has proven ineffective for LDCs. Speakers underscored time and again that decisive action from the global community is imperative to foster innovative solutions that can facilitate sustainable transformation in LDCs. This is particularly critical as progress towards achieving the Sustainable Development Goals (SDGs) by 2030 has stalled and for some SDGs is regressing (United Nations, 2023). The gap in financing for the SDGs in all developing countries is now about \$4 trillion per year – up from \$2.5 trillion in 2015 when the Goals were adopted (UNCTAD, 2023a).

In this article, I propose that the international policy community consider the adoption of a “Global Value Chains for LDCs Initiative” as an integral part of an innovative solution package for LDCs. I illustrate how the initiative provides a novel approach to reducing the disproportionately high trade costs that LDCs face, which could boost their integration into the global economy. I also discuss how the initiative can incentivize multinational firms to engage more with LDCs through global value chains (GVCs). Finally, I propose several avenues for future research.

## 2. Trade costs in least developed countries

The plight of the world's 46 LDCs is one of the most pressing grand societal challenges that the world faces today. These countries, characterized by extreme poverty and vulnerability, are home to 880 million people, or about 12 percent of the world population (UNCTAD, 2023a). Owing to their disadvantaged status in the development process, they critically depend on support from the global community to enable them to overcome deep structural challenges, eradicate poverty, achieve the SDGs and enable their graduation from LDC status. The urgency to provide support was exacerbated by the COVID-19 pandemic, which has triggered the worst recession in 30 years for LDCs, pushing 15 million more people into extreme poverty, mainly in South Asia and sub-Saharan Africa (UNCTAD, 2023a).

A key obstacle hindering LDCs' development is the significant trade costs encountered by firms from these countries (de Melo and Wagner, 2016; OECD, 2015;



Pham and Sim, 2020). Trade costs capture all costs that are incurred to get a good to the final user, other than the cost of production itself (Anderson and Van Wincoop, 2004). They include the costs of getting products *to the border*, which relate to the quality of a country's hard infrastructure, access to trade finance and the availability of logistics services; the costs that are incurred *at the border*, which include policy barriers such as tariffs and non-tariff measures, costs related to procedural delays and costs associated with the use of different currencies; and the costs *behind the border*, which include international transportation costs (both freight and time), legal and regulatory costs, and local distribution costs (wholesale and retail). In LDCs, trade costs are disproportionately higher than in other countries. They amount to the equivalent of a 300 per cent ad valorem tariff on international trade (WTO, 2015). In other words, for every \$1.00 spent on manufacturing a product in an LDC, an additional \$3.00 is incurred as trade costs. These trade costs are more than twice as high as in developed countries, where the same product would face an extra cost of only \$1.34, a difference which substantially reduces the opportunity of LDC firms to participate in global trade.

The high trade costs not only prevent LDC firms from engaging with international markets but also reduce LDCs' export diversity, often confining them to the export of volatile commodities (Mora and Olabisi, 2023). This exacerbates the exposure of LDCs to economic and natural shocks, including climate-related threats and geopolitical turbulence, which is of particular concern as these countries have inadequate resources to cope with such challenges. Notably, this situation is particularly acute for small island developing States, which account for 10 of the 46 LDCs.

There are concerns that several policies and initiatives related to supply chain sustainability may further increase trade costs for LDC firms, marginalizing them even more in the global trading system. Due diligence legislation for supply chain sustainability, such as the European Union's Corporate Sustainability Due Diligence Directive and the Commonwealth's Modern Slavery Act, aims to promote responsible business practices by requiring multinational firms to identify, prevent, mitigate and account for adverse impacts on human rights and the environment along their GVCs (Van Assche and Brandl, 2021). Yet concern exists that extensive due diligence obligations could reduce the involvement of LDCs in GVCs as their suppliers struggle to comply with imposed sustainability standards that are costly to meet. Climate regulations such as the European Union's Cross-Border Adjustment Mechanism raise similar concerns (Pilato and Van Assche, forthcoming). That policy attempts to curtail carbon leakage by imposing a tariff on the carbon emitted during the production of carbon-intensive goods that are imported into the European Union. Simulations by UNCTAD suggest that such a policy would further marginalize LDCs that specialize in intermediate goods used by carbon-intensive industries (UNCTAD, 2023b).

### 3. Previous trade-cost reduction initiatives

Broad consensus exists among trade and development scholars that the international community should do more to reduce the trade costs of LDCs. However, there is disagreement on how to best achieve this (Flentø and Ponte, 2017).

The principal support measure that the international community has adopted to reduce LDC trade costs is the granting of duty-free and quota-free (DFQF) market access to their merchandise exports (Gnangnon and Priyadarshi, 2017). The 2005 World Trade Organization (WTO) Hong Kong Ministerial Conference was an important milestone in this regard. At that time, all developed countries had provided DFQF market access for 97–100 per cent of products imported from LDCs. Since then, a growing number of developing countries have followed suit. This preferential treatment has been accompanied by increasingly transparent methods of calculating the rules of origin. Several studies have found that the provision of DFQF access has substantially strengthened LDC exports (Gnangnon and Priyadarshi, 2017; Ito and Aoyagi, 2019).

A second mechanism to reduce LDC trade costs has been trade facilitation, which seeks to simplify, modernize and harmonize export and import processes at borders. The 2017 Trade Facilitation Agreement has been a critical accord, even though LDCs have found it complicated to implement because of their capacity constraints. In this respect, the Global Alliance for Trade Facilitation has been an important organization that has worked towards providing more technical assistance to improve administrative efficiency and encourage digitization at the border in LDCs. These actions can cut bureaucratic red tape and increase transparency to make it easier and cheaper for LDC firms to trade their goods. The Organisation for Economic Co-operation for Development predicted that trade facilitation can reduce trade costs by 10 per cent in advanced economies, 13.2 per cent in upper-middle-income countries, 15.5 per cent in lower-middle-income ones and 14.5 per cent in low-income ones (Moisé and Sorescu, 2013). Nonetheless, Kurul (2023) did not find evidence that improved border efficiency in LDCs promotes their export diversity.

A third mechanism to reduce LDC trade costs has been the promotion of investment in infrastructural capacity. Often related to “Aid for Trade”, this includes building more efficient ports, better roads, more modern airports and superior electricity grids to support international trade (Gnangnon, 2018; Suwa-Eisenmann and Verdier, 2007). This approach requires significant investment funding, which LDCs lack and which the international community provides in too limited amounts.

Despite significant efforts to lower trade costs through these three mechanisms, the incorporation of LDCs into the global economy has remained stubbornly limited. From 2011 to 2020, the share of LDCs in global exports declined from

0.95 per cent to 0.91 cent, far from the doubling of the share that the United Nations had envisioned in its Istanbul Program of Action (WTO, 2022). For this reason, there is growing demand for alternative approaches to foster the inclusion of LDCs in the global trading system. These policies should not only address the disproportionately high trade costs that LDCs face but also strive to make them an essential component of endeavours aimed at building a more sustainable global economy.

#### **4. The Global Value Chains for Least Developed Countries Initiative**

In the fall of 2021, I collaborated with Gary Gereffi (Duke University) and Stephanie Barrientos (University of Manchester) to endorse an alternative solution for lowering trade costs and making LDCs a central part of the agenda for a sustainable future. This approach, which had been initially proposed by Antimiani and Cernat (2021), was called “Global Value Chains for Least Developed Countries”. We presented the initiative in an open letter addressed to Dr. Ngozi Okonjo-Iweala, Director-General of the WTO, and H.E. Mr. Ahmad Makaila, Ambassador of Chad and LDC Coordinator, in the hope that the members of the WTO would consider it at its 12<sup>th</sup> Ministerial Meeting. The letter received endorsement from 38 leading experts in the field of international trade and development across the globe. In May of 2023, Lucian Cernat and I presented the initiative at a WTO event co-hosted by Finland and Djibouti entitled “Global Value Chains for Least Developed Countries: Enhancing the Participation of LDCs in Global Supply Chains and Unlocking their Trade-Led Development Potential.”

The initiative proposes a new approach to boosting the inclusion of LDCs in the global trading system through the logic of GVCs. Under it, WTO members would complement their existing DFQF scheme based on “direct” LDC exports with a multilateral scheme that would extend a proportional duty-free treatment to the LDC value added that is embodied in exports across the globe. Hence, the value added exports of LDCs would remain duty-free throughout their journey along global and regional value chains, thus fitting the “Made in the World” logic that the WTO has been advocating for the past decade. The scheme can rely on existing customs procedures and documentation (e.g. certificates of origin) that LDCs use to benefit from DFQF schemes, thus limiting the need for new administrative requirements.

The logic of the initiative can be illustrated with a practical example. In Chad, raw cotton is a leading export product. Under the current DFQF scheme, direct exports from Chad face little to no tariffs or quotas to virtually any country around the globe. But if a Turkish textile company uses the raw cotton to make a men’s dress shirt and then exports it to Canada, it will at that time face an 18 per cent tariff,

which applies to the value added made in both Chad and Türkiye. This trade barrier reduces the demand not only for Turkish dress shirts but also for Chadian raw cotton. Under the initiative, the local content value of Chadian cotton exports would be deducted from the dutiable value of Turkish shirts, boosting exports of both Turkish shirts and Chadian cotton. More generally, the initiative would provide a sizeable incentive for downstream producers around the globe to consider LDC export products more carefully.

It is important to point out that the initiative has the potential to boost export diversification into more sophisticated industries. What it does is reduce the trade costs for all LDC exports, but the drop is disproportionately large for those products that have longer GVCs, in which LDC products cross borders more times before reaching the final consumer (Yi, 2003). The GVCs for LDCs Initiative would thus stimulate LDC exports in manufacturing industries that tend to have longer value chains.

Antimiani and Cernat (2021) have used computational general equilibrium modelling to analyze the aggregate effect of the initiative on LDC trade. They estimate that the initiative will increase the value added embodied in LDC exports by more than \$5 billion on an annual basis, with textiles, metal products and other primary goods showing the biggest gains. On average, LDCs would see their domestic value added content in exports increase by 2 per cent and move away from excessive specialization in agrifood production towards the supply of intermediate inputs for a wide range of manufacturing industries.

In addition to lowering trade costs, the initiative has the potential to mitigate the negative exclusionary effects of recent climate and sustainability policies on LDCs. Specifically, it can be designed as a means to boost corporate engagement to enhance the involvement of LDCs in GVCs. This can be complemented with the development of transparent and traceable indicators related to LDC involvement that multinational firms can use to demonstrate their engagement with the SDGs. Goal 1, for example, aims to eradicate poverty in all forms. Multinational firms can highlight their commitment in this respect by tracing their use of LDC exporters and workers in their GVCs.

New digital tools such as blockchain technology can help governments and multinational firms to implement the initiative and achieve related SDG metrics. In a recent article, Cernat (2023) discusses how digital certificates can facilitate LDC trade in organic products along complex supply chains by including relevant information that enhances the traceability of products. Thus, new technologies can help ensure that the initiative does not generate excessive administrative hurdles.

## 5. Conclusion

The Global Value Chains for Least Developed Countries Initiative proposes new pathways through which the global trading system and multinational enterprises can boost the involvement of LDCs in the global economy. We would like to encourage the research community to reflect on the factors that can strengthen these pathways. One question is the role that more liberal rules of origin can play in stimulating LDC exports. Instead of making the value added exports of LDCs duty-free along their GVCs, for example, developed countries could consider making all imports DFQF, regardless of the country of origin, if a minimum percentage of value added has been created in LDCs. Another question is how to ensure that the initiative fosters substantive economic, social and environmental upgrading in LDCs, especially if combined with multinational firm measures to promote social and environmental standards throughout their GVCs. A third question is how the initiative can be structured to promote high-quality investment into LDCs, in the process strengthening the trade-investment-development nexus.

Overall, the initiative is in line with the idea of re-globalization championed by WTO Director-General Ngozi Okonjo-Iweala, which emphasizes the importance of integrating LDCs in GVCs. We strongly encourage the international community to consider the ideas presented in this article as part of a larger package of innovative solutions to facilitate a sustainable transformation in LDCs.

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# Game-changer business models for sustainable development\*

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and Noemi Sinkovics<sup>c</sup>

## Abstract

To address the grand challenges that society faces, incremental change and gradual organizational renewal are not sufficient. A radical transformation of business models is needed. In this paper, we explore game-changer business models that incorporate sustainability principles into their organizational DNA. We draw on two examples from the agrifood sector to illustrate the components of the business model, the impact of Industry 4.0 technologies and the sustainability outcomes. We reinforce the importance of collaboration between policymakers, business leaders and researchers to identify, promote and scale up these business models for transformative societal change.

**Keywords:** business model innovation, game-changer business models, grand challenges, Industry 4.0 technologies, scaling, sustainability

**JEL classification codes:** D20, L20, M13, O14, Q01

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## 1. Introduction

How can organizations become conduits of transformative change and sustainable development? How can they facilitate new ways of doing business by addressing societal challenges and limiting harmful impacts on the planetary resource base? During the World Investment Forum 2023 in Abu Dhabi, members of the global investment-development community highlighted the potential of innovative business models to address grand challenges, including wicked problems such as climate change, food security, poverty, terrorism, infectious diseases, exploitative labor, discrimination and migration (Ferraro et al., 2015; George et al., 2016). Although, or perhaps because, businesses are significant contributors to these challenges, they can serve as agents in addressing these issues (Buckley et al., 2017; Sinkovics et al., 2021c; World Economic Forum, 2020). One line of discussion at the World Investment Forum 2023 emphasized the promise of Industry 4.0 technologies for transforming business models such that business objectives are aligned with social and environmental goals and directly contribute to creating a more sustainable and equitable world. In this paper, we extend this discourse by exploring two examples of game-changer business models.

Game-changers are purpose-driven organizations that aim to create a long-term positive impact on society and the environment. An organizational culture that promotes sustainability and innovation, which is reinforced by visionary leadership, guides them. As opposed to business-as-usual, game-changers break through the conventional ways of industry (Sinkovics et al., 2021b). Their approach to scaling up their business solutions involves intricate integration within an ecosystem and strategic collaborations with partners, such as venture philanthropists, research and development institutions, consumers, governments and regulatory organizations. Although these models are locally based, they may provide global solutions (Ready et al., 2014; Sinkovics et al., 2015; Sinkovics et al., 2014; Subramanian et al., 2023). Industry 4.0 technologies offer unprecedented opportunities to transform business models; firms can harness the capabilities they provide to address aspects of the grand challenges. Examples of these technologies include additive manufacturing, artificial intelligence, big data analytics, biotechnology, blockchain, cloud computing, cyberphysical systems, the Internet of Things, robotics and virtual reality (Bag et al., 2021; Lopes de Sousa Jabbour et al., 2018).

## 2. Dimensions of game-changer business models: examples from the agrifood sector

Food insecurity and hunger are two pressing grand challenges the world is facing. The World Food Programme advises that more than 333 million people are experiencing acute food insecurity, and 783 million people are facing chronic

hunger.<sup>1</sup> Climate change, warfare, economic shocks and rising raw material expenses exacerbate these challenges. Two game-changing companies, RedSea and NatureDots, recognized the urgency to address these issues. By incorporating sustainability into their cultural DNA and leveraging Industry 4.0 technologies, they are creating economic, social and environmental innovations. To illustrate their strategic choices and implementation approaches, we combined and adapted an abridged version of the integrative framework by Sinkovics et al. (2021a) and the triple-layered business model canvas by Joyce and Paquin (2016) (figure 1). The value proposition of a firm in the business model refers to the package of products and/or services offered to the target market. Value creation and delivery comprise key activities, resources, partner networks, channels and customer relationships that support the implementation of the value proposition. Value capture activities include innovations in revenue streams and cost structure. The value intention refers to the attitudes of leaders and managers.

RedSea, a participant in showcase discussions at the World Investment Forum 2023, is a start-up that emerged as a spin-off from a science project at King Abdullah University of Science and Technology in Saudi Arabia in 2018.<sup>2</sup> The company aims to solve the challenge of feeding more than 10 billion people sustainably and to improve the working conditions of agrifood farmers working in extreme weather. They harness Industry 4.0 technologies, particularly genetic technologies, to cultivate crops in climates characterized by droughts, restricted water availability and increasing salinity levels. In addition, they use nanotechnology and wireless technologies to develop greenhouse roofs and monitoring systems. The company created brands like *iyris*<sup>TM</sup>, *SecondSky*<sup>TM</sup>, *Kairos*<sup>TM</sup> Intelligent Agriculture and *Volcano Plant genetics*<sup>TM</sup> for the agritech market. Furthermore, RedSea's innovations led to reductions in water consumption and greenhouse gas emissions, as well as fertilizer and pesticide usage.

NatureDots, an Indian start-up, aims to overcome the challenges faced by fish farmers, including reducing business risks and, by extension, poverty.<sup>3</sup> It has developed the AquaNurch® System for the aquatech market, a real-time data collection technology to monitor water quality parameters and predict risks associated with climate change and weather. The system harnesses the capabilities of artificial intelligence, machine learning, the Internet of Things and big data analytics. NatureDots also expects the system to improve fish health and thereby to increase food and protein security. The company has facilitated market access for fish farmers and increased revenue by offering end-to-end services such as

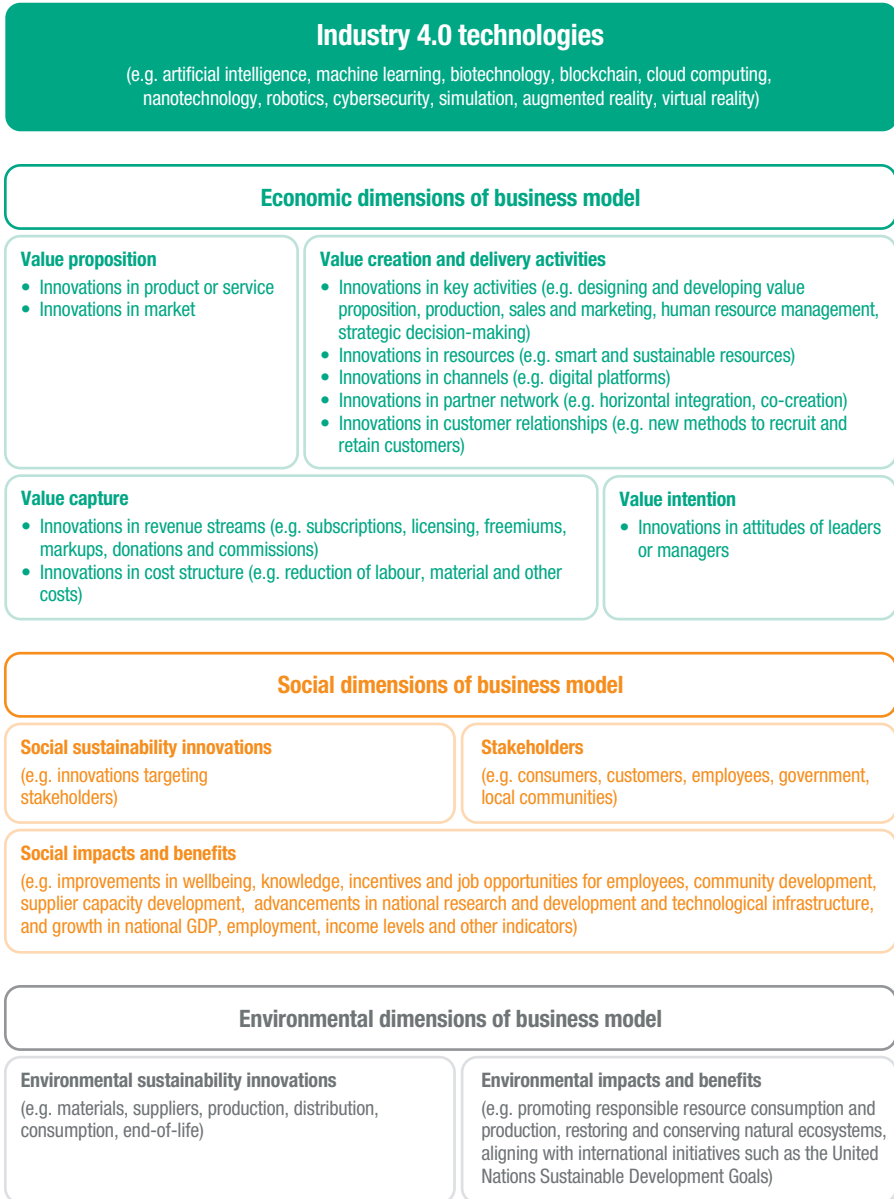
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<sup>1</sup> See "A global food crisis", [www.wfp.org](http://www.wfp.org) (accessed 29 November 2023).

<sup>2</sup> See <https://redsea.ag/company> (accessed 4 December 2023).

<sup>3</sup> See <https://naturedots.com/product> (accessed 4 December 2023).

**Figure 1. An abridged framework for mapping game-changer business models**



fish seeds development, nursery pond construction and fish health monitoring. Implementing these technologies has also led to a reduction in costs because of enhanced productivity. NatureDots anticipates a reduction in water pollution and scarcity, alongside an enhancement of climate change resilience.

The scalability of these business models is enhanced by the availability of a unique combination of resources and capabilities: both companies possess competent internal research and development teams comprising scientists and specialists from diverse disciplines. The teams are dedicated to generating new ideas, acquiring patents and successfully commercializing their innovations. Their high-performance orientation is built on advanced knowledge and talent management capabilities. They invest in training and development and use cross-functional teams for knowledge sharing. Company leaders play a significant role in identifying environmental changes, creating strategic partnerships and reinforcing the organizational culture. These businesses also collaborate with various stakeholders, including clients, suppliers, retailers, governments, local communities and non-governmental organizations. Notably, they partner with local and foreign universities for open innovation projects and engage with venture philanthropists, impact funders and governments to increase financial capacity. For example, RedSea has partnered with the University of Arizona for innovation projects. They have accessed investors, including AppHarvest and Aramco, for funding. NatureDots has engaged with institutions such as the Biotechnology Industry Research Assistance Council of India and AMRUT 2.0 of India, both government programmes, to fund their projects. Frequently, their ecosystem partnerships are facilitated through online platforms. Access to open innovation platforms, such as UpLink, provided by the World Economic Forum, enables them to collaborate with a multitude of partners to unlock innovative business solutions.

These two cases additionally exemplify the spillover effects of generating positive economic, social and environmental outcomes at the firm level on the national economy, on industry and on the global economy. The efforts of RedSea and NatureDots have ramifications for unemployment, sustainable cities and communities, health and climate change.

### **3. Implications for policymakers and concluding remarks**

As the cases demonstrate, there is significant potential for game-changer business models to help address grand challenges. Therefore, policymakers, business leaders and researchers can play an important role in supporting and scaling up these models internationally (Reuber et al., 2021; Tippmann et al., 2023). Building a culture that encourages breakthrough innovators and game-changers is a crucial starting point for the emergence of these businesses. Therefore, the establishment

of incubators and accelerators is necessary to cultivate entrepreneurial spirit, provide training and development opportunities, and facilitate access to finance, sales and distribution networks. Specifically, these institutions need to prioritize the development of the cognitive capabilities essential for navigating global volatility and uncertainty.

Multi-stakeholder partnerships play a crucial role in facilitating the rapid growth of these firms. Hence, establishing an external ecosystem with governments, international organizations, the private sector, civil society, researchers, funders, non-governmental organizations and other stakeholders is essential for collaborative efforts and resource mobilization. To promote human capital development, governments and regulatory organizations need to create infrastructure, including research and development institutions and educational and training facilities. They need to design legal and regulatory frameworks that account for unique needs and specificities. These rules and regulations will facilitate access to fiscal incentives and protection of intellectual property rights and promote fair competition. To provide financial support, they must establish tax incentives, seed-corn funds and other non-dilutive financing mechanisms.

To finance rapid scaling, it is essential to have access to bank loans, impact funding and venture philanthropy. The involvement of impact funders and venture philanthropists can benefit game-changer firms by granting them access to valuable resources and capabilities that facilitate international growth. In addition, it is crucial to have platforms that connect these businesses with ecosystem partners to accelerate their development (Nambisan et al., 2018).

Implementing Industry 4.0 technologies can not only facilitate the creation of sustainable innovations, but also transform the economic model. They play a key role in fostering a better understanding between companies that have corresponding input needs and output opportunities, ultimately leading to the establishment of aligned business relationships (Hofstetter et al., 2021). This is especially important for scaling up innovative solutions. Therefore, policymakers and business leaders are advised to invest in enhancing digital and technical capabilities. They can develop digital platforms to improve their visibility and expand their international presence. To foster a game-changing culture, business leaders should focus on developing effective human resource management practices, such as attracting and keeping talented employees, as well as enhancing their knowledge and talent management capabilities to increase absorptive capacity.

Policymakers also play an important role in reducing and ultimately putting a stop to planned obsolescence. Furthermore, game-changer business models incorporate elements of circularity. Material circularity at an international level is only possible if governments work together within development cooperation programmes to design and implement policies to enable it (Hofstetter et al., 2021). Another avenue

for positive change and scaling up game-changer business models is public procurement. It can be nimbler and more dynamic than regulation, thus being a potential tool for experimentation and process innovation that can ultimately lead to a more empowered government procurement system with a market-shaping impact (Hamilton, 2022).

Researchers play a significant role in contributing to this transformation agenda through their choice of research topics, methodologies and dissemination strategies. The academic literature has generated a multitude of frameworks and tools that are equally valuable for both researchers and policymakers (Sinkovics et al., 2021; Sinkovics et al., 2021a; van Tulder and van Mil, 2023). However, there is a need to consolidate these frameworks and the knowledge that exists in disciplinary silos. There is also a need for a more engaged approach to conducting research. Researchers need to become an active part of multi-stakeholder initiatives through action research and other forms of collaboration.

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# An innovative measure for digital firms' internationalization\*

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## Abstract

In this research note, we propose a novel and innovative measure for the internationalization of digital firms. Our measure overcomes some of the weaknesses that inhibit traditional measures of internationalization in their application to digital firms. The measure uses Google Trends data and captures the volume and distribution of a digital firm's recognition in the digital universe. In addition to developing the measure, we conduct empirical tests to apply our internationalization measure to traditional and digital firms and compare our results to data from UNCTAD's Transnationality Index. Our empirical comparison offers insights into the internationalization of digital firms. We discuss these insights and offer an impetus to developing a theory of digital internationalization.

**Keywords:** degree of internationalization, digital companies, firm internationalization, Google Trends, measuring internationalization, volume of internationalization

**JEL classification codes:** C43, E22, F2, F6, F23, L86, M16

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## 1. Introduction

Digital business models have a long and turbulent history. Originating in the early eighties, they showed euphoric international growth that ended abruptly in the burst of the dot-com bubble. As the financial crisis hit the global economy in 2008, investment and policymaking focused elsewhere. At the same time, successful digital companies turned into digital multinational enterprises (DMNEs) with a global customer footprint and immense political outreach.

While academic research has remained mostly ignorant of the phenomenon, some of the socioeconomic issues surrounding DMNEs, such as political influence (e.g. Cambridge Analytica, Twitter), regulatory oversight (e.g. Binance, Wirecard), tax compliance (e.g. Google, Facebook) and data privacy (e.g. Facebook), have sparked global controversy.

In 2017 UNCTAD first analysed and provided a ranking of the top 100 digital companies, in the *World Investment Report 2017* (UNCTAD, 2017), which investigated the effect of digital MNEs on global investment patterns. The novel analysis in UNCTAD (2017) explained the diverse international footprint of digital companies and developed the foreign direct investment (FDI) lightness index, which captures the light investment footprint of digital MNEs and the impact of digitalization on all industries. Not needing a physical presence in foreign markets to reach consumers, these companies have a very light foreign-asset presence. Digital companies are a very dynamic group that, on the basis of firm-specific advantages in intangible and digital assets, as well as network effects, are able to reach scale in a short time and expand abroad seamlessly. These new asset-light business models are disrupting modes of operation and cross-border processes, affecting the development strategies of host economies in important policy areas such as taxation and employment creation (Trentini et al., 2021).

Subsequently, the academic community recognized DMNEs as a special case of an MNE with unique characteristics, business models, internationalization processes and development implications for host economies.

Digital companies rarely need to physically invest overseas to reach new markets, and their assets are commonly concentrated in a single strategic location. In addition, DMNEs often do not generate sales from customers (i.e. users) but from advertisers, making it difficult to allocate their revenues to a specific geographic location. For these reasons, traditional measures of internationalization may not fully capture the degree of internationalization (and importance) of DMNEs.

The ability of digital companies to break the relation between revenues gained abroad and physical presence in the host economy facilitates their ability to minimize tax payments and deprives many host economies of important fiscal revenues.

In addition, the reliance of DMNEs on intellectual property has made it easier to shift profits to low-tax jurisdictions, further reducing their effective tax rates (called Base Erosion and Profit Shifting – BEPS) (UNCTAD, 2022).

The OECD-led international “Agreement on a Two-Pillar Solution to Address the Tax Challenges Arising from the Digitalisation of the Economy” aims at restoring the nexus between where value added activities take place and where profits are taxed. Pillar One specifically targets the largest DMNEs, which are “the winners of globalization” and restores taxing rights to the “market” countries where DMNEs sell goods and services.

Last year, UNCTAD updated the work first published in UNCTAD (2017) and provided new insights into the landscape of the world’s top digital MNEs (Trentini et al., 2022). The update showed that some digital MNEs reached massive scale in only a few years. Also, of the many new digital companies established since 2018, only a small fraction was included in the new ranking because operational data were missing. Among those included, born digitals and businesses facing consumers (B2C firms) – the main objectives of BEPS Pillar One measures – were shown to be among the “asset-lighter” groups of companies.

In this research note, we propose an alternative measure of internationalization that focuses on the market relevance of companies using Google search data. We argue that such a measure is particularly suitable to study DMNEs complementing traditional transnationality indexes – including the FDI lightness index – with valuable information on rapidly emerging DMNEs, based on granular geographical data, that captures the market – i.e. user – outreach of DMNEs’ operations. These new measures could be a useful tool to gain new insights into the evolution and international outreach of DMNEs but also a helpful instrument to guide policymakers in assessing the scope of BEPS Pillar One. Finally, we discuss the implications and outline use cases of our proposed Google Trends DOI measure.

## **2. Theories and measures of traditional internationalization**

### **2.1 Theories of internationalization**

International business research has produced a rich array of theories explaining the internationalization behaviour of firms. Internalization theory (Rugman, 1980) and the eclectic paradigm (Dunning, 1980) describe firms’ decisions to internationalize in a specific market (through a specific entry mode). Other theories focus more on the firm’s internationalization process across markets and modes. Most traditionally, the learning model of internationalization (Johanson and Vahlne, 1977) predicts that firms will venture into countries that are institutionally, physically and psychically close to them, gradually committing more resources as they learn and then venturing farther into more distant (different) markets.

In the 1990s, the rapid internationalization of some MNEs, especially DMNEs, put this paradigm in question and initiated the internationalization theory of new ventures that was later popularized under the term “born globals” (Oviatt and McDougall, 1994). The theory of born globals explains why some companies do not follow slow, incremental internationalization. However, the literature on born globals suffers from empirical challenges. Commonly defined as companies that have reached a share of foreign sales of at least 25 per cent within a time frame of two to three years after their establishment – often before their public listing – the internationalization process of born digitals is difficult or impossible to measure. This is because accounting data for sales and assets are generally unavailable before the firms’ listing. Moreover, these private firms often do not report detailed data for geographic segments, which impairs the application of traditional measures for degree of internationalization.

Most recently, some researchers have refined the concept of born globals and initiated theorizing on so-called born digitals (Monaghan et al., 2020; Ojala and Pasi, 2006). These are DMNEs that exhibit rapid international growth based on digital business models. Direct stakeholder engagement, automation, network effects, flexibility and scalability generally characterize these digital business models. Using strategies described as “hyperspecialization” and “hyperscaling” (Giustiziero et al., 2023), DMNEs can offer their goods and services without “boots on the ground”. As a result, they can enter markets through limited FDI, even when, in traditional theories of internationalization, large cultural and geographic distances would preclude market entry. In contrast, DMNEs often show a positive relationship between cultural and geographic distances and the choice of FDI as a market entry mode (Stallkamp et al., 2023). At the same time, DMNEs are highly sensitive to tax and legal institutions and choose their country of incorporation strategically rather than historically (Casella and Formenti, 2018; Meyer et al., 2023; UNCTAD, 2017).

Born digitals and DMNEs defy traditional internationalization. On the one hand, they internationalize quickly and break the traditional (negative) relation between distance and market entry. On the other hand, they are thin on assets, thick on user recognition and opaque regarding their cash flows and sales. We argue that these characteristics of DMNEs make it difficult to apply traditional measures of firm internationalization to DMNEs.

## **2.2 Measures of internationalization**

Accompanying these traditional theoretical frameworks, international business scholars have developed various measures to capture firms’ degree of internationalization. Traditional approaches to measuring firm internationalization can be categorized into three groups (Marshall et al., 2020; Sullivan, 1994): performance-related measures, structural measures and attitudinal measures.

Performance-related measures focus on costs and revenues and include the ratio between foreign sales and total sales (FSTS) or foreign profits as a percentage of total profit (FPTP). Structural measures are based on the locational placement of firms' resources or assets. They include the ratio of foreign assets to total assets (FATA), foreign employees over total employees (FETE) or overseas subsidiaries as a percentage of total subsidiaries (OSTS), and psychic dispersion of international operations (PDIO). Attitudinal measures of internationalization are rare and focus on, for example, top managers' international education or experience.

Most comprehensively, there are approaches to creating compound measures of these three groups. The most recognized and frequently applied compound measure is the Transnationality Index (TNI), published by the United Nations Conference on Trade and Development (UNCTAD). The measure combines structural attributes (FATA, FETE) with a performance-related measure (FSTS). The TNI has the advantage of relying on mostly available information of comparable quality across countries and companies – especially for publicly listed ones – and of combining all operative areas of a company. Public companies are obliged to report in the notes of their financial accounts the business and geographic segmentation of their operations and assets. The only variable that is less often reported – despite growing pressure to improve on environment, social and governance (ESG) reporting – is foreign employment (Trentini, 2021).

A major drawback of the TNI and in general of indexes distinguishing foreign versus domestic measures is the home-market bias. Companies from small home economies are more likely to have high internationalization rates, as they are forced to penetrate foreign markets to reach significant scale. As UNCTAD notes, the TNI “does not take into account the size of the home country, nor does it distinguish between companies whose activities are concentrated in a few foreign countries and companies whose activities are spread across numerous host countries” (UNCTAD, 2007, p. 13). As a consequence, a high TNI value can reflect a home country's locational advantages (a small market, for example) rather than indicate strong international competitiveness on the part of the home-country firms (Trentini, 2021).

One solution to the home-country bias is the use of the Geographic Spread Index, which is the square root of the share of foreign affiliates times the number of host economies. UNCTAD computes and ranks financial companies by this index because the nature of financial companies' assets – highly liquid and thus easily transferred across borders – differs from that of non-financial MNEs, making the interpretation of the foreign assets index less meaningful. This relates to the issue of the appropriateness of the foreign asset index for digital companies, which typically report only a very limited amount of fixed tangible assets, and could provide a valid alternative for measuring their internationalization (Trentini, 2021).

Most recently, Marshall et al. (2020) proposed the RIMS (ratio of international market shares) measure as an alternative compound measure of firm internationalization. The RIMS measure captures the “average depth of penetration across the breadth of all the markets for the rest of the world excluding the firm’s primary market and then compares this to the depth of penetration within the firm’s primary market” (Marshall et al., 2020, p. 1136).

Contrary to the other measures of internationalization, RIMS is not based on a simple foreign-to-domestic distinction but a distributional measure of internationalization. Distributional measures are based on the idea that the internationalization of a company is not determined by its home market or its operations outside of this home market. Rather, in an international company, its home-country operations should not be distinguishable from its operations in all other markets (Fisch, 2012). Distributional measures commonly use some form of Herfindahl Index (HHI) to measure how evenly a company’s operations are distributed across all countries (not just home versus domestic). A fully internationalized company ( $HHI = 1$ ) would have equal and evenly distributed operations in every country. The origin of the company and a distinction between foreign and domestic is not applied. Although scholarship considers distributional measures superior, their availability is limited because they require detailed data for a company’s operations in every country – data not available for the majority of MNEs. Table 1 summarizes traditional approaches to measuring the degree of internationalization for MNEs.

Despite their wide application, traditional measures have several limitations (Marshall et al., 2020). Owing to the unique characteristics (i.e. rapid scaling and opaque structure) of DMNEs, these limitations, we argue, are even more salient when applied to firms that use digital business models.

First, many measures are country-centric, distinguishing only between domestic and foreign operations. Applied to traditional MNEs, the measures do not capture the number of countries or in which countries the firm operates or how diverse this set of countries is. In addition, the measures are very sensitive to home-country size. Applied to DMNEs, this country-centric perspective is even more problematic since digital ventures are highly mobile and incorporate strategically in locations of favourable taxation or regulation. As a result, the domestic market is often not their primary market of operations – which upends the fundamental logic of many traditional measures of degree of internationalization.

Second, traditional internationalization measures focus on the placement of MNEs’ resources or the sources of their performance. DMNEs can serve their market from any location and do not require location-based assets in all the markets they serve (Stallkamp et al., 2023). Consequently, applying structural measures of internationalization to DMNEs leads to biased results. Similarly, DMNEs’ cash flows are more difficult to place in specific countries. During their growth phase, many



DMNEs do not generate positive cash flows. If they do, they are not earmarked for a particular location. Whereas it is easy for MNEs operating in the physical world to identify their buyers and their locations, in the digital world business models are less transparent. More importantly, the source of a DMNE's sales may not reflect its market-side internationalization. Take, for example, the case of Facebook.

**Table 1. Weaknesses of measures of internationalization**

Measure	Weaknesses
Foreign sales to total sales (FSTS)	<ul style="list-style-type: none"> <li>Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of sales across foreign markets)</li> <li>Sales are potentially biased because of tax optimization (attribution of sales to parent versus subsidiary)</li> </ul>
Foreign assets to total assets (FATA)	<ul style="list-style-type: none"> <li>Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of assets across foreign markets)</li> <li>Assets are potentially biased because of tax optimization (e.g. intellectual property and patent allocation)</li> </ul>
Foreign profits to total profits (FPTP)	<ul style="list-style-type: none"> <li>Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of profits across foreign markets)</li> <li>Profits are potentially biased because of tax optimization (e.g. transfer pricing)</li> </ul>
Foreign employees to total employees (FETE)	<ul style="list-style-type: none"> <li>Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of employees across foreign markets)</li> </ul>
Overseas subsidiaries of total subsidiaries (OSTS)	<ul style="list-style-type: none"> <li>Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of sales across foreign markets)</li> <li>Equal weighting of target markets</li> </ul>
Number of countries with operations	<ul style="list-style-type: none"> <li>Equal weighting of target markets</li> <li>Ignores size of country operations</li> <li>Assumes equal relevance of markets</li> </ul>
Psychic dispersion of international operations (PDIO)	<ul style="list-style-type: none"> <li>Equal weighting of target markets</li> <li>Ignores size of country operations in its unweighted form</li> <li>Assumes symmetric distances</li> <li>Relevance of psychic distance dimensions may vary</li> </ul>
Transnationality Index (TNI)	<ul style="list-style-type: none"> <li>Compound measure including FSTS, FATA and FETE</li> <li>Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of sales across foreign markets)</li> <li>Balances individual weaknesses of compounds through aggregation</li> </ul>
Diversification	<ul style="list-style-type: none"> <li>Distribution-based measure (Herfindahl-based)</li> <li>Requires country or at least regional revenue data</li> </ul>
Ratio of international market shares (RIMS)	<ul style="list-style-type: none"> <li>Distribution-based measure (Herfindahl-based)</li> <li>Requires country or at least regional revenue data</li> </ul>

Source: Authors' compilation.

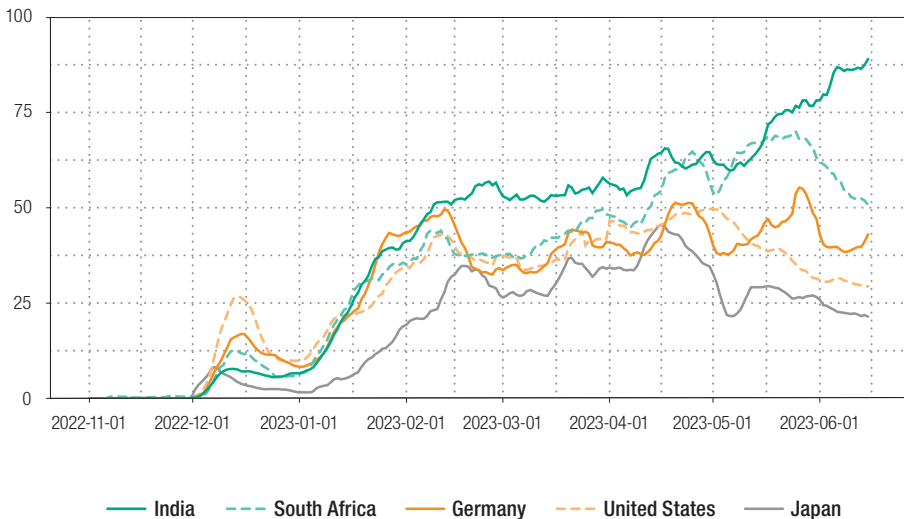
Although Facebook's primary selling proposition is its global outreach to users, it generates revenues from advertising customers. In measuring the degree of internationalization, the source of cash flows (i.e. advertisers) captures only one aspect of market-side internationalization and disregards the immense importance of user-side internationalization.

### 3. Digital MNEs and their internationalization

Before addressing measurement, it is important to conceptualize DMNEs and their internationalization properties. This section refers to work included in UNCTAD (2017) and the background research in Casella and Formenti (2018).

DMNEs are often born global with high speeds of internationalization. ChatGPT, for example, first received digital recognition and search activity in December 2022. On 1 April, just five months later, it exceeded Twitter in net recognition for the first time. DMNEs' fast pace of internationalization cannot reliably be measured or studied using annual accounting data. Figure 1 shows the immense speed of internationalization of ChatGPT in the digital world, using search queries from Google Trends.

**Figure 1. ChatGPT: Relative search volume on Google, November 2022–July 2023**



Source: Authors' compilation, based on Google Trends.

Note: Data are smoothed, using a seven-day moving average.

DMNEs are *centralized* organizations. Their digital business models allow them to internationalize from a central location with little investment in their host countries. Thanks to their digital business models, DMNEs do not require substantial assets in any foreign market. Rather, they are *thin on assets*, serving users and advertisers through digital distribution channels.

Often, DMNEs *strategically incorporate* their headquarters in countries that offer preferential taxation or regulatory environments. In such cases, the classic distinction between domestic and foreign becomes blurred. This impairs the application of many of the most common measures of internationalization. Conversely, MNEs create subsidiary networks across the globe from their historically evolved headquarters to serve their customers most efficiently.

Despite their large scale, DMNEs are *highly specialized* in automated digital processes for their users. Users are not necessarily paying customers, as in traditional MNEs. Rather, they form the platform that the DMNE seeks to commercialize. The efficiency of operations is of little concern because digital platforms scale effortlessly and without many resources across individual users.

Though foreign assets are thin and not necessary for DMNEs to make a substantial impact on a country, outreach to users is of utmost importance for their financial valuation and ability to generate cash flows. As such, DMNEs are intensely market or user oriented.

Despite the high importance of market relevance, the *location of sales is often opaque* and consequently difficult to identify. Table 2 summarizes the conceptual differences between MNEs and DMNEs, focusing on their internationalization.

**Table 2. Differences between MNEs and DMNEs**

Characteristic	MNEs	DMNEs
Internationalization speed	Gradual and learning-based	Born global
Location-based asset requirements	Location-based assets necessary for operations	Location-based assets only for compliance or strategic reasons
Organization	Decentralized network of subsidiaries	Centralized
Scalability	Low because of high capital requirements	High because of digital rollout
Home base	Historically evolved	Strategically selected
Strategic focus	Widely diversified	Highly specialized
Value chain	Physical	Digital
Orientation	Customer	User
Transparency and reporting	High transparency because of physical product flows	Low because of predominantly digital value chain

Source: Authors' compilation.

#### 4. Limitation of traditional measures of internationalization in their application to DMNEs

The conceptual idiosyncrasies of DMNEs make traditional measures of internationalization particularly problematic and potentially biased. This poses difficulties when DMNEs and traditional MNEs are compared in an empirical sample. DMNEs' low need for location-based assets overemphasizes their decentralized nature. The sales of DMNEs are highly distorted and not necessarily identical to their user outreach which, economically and politically, is far more important. DMNEs' business models differ from MNEs' business models in that MNEs use (foreign) assets to reach foreign customers whereas DMNEs use digital distribution to reach users.

Consider, for example, OpenAI, the firm behind ChatGPT and an archetypical DMNE. The firm's core product (ChatGPT) and distribution are digital, and its core assets are related to research and development. According to media reports, its revenues were \$28 million in 2022,<sup>1</sup> and in 2023, it was reported to have about 375 employees.<sup>2</sup> OpenAI also has attracted considerable investment, for example, from Microsoft: \$1 billion in 2019 and \$10 billion in 2023, according to open sources.<sup>3</sup> Yet, OpenAI and ChatGPT are virtually nonexistent in publicly available accounting data. As the firm's filings and annual reports are not publicly available, traditional measures of internationalization would not identify OpenAI as an MNE with a global reach. Given the substantial media coverage of ChatGPT and its (useful, questionable or even criminal) applications, this appears to be a stark misclassification. According to OpenAI, ChatGPT was available in 162 countries in June 2023.<sup>4</sup>

However, the challenges in applying traditional measures of internationalization to "non-traditional" DMNEs can also relate to the (deliberately) opaque business models of these firms. Regulatory reasons or tax jurisdiction may induce DMNEs to keep the geographic sources of their revenues unknown or even to hide them. In June 2023, for example, the Securities and Exchange Commission accused the world's biggest cryptocurrency trading exchange Binance and its competitor Coinbase of fraudulent reporting. Part of the case against the two DMNEs is that they circumvented United States regulators by illegally channeling United States trades through international offshore companies. In addition, Binance is accused of

<sup>1</sup> Erin Woo and Amir Efrati, "OpenAI's losses doubled to \$540 million as it developed ChatGPT", *The Information*, 4 May 2023.

<sup>2</sup> Kevin Roose, "How ChatGPT kicked off an A.I. arms race", *The New York Times*, 3 February 2023.

<sup>3</sup> Crunchbase, "OpenAI – financials", [www.crunchbase.com/organization/openai/company\\_financials](https://www.crunchbase.com/organization/openai/company_financials) (5 December 2023).

<sup>4</sup> OpenAI, "ChatGPT supported countries", <https://help.openai.com/en/articles/7947663-chatgpt-supported-countries> (accessed 5 December 2023).

fraudulently misleading United States regulators about the size of its United States assets and sales.<sup>5</sup> This case, just the latest of many controversial cases about DMNEs' reporting of assets and sales, also illustrates the challenges of applying traditional measures of internationalization to them —even if public accounting data were available.

Given the challenges in applying traditional measures to DMNEs, the question is, what should a useful measure of internationalization for DMNEs entail. First, a useful measure should be comparable between MNEs and DMNEs. Second, it should be based on distributional data rather than a crude binary distinction of home and foreign business, to avoid home-country bias and biases from strategic incorporation. Third, it should be readily available for a universe of opaque digital enterprises. Finally, it should be able to capture rapid internationalization processes and offer more interyear granularity.

In the following section, we propose a measure of internationalization based on Google user data.

## 5. Proposing a measure of market-side internationalization of digital MNEs using Google Trends

The global dominance of Google as an everyday search engine with a market share of 93.11 per cent allows researchers to reach almost 7 billion people and gather valuable data on their socioeconomic behaviour.<sup>6</sup> The second most used online search engine, Bing, reaches only 2.77 per cent of the global market share. The overwhelming majority of people not only use Google to search for information but, first and foremost, to navigate the Internet in their daily behaviour as consumers, stakeholders and even employees or investors. As such, Google accompanies us in our private behaviour. Allowing us to replicate the socioeconomic behaviour of billions of individual users, Google provides a uniquely broad survey instrument for researchers in various disciplines.

To capture the non-traditional internationalization of digital MNEs, we propose to use the *globaltrends* package.<sup>7</sup> The package uses country-level scores of a particular search term – in our specific case, a digital MNE – to develop two conceptually distinct measures of internationalization. The *volume of internationalization (VOI)*

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<sup>5</sup> Matthew Goldstein, Ephrat Livni and Emily Flitter, "Coinbase accused of breaking market rules as crypto crackdown widens", *The New York Times*, 6 June 2023.

<sup>6</sup> Globalstats, "Search engine market share worldwide", <https://gs.statcounter.com/search-engine-market-share> (accessed 5 December 2023).

<sup>7</sup> Harald Pühr, "globaltrends-Measure global trends with Google Trends (R package)", 23 June 2021 <https://github.com/ha-pu/globaltrends>.

captures the global volume of digital interest by Google users in a specific company. To scale and ensure comparability, the VOI is scaled to a reference group of highly searched terms: “gmail,” “map,” “translate,” “wikipedia,” and “youtube” (which can be altered by the user to test for robustness). In simple terms, the VOI captures how often a search term (firm, person, product, event) is searched for relative to the most often searched terms. It can be conceptualized as a measure of global scale or size. This first measure of volume can – similarly to the value of foreign assets for UNCTAD’s top 100 MNEs – help select a group of highly relevant (high-growth) DMNEs from which to compile and update the ranking of top 100 DMNEs.

The *degree of internationalization (DOI)* is more relevant to our research note and is used in further analyses. It is a distribution-based measure that captures how evenly distributed the VOI is across all countries. As with most other distributional measures (e.g. RIMS), the DOI is scaled between 0 and 1. A DOI of 0 would result from a person that is only searched for in one country. A DOI of 1 would mean the person has equal search activity, interest and recognition in *all* countries. The two measures, DOI and VOI, are empirically related as size often correlates with global outreach. Still, they are conceptually distinct since a small company may also have a very high DOI if it sells equally few products in all countries. In this case, the company may be small, but it has a very international footprint. In line with most traditional distributional measures of internationalization and the theoretical construct of internationalization, the baseline DOI does not weight countries according to their size, economic relevance or number of Internet users (the globaltrends package allows weighted DOI for robustness checks).

We argue that this distinction between volume and degree of internationalization is particularly important for digital MNEs since digital business models can more easily be rolled out across countries, even by smaller firms. On the other hand, manufacturing firms face scale restrictions and must grow their operations to become international, establishing a clearer correlation between size and degree of internationalization. In our analysis and discussion below, we focus on the Google Trends DOI since its interpretation is more directly related to an MNE’s degree of internationalization than the Google Trends VOI.

Before discussing the use of Google Trends data to measure internationalization, it is important to consider what Google Trends data validly reflects. Users rely on Google to search for information and to navigate the Internet. As such, Google search queries are highly valid measures of interest, recognition and awareness. Relaxing the definition of internationalization from a purely transactional or operational conceptualization to a more market-oriented view, we argue that search interest on Google can also serve as a proxy measure for international digital outreach. As with all proxy measures, the use of the Google Trends measure has some limitations and advantages, especially regarding DMNEs, we argue. It is worth noting that traditional performance-related or structural measures of

internationalization are arguably also limited to capturing specific dimensions and do not holistically capture the concept of internationalization or internationality of a firm (e.g. the culture of the company, the diversity within the company, the distance it covers and its impact on people). Thus, although Google Trends measures must be applied with caution, they can capture a meaningful dimension of internationalization such as a user's outreach that other proxies, we argue, are less capable of capturing.

We illustrate potential insights by using Google Trends as a measure for internationalization by applying it to the internationalization of ChatGPT. As mentioned earlier, ChatGPT and OpenAI are virtually nonexistent by traditional measures of internationalization. To this end, we use the `globaltrends` package to download data from Google Trends and compute the VOI and DOI for ChatGPT. Panel A of figure 2 shows the VOI – a measure of the intensity of global interest. Interest in ChatGPT grew rapidly from November 2022 to February 2023, when Microsoft announced its \$10 billion increase in funding for ChatGPT. Interest peaked in April 2023, probably over the publication of GPT-4 (a highly improved version of the model underlying ChatGPT) and substantial regulatory concerns regarding ChatGPT and the application of AI in general. Panel B of figure 2 shows the DOI – a measure of the distribution rather than the intensity of global interest. The line plot shows how ChatGPT's DOI increased from November 2022 onwards and has remained stable since April 2023. A Google Trends DOI of 0.65 is extremely high and comparable to that of the most international DMNEs analysed later. The drop in DOI in February 2023 indicates that the distribution of search volume for ChatGPT has become more “uneven.” This is to say that the search volume has become more concentrated, which indicates a lower degree of internationalization; however, as our data show, the distribution quickly reverted to its more even state.

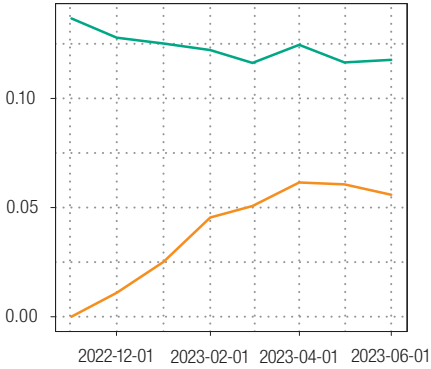
It is important to mention a trait of distributional measures that is often overlooked. A decrease in DOI does not necessarily indicate a decrease in global interest for the firm. It indicates a more unevenly distributed interest. If, for example, an event increases interest for a particular company in one country (e.g. Amazon's Black Friday sale), then the DOI will decrease because the United States has temporarily become more dominant in the global footprint of Amazon. This Black Friday effect on Amazon's DOI is visible in figure 3, where dotted lines mark Black Friday events. The spikes in the total (global) VOI are mirrored by slumps in the DOI. As Amazon's sales become more strongly concentrated in the United States for one day, the company became temporarily less international.<sup>8</sup>

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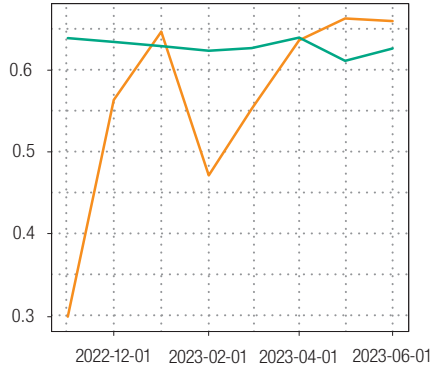
<sup>8</sup> It is worth mentioning that the same decrease in internationalization would be picked up by FSTS; however, available measures rarely allow for daily data.

**Figure 2. ChatGPT: VOI and DOI, November 2022–June 2023**

**a. Google Trends VOI**



**b. Google Trends DOI**

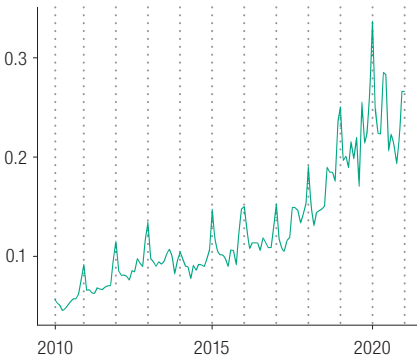


— ChatGPT — Twitter

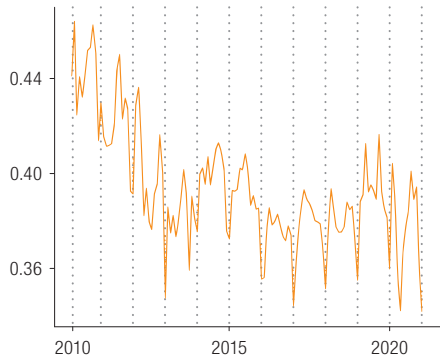
Source: Authors' compilation, based on Google Trends.

**Figure 3. Amazon.com: VOI and DOI, 2010–2021**

**a. Volume of internationalization**



**b. Degree of internationalization**



DOI computer as GINI.

Source: Authors' compilation, based on Google Trends.



A sudden increase in search queries in a location will have the same effect as a decrease in DOI in any distributional measure. Therefore, researchers should use both the volume and degree of internationalization when interpreting these indices.

Another important property of Google Trends data is its extremely fine granularity. Whereas most MNEs report data only on aggregated geographic segments (if data are available), Google Trends allows analysis at the country and state levels. In addition, data are available at a daily or weekly frequency. This allows scholars to better understand the fast-changing dynamics of the international outreach of DMNEs. In figure 1, we show the relative search volume for ChatGPT in Germany, India, Japan, South Africa and the United States. Based on Google search volume, interest in ChatGPT in the United States lead the interest in other countries. However, in mid-January, interest in ChatGPT in these countries picked up and exceeded the interest in the United States. The data also provide two interesting insights into country differences. First, interest in ChatGPT by Japanese Google users was less than that of users in other countries. Second, while interest in Germany, Japan, South Africa, and the United States started declining in May 2023, interest in India still grew in June 2023.

## **6. Empirical assessment and comparison of the Google Trends DOI**

### **6.1 Data collection and baseline analysis**

A meaningful comparison and discussion of differences in various measures of internationalization and how they relate to traditional MNEs and DMNEs requires data from several sources. Consequently, we gather data from several data sets and use these data to compute various measures for the degree of internationalization (see table 3 for descriptive statistics).

For traditional MNEs, we first compute FSTS, FATA, FFTP and share of foreign subsidiaries for S&P500 firms from filings with the United States Securities and Exchange Commission. Second, we are grateful for data provided on the RIMS measure of firm internationalization for 484 MNEs. For the same sample MNEs, we use the `globaltrends` package to obtain Google Trends DOI and VOI. The three data sets establish a baseline comparison between traditional measures of internationalization and the Google Trends DOI. This comparison reveals a consistently positive but moderate correlation between traditional and Google Trends measures of internationalization.

The correlation across all measures of 0.324 highlights that although the three measures all capture degree of internationalization, they capture different facets of the construct and are not perfectly substitutable. The average correlation between Google Trends DOI and traditional measures (FSTS, FATA, FFTP) is 0.331.

**Table 3. Descriptive statistics, MNEs versus DMNEs**

Parameter		Observations	Minimum	Mean	Maximum	Standard deviation
Google Trends DOI	MNEs	851	0	0.176	0.498	0.109
	DMNEs	198	0	0.188	0.627	0.125
Foreign assets to total assets	MNEs	851	7.593	67.629	100	21.566
	DMNEs	169	0	33.780	99.811	25.258
Foreign employees to total employees	MNEs	851	1.693	59.503	100	23.611
	DMNEs	n.a.	n.a.	n.a.	n.a.	n.a.
Foreign sales to total sales	MNEs	851	2.995	70.168	100	21.487
	DMNEs	195	3.07	43.415	99.992	24.982
Transnationality Index	MNEs	851	4.314	65.767	99.590	19.172
	DMNEs	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Author's estimations, based on Google Trends and UNCTAD FDI/MEN database.

The average correlation among the traditional measures – FATA, FSTS, and RIMS – is 0.317.<sup>9</sup> In other words, the Google-based measure of internationalization appears to capture internationalization as reliably (or unreliably) as the other measures. Looking further into individual traditional measures, the Google Trends DOI correlates most strongly with the market-related indexes, FSTS (0.378) and RIMS (0.364).

Third and finally, we obtain the TNI from UNCTAD for the largest 100 MNEs, including the index's subdimensions of FATA, FSTS and FETE. The pattern of correlations in this sample is similar to that in our previous analysis. While the Google Trends DOI measure is significantly correlated with FSTS and the TNI, there is no significant correlation with FETE and FATA.

These comparisons (table 4, figure 4) suggest two findings: Google Trends DOI has a slightly higher correlation (RIMS: 0.364) with the only available internationalization measure that is based on distributional data and not on a simple foreign versus domestic dichotomy such as FSTS (0.293) or FATA (0.161). Second, Google Trends DOI appears more sensitive to sales (FSTS: 0.378) than physical assets (FATA: 0.250).

<sup>9</sup> This excludes TNI, which is based on FSTS and FATA, and thus naturally correlated with these measures.

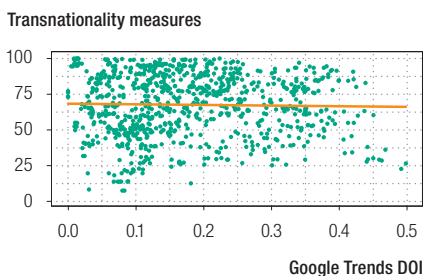
**Table 4. Bivariate correlations between traditional measures of internationalization and Google DOI for MNEs**

Parameter1	Parameter2	Correlation	p-value	Observations
Google Trends DOI	Foreign sales to total sales	0.291	0.000	851
Google Trends DOI	Foreign sales to total sales	-0.023	1.000	851
Google Trends DOI	Foreign employees to total employees	0.026	1.000	851
Google Trends DOI	Transnationality Index	0.111	0.008	851
Foreign sales to total sales	Foreign assets to total assets	0.599	0.000	851
Foreign sales to total sales	Foreign employees to total employees	0.584	0.000	851
Foreign sales to total sales	Transnationality Index	0.838	0.000	851
Foreign assets to total assets	Foreign employees to total employees	0.664	0.000	851
Foreign assets to total assets	Transnationality Index	0.871	0.000	851
Foreign employees to total employees	Transnationality Index	0.878	0.000	851

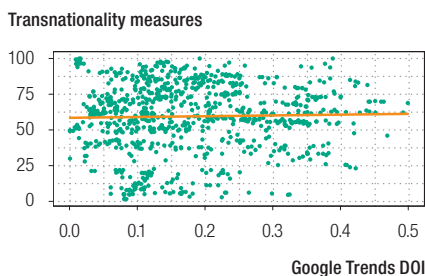
Source: Author's estimations, based on Google Trends and UNCTAD FDI/MEN database.

**Figure 4. Measures of internationalization for MNEs**

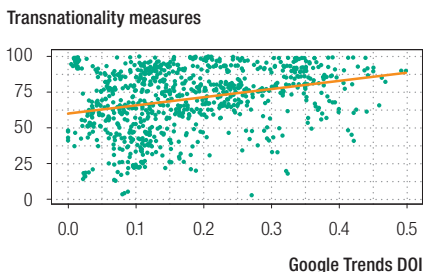
**a. Foreign assets to total assets**



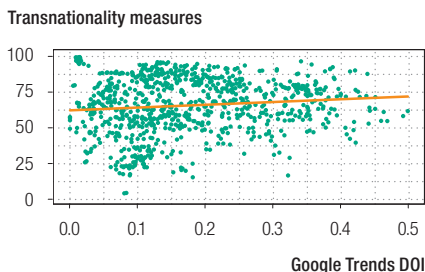
**b. Foreign employees to total employees**



**c. Foreign sales to total sales**



**d. Transnationality index**



Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

For digital firms, we obtain internationalization data from UNCTAD for the largest 200 DMNEs. Data are available for only two years, which could result in lower reliability for our correlation analysis (table 5, figure 5). The Google Trends DOI has a low positive correlation (0.076) with FSTS and a negative correlation with FATA (-0.271). This means that the difference between the Google Trends DOI and traditional measures of internationalization is much larger for DMNEs than for MNEs. In the case of DMNEs, the measures appear to assess very different aspects of internationalization. This could have two reasons: (a) traditional measures or the Google Trends DOI are inappropriate for capturing the internationalization of DMNEs, or (b) the two capture complementary aspects of internationalization. In the following section, we outline why we believe that Google Trends DOI can complement the analysis on DMNEs' internationalization process. Nevertheless, we propose that Google Trends DOI and traditional measures should be used jointly because they capture different aspects of the internationalization of DMNEs.

In the previous section, we compared Google Trends DOI with other available indices, data sets and rankings, such as the Top 100 MNE and DMNE list from UNCTAD. In other words, we have relied on other samples rather than using Google Trends to identify and select the most "international" companies. The Google Trends VOI and DOI can monitor the degree of internationalization in real time for many firms, products or persons. As such, they theoretically lend themselves to selecting and ranking of firms. The immense data availability and the ability to survey many firms with little effort certainly benefit researchers. However, researchers should be aware of the biases of Google Trends indexes (e.g. business-facing versus consumer-facing, or B2B versus B2C). These can be acknowledged by (a) creating separated rankings for such biased groups and (b) using an econometrically more sophisticated technique based on regression models that accounts for the characteristics of the country (similar to three- or five-factor models; Fama and French, 1992). It is worth noting that (other forms of) bias also exist when using traditional measures to rank firms by their DOI or VOI. Foreign-to-total measures favour companies from smaller markets, and asset-related measures discriminate against firms with asset-thin business models such as DMNEs (Trentini, 2021). Similarly, sales- or employee-based measures load more heavily on some industries than others.

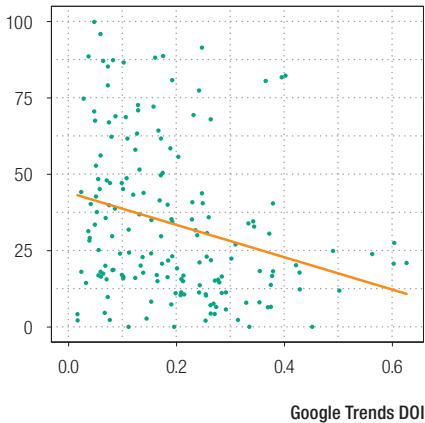
**Table 5. Bivariate correlations between traditional measures of internationalization and Google DOI for DMNEs**

Parameter1	Parameter2	Correlation	p-value	Observations
Google Trends DOI	Foreign sales to total sales	0.076	0.583	195
Google Trends DOI	Foreign assets to total assets	-0.271	0.001	169
Foreign sales to total sales	Foreign assets to total assets	0.615	0.000	166

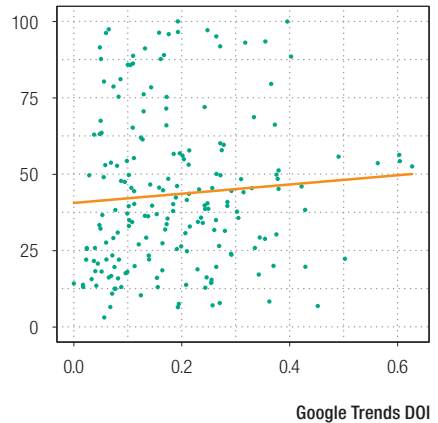
Source: Author's estimations, based on Google Trends and UNCTAD FDI/MEN database.

**Figure 5. Comparison of measures of internationalization for DMNEs****a. Foreign assets to total assets**

Transnationality measures

**b. Foreign sales to total sales**

Transnationality measures



Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

## 6.2 Comparing traditional and digital MNEs across internationalization measures

If we compare descriptive statistics for the different internationalization measures for MNEs and DMNEs (table 3), an interesting pattern emerges that coincides with the theoretical differences set out in the previous section. Measured with traditional measures, the average MNE is two times more international in assets (MNE: 68 per cent; DMNE: 34 per cent) and 50 per cent more international in sales than the average DMNE (MNE: 70 per cent; DMNE: 43 per cent).

Applying a Google-based measure, DMNEs are slightly more international than MNEs. The most international company, both digital and traditional, using Google Trends DOI is Alphabet (0.627); the largest traditional company, Samsung Electronics (0.463), has a 26 per cent lower degree of internationalization. Naturally, Google DOI, which is based on companies' global digital footprint, loads more heavily on DMNEs than traditional MNEs.

Applying traditional FATA, Rio Tinto tops the list of traditional MNEs, with 99.8 per cent in foreign assets. Just Eat Takeaway.com, the DMNE with the highest FATA, comes close to 99.8 per cent of foreign assets. Founded in Spain, Rio Tinto lists

and maintains head offices in London and in Melbourne. This makes the distinction between foreign and domestic sales or assets difficult. Furthermore, the complex corporate structure reduces the transparency of cash flows. Rio Tinto is very asset-heavy (\$96.7 billion). At the same time, it is slim on the market side, with more than \$55 billion of revenues coming from only 2,000 customers (Rio Tinto, 2023). On its website, Rio Tinto claims operations in 35 countries, a surprisingly small footprint for the most internationalized traditional MNE. Similarly, Just Eat Takeaway.com maintains a dual listing resulting from a merger between London-based Just Eat and Amsterdam-based Takeaway.com. According to their website, they serve 16 markets plus Australia, Canada, New Zealand and the United States. Though certainly large multinational companies, the two examples highlight the problematic distinction between foreign and domestic that underpins most traditional measures of internationalization. In both cases, a distributional measure of sales or assets that distinguishes the foreign-to-domestic ratio and the distribution across all countries would have rated the two companies much lower in internationalization.

The differences in company rankings in table 6 between Google-based measures and traditional measures reveal further insights. Among traditional measures, Rio Tinto dominates with a TNI of 99 per cent, followed by Anglo American (United Kingdom; 95 per cent), Altice Europe (Netherlands; 93 per cent), Linde (Germany; 92 per cent), and Foxconn/Hon Hai Precision Industries (Taiwan Province of China; 90 per cent). Strikingly, the list does not include a single United States-based company. This is because when applying the FATA, FSTS and FETE measures, companies originating from small countries naturally have higher ratios of foreign business. The ranking of the Google Trends DOI is led by Samsung Electronics (Republic of Korea), Huawei Technologies (China), Vinci (France), Airbus (France) and SAP (United States). Most remarkably, Rio Tinto ranks lowest overall in the Google Trends DOI (table 7). Thus, according to traditional measures, the most internationalized company is the least international in the digital world. Similarly, Altice Europe, third in the TNI ranking, is only two spots from the bottom of the Google Trends DOI ranking. This comparison supports our prior assessment that the Google Trends DOI inhibits less home-country bias but tends to load more heavily on consumer-oriented, asset-light companies.

Turning toward DMNEs in tables 8 and 9, we observe a similar pattern. The Google Trends DOI ranks consumer-facing companies Alphabet, Meta, Netflix, Pinterest (all United States) and Alibaba (China) as the most internationalized firms and iMarketKorea (Republic of Korea), Grupo Televisa (Mexico), Graham Holdings, Roper Technologies and Qurate Retail (all United States) as the least internationalized firms. The traditional measures of FSTS and FATA are led by Just Eat Takeaway.com (FATA) and Delivery Hero (FSTS). Interestingly, Twitter (now X; United States) appears among the least international companies measured in FATA, and Alibaba Group (China) features among the least international companies measured in FSTS.

**Table 6. Top five internationalized MNEs by internationalization measure**

Measure	Rank	MNE	Value
Google Trends DOI	1	Samsung Electronics	0.463
	2	Huawei Technologies	0.421
	3	Vinci	0.418
	4	Airbus	0.394
	5	SAP	0.381
Foreign assets to total assets	1	Rio Tinto	99.758
	2	British American Tobacco	99.336
	3	Veolia Environnement	96.972
	4	ArcelorMittal	96.633
	5	Anglo American	96.032
Foreign employees to total employees	1	Rio Tinto	99.587
	2	Glencore	97.165
	3	Anglo American	96.825
	4	CK Hutchison	93.000
	5	Altice Europe	91.046
Foreign sales to total sales	1	ArcelorMittal	100
	2	Rio Tinto	99.426
	3	Roche	99.040
	4	Altice Europe	98.349
	5	Hon Hai Precision Industries	97.924
Transnationality Index	1	Rio Tinto	99.590
	2	Anglo American	95.128
	3	Altice Europe	93.481
	4	Linde	92.070
	5	Hon Hai Precision Industries	90.909

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

**Table 7. Bottom five internationalized MNEs by internationalization measure**

Measure	Rank	MNE	Value
Google Trends DOI	1	Rio Tinto	0.014
	2	Legend Holdings	0.022
	3	Nippon Telegraph & Telephone	0.026
	4	Altice Europe	0.027
	5	Softbank Group	0.036
Foreign assets to total assets	1	State Grid Corporation of China	7.598
	2	Saudi Aramco	12.689
	3	China National Petroleum	21.882
	4	Sinopec	26.010
	5	Samsung Electronics	28.616
Foreign employees to total employees	1	State Grid Corporation of China	1.693
	2	China COSCO Shipping	4.897
	3	China National Offshore Oil	5.233
	4	Sinopec	6.653
	5	China National Petroleum	9.947
Foreign sales to total sales	1	State Grid Corporation of China	3.650
	2	ChemChina	13.061
	3	Sinochem	13.693
	4	China COSCO Shipping	18.091
	5	Nippon Telegraph Telephone	18.687
Transnationality Index	1	State Grid Corporation of China	4.314
	2	Saudi Aramco	15.521
	3	Sinopec	21.590
	4	ChemChina	26.123
	5	China National Petroleum	26.340

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.



Thus, traditional measures capture DMNEs' operational footprint whereas the Google DOI and VOI capture firms' digital outreach to users, giving a more forward-looking picture of their operations. The Google trends indexes give an indication of where sales, profits and possibly also assets may be reported in future financial disclosures – if the digital company is in the scope of BEPS Pillar One measures – helping restore taxing rights in those locations.

On an industry level, annex tables A1 and A2 in the online appendix show that for MNEs, aircraft, consumer electronics, textiles, and computer and data processing tend to have higher internationalization scores than FATA. In contrast, FATA ranks food and beverages, metals and metals products, and business services higher. Compared with FSTS, business services score much higher in traditional measures. DMNEs cover only four industries: digital content, digital solutions, e-commerce and Internet platforms. Based on data from the Google Trends DOI, Internet platforms are the most international industry. According to the traditional measures

**Table 8. Top five internationalized DMNEs by internationalization measure**

Measure	Rank	MNE	Value
Google Trends DOI	1	Alphabet	0.604
	2	Meta Platforms	0.603
	3	Pinterest	0.502
	4	Netflix	0.491
	5	Alibaba Group	0.452
Foreign assets to total assets	1	Just Eat Takeaway.com	99.811
	2	Thomson Reuters	91.408
	3	Wolters Kluwer	88.663
	4	WeWork	88.115
	5	Mercadolibre	87.302
Foreign sales to total sales	1	Delivery Hero	99.992
	2	Spotify Technology	99.938
	3	Amadeus IT Group	97.401
	4	Thomson Reuters	97.110
	5	Micro Focus International	96.532

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

**Table 9. Bottom five internationalized DMNEs by internationalization measure**

Measure	Rank	MNE	Value
Google Trends DOI	1	iMarketKorea	0.000
	2	Grupo Televisa	0.017
	3	Graham Holdings	0.023
	4	Roper Technologies	0.033
	5	Qurate Retail	0.037
Foreign assets to total assets	1	Akamai Technologies	0.000
	2	Alibaba Group	0.000
	3	Grupo Televisa	2.108
	4	Twitter	2.251
	5	Applovin	2.256
Foreign sales to total sales	1	Naver	3.070
	2	Yandex	6.476
	3	Alibaba Group	6.811
	4	Tencent Holdings	7.032
	5	DiDi Global	7.516

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

of FATA and FSTS, Internet platforms rank last, and e-commerce dominates FATA and FSTS. Summarizing these observations, we conclude that Google-based internationalization measures have these characteristics:

- a. They yield similar results when applied to traditional MNEs. They may, consequently, be used as a complement to traditional measures.
- b. They yield very different, partially contradicting results when applied to DMNEs. Because traditional measures of FATA and FSTS are potentially problematic in asset-thin DMNEs, the Google Trends DOI may be a superior or, at least, valuable complement to traditional measures.
- c. They load more heavily on market-or customer-oriented companies than traditional measures in both MNEs and DMNEs.
- d. They suffer less from home-country bias in both MNEs and DMNEs.

## 7. Discussion

The Google Trends DOI captures a market- or user-side form of internationalization. As a result, we argue that they more effectively capture DMNEs' internationalization since DMNEs scale their international operations from strategically placed assets in a few countries that do not necessarily match their digital and commercial footprint. In addition, the origin of reported sales for many DMNEs does not necessarily coincide with the true origin of the cash flows or the users.

Beyond the validity of the Google Trends DOI, Google-based data have several practical advantages. Google Trends data are available for every region and country and in a daily format. Contrary to traditional measures that are rarely reported in sufficient granularity to create distribution-based measures of internationalization, in Google Trends complete data are available. The daily granularity allows researchers to capture fast internationalization patterns, often found in DMNEs, such as ChatGPT. It is even possible to capture specific transactions if a company or academic researcher seeks to study a firm's market entry into a specific country.

A second practical strength of the Google Trends DOI is its standardization, achieved by scaling it to a group of reference terms. This means that the internationalization of a company can be compared with the internationalization of non-economic actors whose global impact and internationalization do not manifest through sales, assets or employees. Therein, the Google Trends DOI opens up entirely new applications of internationalization in other disciplines. It can be used to study universities, policy institutions, sports teams and even persons, ideas or ideologies (Aguzzoli et al., 2021).

Despite these advantages in validity when applied to DMNEs and the remarkable opportunities that result from superior data availability, Google Trends data have some weaknesses. For some companies, the Google Trends DOI may suffer from keyword contamination. This happens when the name of a company corresponds to a term that users may use for other purposes (e.g. Tesla, the company, and Tesla, the historical person). The use of search topics in Google Trends can reduce this problem. A second problem results from differences in languages and market share of Google within countries. Because the Google Trends DOI can draw on more than 130 countries to calculate its unweighted distribution, a potential bias from a single country, such as China or the Russian Federation, would not materially affect it. Also, such bias would affect all companies' distributions, thus allowing for an unbiased comparison of companies' degrees of internationalization; however, Chinese or Russian DMNEs might appear "smaller" than their Western counterparts.

The measures allow researchers to triangulate data (Nielsen et al., 2020) to overcome issues in the measurement of internationalization (Verbeke and Forootan, 2012; Verbeke et al., 2009). Therefore, scholars can use Google Trends measures

to operationalize the degree of internationalization independent of the type of value chain activity, entry mode choice and strategic motives for internationalization. Moreover, researchers can separate the dispersion of international operations (i.e. degree of internationalization) from the intensity of international operations (i.e. volume of internationalization).

## 8. Conclusions and way forward

In this paper we proposed new internationalization measures specifically suited to study the evolution and internationalization process of digital MNEs. The proposed Google Trends DOI and VOI enhance the quality and diversity of internationalization measures in the international business community and offer valuable insights for policymakers that traditional measures may not capture, helping them locate the operations of digital companies. As an open-source software package, globaltrends provides unrestricted access to a rich, novel data source.<sup>10</sup>

Google Trends VOI and DOI capture the market- or user-side dimension of a firm's internationalization and give a forward-looking picture of emerging digital champions, providing a useful tool first for selecting the next top 100 DMNEs and then for studying the evolution and internationalization patterns of digital companies. This is important as these new business models are adopted gradually across different economic sectors, impacting and significantly changing international investment patterns and international production networks.

These measures are more capable of tracking the location of DMNEs' digital operations, which is often unrelated to the placement of assets and sales. The market-side characteristics of Google Trends indexes make them a particularly valid instrument for selecting and detecting DMNEs that are potentially in scope for the BEPS Pillar One and – more in general – are useful tools for evidence-based policymaking (e.g. regulatory interventions) in the frame of the digital economy.

Google Trends indexes should complement traditional measures of internationalization such as the TNI and the FDI lightness index, which are better at capturing the physical operations of well-established firms.<sup>11</sup> For example, comparing the locations of assets (FATA), employees (FETE) and sales (FSTS) of DMNEs with the locations of users measured with Google DOI can provide interesting insights. If the location of users differs substantially from operations

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<sup>10</sup> Using the proposed measures to operationalize internationalization therefore enhances reproducibility, replicability and transparency in international business research (Aguinis et al., 2017; Beugelsdijk et al., 2020).

<sup>11</sup> Ideally, researchers also include an additional control for B2B versus B2C to capture systematic biases (Puhr and Müllner, 2021; Trentini et al., 2022).

(i.e. sales, assets and employees), this can indicate tax or regulatory arbitrage by DMNEs. Tracking diverging trends between the TNI and its subindexes and these new Google measures can enable policymakers to address the economic impact of FDI in host economies.

More in general, considering both measures can help policymakers predict how international production networks will evolve and prepare adequate developmental strategies to leverage the new economy. When studying the effects of internationalization on companies, researchers should reflect on the mechanisms that underpin the hypothesized effect and select the more appropriate measure for hypothesis testing and control for other dimensions of internationalization.

The detailed data available on Google Trends opens new avenues of research, for example studying how internationalization affects firms' vulnerability to consumer activism. Google-based measures are more reflective of the international scale of these consumers, capturing companies' exposure to international consumers on a daily basis. Thanks to better ESG disclosures, consumers today are better informed about corporate practices and can be more demanding of corporations. Similarly, the availability of high-frequency data allows researchers to study the reactions of global financial markets to an event (Puhr and Müllner, 2022). In that case, Google Trends measures accurately reflect the companies' worldwide recognition among consumers and investors. Finally, beyond financial and tax relevance, the location of users and the global footprint of DMNEs are relevant for socioeconomic and political issues. DMNEs such as Facebook, Google, Twitter and Youtube have, in the past, played an important role in shaping the sociopolitical dynamics of countries and regions (e.g. the Arab Spring, the Cambridge Analytica exposure, social media restrictions). Studying these sociopolitical effects could widen knowledge about the global impact of DMNEs beyond their economic contribution.

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## Appendix

**Appendix table A1. Average values for measures of internationalization by industry for MNEs**

Industry	Observations	Google Trends DOI	Foreign assets to total assets	Foreign employees to total employees	Foreign sales to total sales	Transnationality Index
Aircraft	17	0.327	64.278	61.770	82.682	69.577
Building materials	16	0.165	84.678	71.583	76.887	77.716
Business services	10	0.062	87.358	90.732	87.098	88.396
Chemicals	21	0.114	85.686	74.544	86.181	82.137
Computer and data processing	23	0.274	72.263	61.028	76.661	69.984
Construction	6	0.160	68.362	58.402	53.779	60.181
Consumer electronics	7	0.326	77.506	70.417	91.557	79.827
Electricity, gas and water	118	0.120	60.959	55.399	58.688	58.349
Finance	7	0.077	14.554	22.396	24.609	20.520
Food and beverages	28	0.149	91.191	83.029	84.881	86.367
Health care services	3	0.221	78.102	51.727	57.770	62.533
Industrial and commercial machinery	16	0.277	79.883	57.881	78.522	72.095
Media	6	0.125	48.286	69.548	40.068	52.634
Metals and metal products	18	0.167	85.526	66.151	87.717	79.798
Mining, quarrying and petroleum	190	0.149	65.682	52.872	65.300	61.285
Motor vehicles	89	0.273	55.285	53.288	76.423	61.665
Pharmaceuticals	61	0.244	71.778	66.622	86.411	74.937
Real estate	2	0.071	66.62	67.495	53.015	62.377
Retail trade	27	0.140	70.773	72.489	65.034	69.432
Telecommunications	97	0.176	66.435	64.288	67.120	65.947
Textiles, clothing and leather	10	0.289	63.512	77.731	89.008	76.750
Tobacco	22	0.103	91.464	61.976	79.221	77.554
Transport and storage	32	0.176	69.306	40.333	72.025	60.555
Wholesale trade	25	0.085	59.807	56.076	46.262	54.048

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.



**Annex table A2. Average values for measures of internationalization by industry for DMNEs**

<b>Industry</b>	<b>Observations</b>	<b>Google Trends DOI</b>	<b>Foreign assets to total assets</b>	<b>Foreign sales to total sales</b>
Digital content	74	0.162	38.717	44.242
Digital solutions	59	0.190	29.811	39.662
E-commerce	39	0.156	42.574	50.887
Internet platforms	26	0.304	17.317	38.050

*Source:* Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.



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Quotations should be accompanied by the page number(s) from the original source (e.g. “Cantwell, 1991, p. 19” and “UNTAD, 2019, pp. 104–105”). Quoted words, sentences and paragraphs are enclosed within double quotation marks. Single quotation marks are used to enclose quotations within quotations.

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Examples:

<sup>1</sup> India, Ministry of New and Renewable Energy, “India achieves 100 GW milestone of installed renewable energy capacity”, 12 August 2021, <https://pib.gov.in>.

<sup>2</sup> European Commission, “What category do I fit into?”, EU Immigration Portal, <https://ec.europa.eu/immigration> (accessed 13 December 2021).

<sup>3</sup> Based on UNCTAD, “International investment agreements navigator”, Investment Policy Hub, <https://investmentpolicy.unctad.org/international-investment-agreements> (accessed 15 April 2018).

<sup>4</sup> *The Financial Times*, “Gig workers should get pension rights now, says regulator”, 19 May 2021.

<sup>5</sup> Bloomberg News, “Tracking tax runaways”, Bloomberg Special Reports: Corporate Tax Inversions, 1 March 2017, [www.bloomberg.com/graphics/tax-inversion-tracker](http://www.bloomberg.com/graphics/tax-inversion-tracker).

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Cantwell, John (1991). “A survey of theories of international production”, in Christos N. Pitelis and Roger Sugden, eds., *The Nature of the Transnational Firm* (London: Routledge), pp. 16–63.

Cantwell, John, John H. Dunning and Sarianna M. Lundan (2010). “An evolutionary approach to understanding international business activity: the co-evolution of MNEs and the institutional environment”, *Journal of International Business Studies*, 41, pp. 567–586.

Dunning, John H. (2000). “The eclectic paradigm as an envelope for economic and business theories of MNE activity”, *International Business Review*, 9(1), pp. 163–190.

UNCTAD (United Nations Conference on Trade and Development) (2009). *Investment Policy Monitor*, No. 1, 4 December. [unctad.org/system/files/official-document/webdiaeia200911\\_en.pdf](http://unctad.org/system/files/official-document/webdiaeia200911_en.pdf).

\_\_\_\_\_(2019). *World Investment Report 2019: The Special Economic Zones* (New York and Geneva: United Nations).

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