

Effect of Productive Capacities on Economic Complexity: Do Aid for Trade Flows Matter?

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Abstract This is the first study to examine the effect of productive capacities on economic complexity and understand whether the Aid for Trade (AfT) flows is important for this effect in recipient countries. The analysis uses a sample of 126 developed and developing countries for 2002-2018 and adopts the two-step system Generalized Method of Moments approach. Results show that strengthening productive capacities enhances economic complexity. Furthermore, productive capacities and total AfT flows are strongly complementary in positively affecting economic complexity, and the degree of complementarity is higher for poor countries than for other AfT-recipient countries. Similarly, productive capacities are strongly complementary with total Non-AfT flows, as well as for total development aid. These findings highlight the need for scaling-up development aid flows, notably AfT flows, in favor of developing countries and poor countries having the lowest levels of productive capacities.

Keywords: Productive Capacities, Economic Complexity, Aid for Trade Flows, Other Development Aid (i.e., Non-AfT Flows), Total Development Aid

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I. Introduction

Do productive capacities increase economic complexity (i.e., enhance economic sophistication), and are Aid for Trade (AfT) flows important for the effect of productive capacities on economic complexity? This empirical study addresses these two questions. The latter question is highly relevant in the current context where the COVID-19 pandemic has exposed structural vulnerabilities of developing economies, and the least-developed countries¹⁾ (LDCs) among them, and underlined the need for national policymakers, international and regional institutions, and the academic community to explore methods for strengthening productive capacities to build economies that are more resilient and immune to future shocks.

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The United Nations Conference on Trade and Development (UNCTAD) has been advocating for strengthening productive capacities in developing, and particularly in LDCs with a view to promoting structural transformation of economies and sustainable growth and development. It has provided a first definition of the concept of “productive capacities” in its report on LDCs in 2006, titled “The Least Developed Countries Report 2006: Developing Productive Capacities” (see UNCTAD, 2006). According to this report (UNCTAD, 2006, p61), productive capacities²⁾ are “the productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop.” Since 2006, many analytical works, though not evidence-based studies, have focused on the issue of “how to foster productive capacities in developing countries,” including on challenges faced by developing countries and LDCs in fostering productive capacities, and the appropriate policies to address them (e.g., Cornia and Scognamiglio, 2016; UNCTAD, 2016, 2020c). Enhancing productive capacities³⁾ has also been the subject of intense discussions at several international conferences, for example, the fourth United Nations Conference on LDCs in 2011, the second United Nations Conference on Landlocked Developing Countries in 2014, and the fourteenth session of the UNCTAD in 2016. However, studies so far have ignored availability of data on productive capacities to help perform relevant data-based analyses of “how to foster productive capacities in developing countries.” These evidence-based analyses would help identify where the challenges related to the development of productive capacities in developing countries lie, and how to address them, with the support of donors and the international community, to ensure that these economies engage on a path of sustainable economic growth and development. To facilitate formulation and implementation of evidenced- based policies related to the issue of productive capacities, in 2020, the UNCTAD has developed an index⁴⁾ of productive capacities (covering the period 2000-2008) based on the definition of the concept of “productive capacities” by UNCTAD (2006). The 2020 UNCTAD report on LDCs titled “The Least Developed Countries

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- 1) Least developed countries are countries qualified by the United Nations as the poorest and most vulnerable ones to external and environment shocks. Information on the criteria used to include a country in or graduate it from the category of LDCs could be obtained in the United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (OHRLLS) (see online at: <https://www.un.org/ohrls/>).
 - 2) Other definitions of the concept of “productive capacities” have been provided by international organizations and bodies other than the UNCTAD. These organizations have focused on some specific aspects of productive capacities, including the industrial, trade, or human capacity facets (UNCTAD, 2006: 62-63). For example, another definition of “productive capacities” refers to it as “a set of different types of productive, organizational, technological and innovation capabilities embedded in organizations, institutions and infrastructures whose integration determines the capacity of a country to produce goods and services in a competitive global market” (UNCTAD, 2020a: 29).
 - 3) The importance of fostering productive capacities for sustainable development in developing countries has been underlined in the 2030 Agenda for Sustainable Development, the Istanbul Programme of Action, the Vienna Programme of Action, the Nairobi Azimio and Nairobi Maafikiano.
 - 4) Data on the index of productive capacities are available on the UNCTAD's statistics portal: <https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx>

Report 2020: Productive Capacities for the New Decade” (see UNCTAD, 2020b) discusses extensively the methodologies used to construct this index and presents its development over time and across countries, for example, for developed countries, developing countries, and LDCs (see UNCTAD, 2020b: Chapter 3). It also explores the policies that could be implemented by LDCs to develop productive capacities in the new decade (see UNCTAD, 2020b: Chapter 5).

The World Trade Organization (WTO) has also focused on the issue of productive capacities in its developing members. In fact, the preamble of the Marrakesh Agreement establishing the WTO recognizes⁵⁾ *“the need for positive efforts designed to ensure that developing countries, and especially the least developed among them, secure a share in the growth in international trade commensurate with the needs of their economic development.”* Thus, recognizing challenges faced by developing countries and the LDCs to better integrate in the multilateral trading system, WTO members launched the Aft Initiative at the WTO Ministerial Conference held in Hong Kong China in 2005. The genuine purpose of this initiative is to “help developing countries, particularly LDCs build the supply-side capacity and trade-related infrastructure that they need to assist them to implement and benefit from WTO Agreements and more broadly to expand their trade” (see WTO, 2005, Paragraph 57). Aft flows represent the part of the total official development assistance (ODA) flows that are devoted to promoting international trade in the recipient countries. They aim not only to build economic infrastructure⁶⁾ (through development of hard and soft infrastructure) but also to strengthen the capacity of the productive sectors to increase production of competitive goods and services for the international market. These aid flows also intend to build the capacity of policymakers in beneficiary-countries through technical assistance and capacity-building activities to implement trade and trade-related policies consistent with the WTO rules and to compensate domestic trading firms for losses incurred in the trade liberalization process.

This study is perhaps the first empirical analysis to use the index of productive capacities developed by the UNCTAD (data on this index and its components were posted on the UNCTAD's statistics portal on February 8, 2021). It investigates the effect of productive capacities (as defined by UNCTAD, 2006, 2020b) on economic complexity, and whether Aft flows influence this effect. The focus on economic complexity as a potential outcome of fostering productive capacities is dictated by the fact that economic complexity is not only an important driver of current economic growth but also a good predictor of countries' future economic growth and economic development patterns.⁷⁾ The concept of economic complexity (also referred

5) See online at: https://www.wto.org/english/docs_e/legal_e/04-wto_e.htm

6) The hard dimension of infrastructure refers to tangible infrastructure, such as roads, ports, highways, and telecommunications, while the soft dimension concerns transparency, customs management, business environment, and other intangible institutional aspects (see Portugal-Perez and Wilson, 2009, 2012).

7) See, for example, Albeaik et al. (2017); Caldarelli et al. (2012); Cristelli et al. (2015); Hausmann et al. (2007); Hausmann and Hidalgo (2009, 2011); Hidalgo et al. (2007); Mealy et al. (2019); Poncet and Starosta de Waldemar (2013a, b); Stojkoski et al. (2016); Zhu and Li (2017).

to as “economic sophistication”) is relatively new in the literature and represents the amount of productive knowledge embedded in a country’s productive structure (e.g., Caldarelli et al., 2012; Cristelli et al., 2015; Hausmann and Hidalgo, 2014; Hausmann and Hidalgo, 2009; Hidalgo et al., 2007; Utkovski et al., 2018). According to Lall et al. (2006), economic complexity is the extent to which countries can produce and export knowledge goods through the knowledge formed in those countries. This concept builds on the idea that diverse and exclusive capabilities are needed to produce complex goods, i.e., goods of high value added, that cannot be easily produced by other countries. As defined by Hausmann and Hidalgo (2009), complex economies are those characterized by a wide range of products (i.e., greater export product diversification) that other countries would not be able to produce easily because of the specific capabilities needed to grow them (i.e., these types of products are qualified as having a low ubiquity). These signify that simpler economies, such as LDCs that mainly export products with low value added, including primary commodities, have a low level of export product diversification and high ubiquitous products (i.e., products can be easily produced by other countries).

While several studies⁸⁾ are focusing on the macroeconomic effects, very few have considered the determinants of economic complexity (e.g., Chu, 2020; Hausmann & Hidalgo, 2014; Lapatinas, 2019; Lapatinas and Litina, 2019; Sepehrdoust et al., 2019). Thus, by investigating the effect of productive capacities on economic complexity, this study contributes to the literature on the determinants of economic complexity.

This empirical study considers 126 countries (both developed and developing countries) with data spanning the period 2002-2018 and establishes several findings. First, fostering productive capacities induces greater economic complexity across the full sample, as well as various sub-samples, with LDCs experiencing the lowest positive effect of productive capacities on economic complexity. Furthermore, the total AfT flows increase economic complexity, including in countries with low levels of productive capacities. Finally, productive capacities have a higher positive effect on economic complexity in countries that receive higher amounts of Non-AfT flows.

This study is presented in four sections. Section 2 presents a theoretical discussion on the effect of productive capacities and AfT flows on economic complexity. Section 3 presents the empirical analysis and establishes the model specification, presents the data analysis, and discusses the econometric approach to estimate this model. Section 4 interprets the empirical results, and Section 5 concludes.

8) Apart from studies cited above concerning the effect of economic complexity on economic growth and development, other studies on the macroeconomic effects of economic complexity have focused of economic complexity on income inequality (e.g., Hartmann et al., 2017; Le Caous and Huarng, 2020; Lee and Vu, 2020), improve human development (e.g., Le Caous and Huarng, 2020), economic growth volatility (e.g., Güneri and Yalta, 2020; Maggioni et al., 2016; Miranda-Pinto, 2021), economic growth cycles (e.g., Canh and Thanh, 2020), labor share (Arif, 2021), and poverty (Gnangnon, 2021a).

II. Theoretical framework

This section discusses how, from a theoretical perspective, both productive capacities (sub-section 2.1) and AfT flows (sub-section 2.2) could influence economic complexity.

A. Effect of productive capacities on economic complexity

As noted earlier, the concept of “productive capacities,” as defined by the UNCTAD (UNCTAD, 2006; 2020b), has three dimensions-productive resources, entrepreneurial capabilities, and production linkages-that together determine a country's capacity to produce goods and services and facilitates growth and development. Productive resources include physical capital (e.g., hard and soft infrastructure and machinery and equipment) and resources accumulation (e.g., human capital accumulated and natural resources) used by productive firms and farms to expand the range of goods and services produced. Entrepreneurial capabilities encompass skills, knowledge, and information available to enterprises to mobilize productive resources to transform inputs into outputs, and become competitive or enhance their competitiveness, to invest, innovate, upgrade products and their quality, and even create markets (UNCTAD, 2006: 64). Entrepreneurial capabilities also include entrepreneurship and technological capabilities that shape the complex interaction of individual firm/farm with the macroeconomic environment (Lall, 1992; UNCTAD, 2018, 2020b). Production linkages are the flows of goods and services, knowledge, technology and information, and productive resources (notably human resources) among productive units (firms/farms). These linkages involve exchanges among firms/farms located in different sectors with different sizes and ownership (UNCTAD, 2020b). UNCTAD (2020b: Chapter 3, Annex A) and UNCTAD (2021) describe the methodologies used computing the overall productive capacities, including its eight components.

A country's fundamentals, shaped by its endowments of physical and human capital, labor, and natural resources, and the quality of its institutions, determine the relative costs and patterns of specialization (Hausmann et al., 2007). As noted earlier, a country's level of economic complexity is characterized by the “knowledge” materialized in its productive structure (e.g., Hausmann and Hidalgo, 2014; Hausmann and Hidalgo, 2009; Hidalgo et al., 2007; Utkovski et al., 2018). Moreover, a country's knowledge endowment that affects its capacity to produce (and export) goods and services forms the basis of its productive capacities. Productive capacities encompass productive resources (through physical and resource accumulation), entrepreneurial capabilities (developed through technological learning and innovation), and production linkages (through backward and forward linkages that arise from greater specialization of firms and farms and division of labor) that determine a country's capacity to produce goods and services. According to the UNCTAD (Chapter 2, p 31), greater productive capacities lead to a dense

and complex economy. Therefore, strengthening productive capacities appear to induce greater economic complexity, i.e., greater economic sophistication. Then, how can the strengthening of productive capacities help promote economic sophistication?

Developing productive resources requires investment in both physical and social infrastructure (i.e., human capital through education and health). Improving physical infrastructure implies investing in energy, transport, and communications (i.e., information, communication, and technology (ICT) tools, which form the backbone of the digital economy). Physical infrastructure helps reduce trade costs and promote firms' competitiveness in export markets (e.g., Djankov et al., 2010; Francois and Manchin, 2013; Helble, 2014; Limao and Venables, 2001; Olarreaga, 2016; Portugal-Perez and Wilson, 2012). Similarly, Olarreaga (2016) and Portugal-Perez and Wilson (2012) showed that communications infrastructure, including ICTs, help reduce trade costs and generate higher trade flows. Dennis and Shepherd (2011) and Beverelli et al. (2015) theoretically and empirically demonstrated that infrastructure development that facilitates trade encourages export product diversification, including at the extensive margins. Sepehrdoust et al. (2019) noted the critical role of infrastructure in promoting economic sophistication. Moreover, several empirical studies⁹⁾ have highlighted that greater access to the ICTs, notably the Internet, enhances trade flows and promotes both export product diversification (e.g., Visser, 2019) and services export diversification (e.g., Gnanngnon, 2020a). Lapatinas (2019) empirically found that by facilitating the creation of new products, and hence acceleration of productive capacity, greater access to the Internet contributes to greater economic sophistication, i.e., economic complexity. In fact, access to the Internet allows firms to benefit from a wide range of knowledge information (information on clients, suppliers, and competitors) and ideas (e.g., Arthur, 2007; Paunov and Rollo, 2016). This could facilitate generating new export products (e.g., Krugman, 1979; Grossman and Helpman, 1989), including sophisticated ones, and benefit small firms, in particular (e.g., Acs et al., 1994). Similarly, enabling informal firms greater access to the Internet allows them to overcome key barriers (e.g., limited resources) that hamper their ability to build knowledge networks and innovate (e.g., Jensen, 2007). These explain why promoting access to the Internet increases the number of innovating firms and enhances inclusive innovation in emerging and developing countries (e.g., OECD, 2015; Paunov, 2013). In turn, as innovation promotes export product diversification (e.g., Chen, 2013), one can expect that the Internet and ICT tools could promote export product diversification toward highly sophisticated goods. Moreover, Cirera et al. (2015) used firm-level data concerning Brazil to show that innovative efforts play a key role in explaining firms' export diversification. Thus, we can expect that physical infrastructure would be positively associated with economic complexity.

Studies have also underlined that human capital development is essential for economic

9) These works include, for example, Abeliatsky and Hilbert (2017); Freund and Weinhold (2002); Freund and Weinhold (2004); Gnanngnon and Iyer (2018); Lin (2015); Osnago and Tan (2016) and Vemuri and Siddiqi (2009).

sophistication. As noted earlier, human capital development contributes to determining the type of goods (and services) that a country can export (e.g., Hausman et al., 2007). This argument is supported by many empirical studies on the macroeconomic determinants of export product diversification (e.g., Agosin et al., 2012; Giri et al., 2019; Gnanngnon, 2019, 2020a, 2020b; Gnanngnon & Roberts, 2017; Osakwe et al., 2018; Zhu & Fu, 2013). For example, countries endowed with low-skilled workers are likely to export goods and services that require low-skilled human resources, while countries with highly developed skills could export highly sophisticated goods (and services). Therefore, enhancing human capital could encourage the development of new and sophisticated products and enhance economic complexity. Lapatinas and Litina (2019) obtained empirical evidence that countries whose populations enjoy a high-intellectual quotient produce and export more complex goods.

Given the potential positive effect of innovation on economic complexity, and given that knowledge development is at the heart of the complexification of economies, it can be argued that improved entrepreneurial capabilities contribute to greater economic sophistication (e.g., Caldarelli et al., 2012; Cristelli et al., 2015; Hausmann et al., 2014; Hausmann & Hidalgo, 2009; Hidalgo et al., 2007).

Finally, enhanced production linkages are likely to facilitate the complexification of economies (UNCTAD, 2020b - Chapter 2). Production linkages permit the flows of goods and services, knowledge, technology and information, and productive resources (including human resources) (UNCTAD, 2020b). Hence, strengthening production linkages would promote the exchange of ideas, innovation, and development of new products with high value added, which could ultimately result in greater economic complexification. Production linkages require, *inter alia*, development of the private sector, accompanied by sound policies and strong institutions to facilitate exchanges among firms in different sectors.

According to UNCTAD (2020b), developing the private sector involves facilitating their access to domestic credit, which means development of the domestic financial sector; reducing the time to export and import; ensuring the enforcement of contracts; reducing the number of days required to start a business; reducing the cost to export a container; and developing policies that encourage submission of trademarks applications and patent applications (see UNCTAD, 2020b: Chapter 3, Annex A, page 91). Overall, developing the private sector here entails facilitating firms' access to domestic credit, developing a business-friendly environment, and promoting innovation. Thus, discussing the effect of the private sector implies examining how facilitating firms to credit in the domestic financial sector, developing an environment conducive to business, and promoting innovation would facilitate the development of complex products.

Trade facilitation, which involves, *inter alia*, reducing time to export and import, promotes firms' exports (e.g., Hendy & Zaki, 2021) and particularly enhances export product diversification (e.g., Beverelli et al., 2015; Dennis & Shepherd, 2011), which, in turn, promote economic complexity.

Besides, the development of a business-friendly environment strengthens firms' innovation performance (e.g., Wu et al., 2015), which increases the level of economic complexity. A better institutional and governance quality fosters export product upgrading (e.g., Omgba, 2014; Zhu & Fu, 2013). Therefore, an environment conducive to the development of business activities, including those related to international trade, may foster economic complexity.

Nguyen et al. (2020) empirically tested whether innovation, measured by the number of patents (i.e., the amount of explicit knowledge), influences economic complexity, the latter reflecting the amount of productivity knowledge accumulated by a country. They found a strong positive effect of innovation on economic complexity.

Regarding the effect of firms' access to credit provided by domestic financial sector on economic complexity (i.e., the effect of deepening the domestic financial system on economic complexity), studies have noted that financial development could help countries export complex products if financial resources allocated by banks to trading firms were used to produce and export high value-added products (e.g., Agosin et al., 2012). However, if those financial resources were invested in the production and export of existing goods and services (that are of low value added, such as primary commodities) in which the country has a competitive advantage, then financial development would be negatively associated with economic complexity (e.g., Agosin et al., 2012). Nguyen et al. (2020) reported that an oversized financial sector does not promote economic complexity; rather, the financial markets' efficiency positively drives economic complexity. In turn, Nguyen and Su (2021) revealed that financial institutions and markets, including depth, access, and efficiency, have a strong positive effect on economic complexity.

Against this backdrop, a strong private sector may be associated with the development of complex export products.

Narrowly defined, structural change in the production of an economy (also referred to as "structural transformation") reflects the reallocation of economic activity across three broad sectors (i.e., agriculture, manufacturing, and services) that accompanies the process of modern economic growth (Herrendorf et al. 2014, p. 857). This involves moving productive resources from low- to high-complexity activities (e.g., Sørensen et al., 2020). McMillan and Verduzco-Gallo (2014) showed high productivity gains are associated with structural change. Against this backdrop, greater structural change in production would be associated with greater economic complexity. This is more likely insofar as goods exports strongly reflect domestic production for manufacturing sectors or sectors related to physical goods (Saltarelli et al. 2020).

Overall, the development and strengthening of productive capacities are likely to lead to greater economic complexity. The overall productive capacity index developed by the UNCTAD (see UNCTAD, 2020b) contains eight components, which reflect the three dimensions of productive capacities highlighted earlier, namely, productive resources, entrepreneurial capabilities, and production linkages. These eight indicators include ICTs, energy, transport, structural

change, natural capital endowment, human capital, the private sector, and institutional quality. Thus, all indicators except for the natural resources' indicator would be positively associated with economic complexity. The effect of natural resources on economic complexity could depend on whether countries rely on these resources to produce highly sophisticated goods or whether such resources hinder their ability (e.g., through the Dutch disease phenomenon) to diversify export products away from low value-added and toward complex goods (e.g., Bahar & Santos, 2018; Djimeu & Omgba, 2019; Ross, 2019). Using the rents extracted by natural resource-dependent countries from domestic sales and export of natural resources products to expand the range of export products (by producing and exporting products with higher value added) would contribute to the economic complexity. Briefly, while dependence on natural resources could positively or negatively influence economic sophistication, the other components of the overall productive capacity index would likely positively influence economic complexity.

B. Effect of aft flows on economic complexity

Studies on the effect of AfT flows have usually used the categorization of AfT flows by the OECD, which distinguishes three main components, including AfT flows related to economic infrastructure,¹⁰⁾ AfT flows aiming at fostering productive capacities,¹¹⁾ and aid dedicated to trade policy and regulations.¹²⁾ Therefore, examining the effect of total AfT flows on economic complexity implies considering the effect of the three components on economic complexity. The effect of AfT flows on export product diversification follows a theoretical rationale: AfT flows for economic infrastructure, including soft and hard infrastructure, could reduce trade costs (e.g., Busse et al., 2012; Cali & TeVelde, 2011; Portugal-Perez & Wilson, 2009; Vijil & Wagner, 2012) and, hence, promote the export of complex products, because developing infrastructure such as roads, ports, and energy reduces trade costs and improves trading firms' competitiveness. It also provides incentives to firms to invest on R&D and other activities aimed at identifying new export products, including complex ones. Similarly, improving people's access to ICT tools could reduce transaction costs, support knowledge improvement and innovation, and lead to the export of complex products. Therefore, higher AfT flows for economic infrastructure could lead to greater economic complexity. AfT for trade policy and regulation helps facilitate the movement of trade flows across borders by improving the border and transport efficiency by reducing the time, cost, and number of documents required in export and import procedures (e.g., Anderson & Marcouiller, 2002; Busse et al., 2012; Cali and TeVelde, 2011; Helble et al., 2012; Sohn, 2013; Portugal-Perez and Wilson, 2009, 2012; Wilson et al., 2003, 2005). AfT

10) This category of AfT covers transport and storage, communications, and energy generation and supply.

11) AfT for productive capacities covers the sectors of banking and financial services, business and other services, agriculture, fishing, industry, mineral resources and mining, and tourism.

12) This type of AfT flows concerns trade policy and regulations, as well as trade-related adjustment interventions.

related to trade policy and regulation also helps in building the capacity of recipient countries' trade policymakers, which occurs through the WTO's technical assistance and capacity-building activities and other organizations involved in trade activities. Policymakers have trade policy tools that help comply with their country's commitments to the WTO and develop an export strategy conducive to sustainable development. Gnanngnon (2018) found that higher AfT flows for trade policy and regulation are associated with greater trade policy liberalization. As trade policy liberalization can also lead to greater economic complexity (e.g., Sepehrdoust et al., 2019; see also the discussion on the effect of trade openness on economic complexity), it follows that an increase in AfT flows would promote economic complexity.

AfT for building productive capacity directly targets productive sectors to expand the range of products and services exported by recipient countries. Such AfT flows would result in greater economic sophistication if they were used to encourage the diversification of the export products basket of the recipient countries toward increasingly high value-added products. However, if AfT for productive capacity was allocated to the production of goods (and services) in which the country already has a competitive advantage, it would result in lower economic complexity, as such AfT flows would not help add significant value to the range of products exported by the recipient-country. Overall, theoretically, higher total AfT flows would be associated with greater economic complexity.

Some empirical studies have considered the effect of AfT flows on export product diversification, which is an important aspect of economic complexity. Gnanngnon (2019a) examined the effect of total AfT flows on export product diversification but not the effect of the components of total AfT flows on export product diversification. The analysis revealed that the total AfT flows promote export product diversification, in both LDCs and Non-LDCs. Kim (2019) investigated the effect of both total AfT flows and the components of the latter on export product diversification and found that the total AfT flows are associated with greater export product diversification only in the short run, not in the long term. Among the components of total AfT flows, only AfT for productive capacity building positively affects export product diversification. Interestingly, Kim (2019) extended the analysis by exploring whether AfT flows matter for economic complexity and found that neither total AfT nor its components significantly influence economic complexity. Gnanngnon (2019b) investigated the structural policies that matter for the effect of total AfT flows on export product diversification and found that the total AfT flows promote export product diversification in countries that liberalize trade policies, experience greater openness of the capital account, or enjoy better institutional and governance quality. In contrast, in countries that are financially developed, AfT flows tend to result in greater export product concentration. Gnanngnon (2019c) also considered the effect of total AfT flows on export structure in the recipient countries, where export structure has been measured not by an index of export product diversification but by different export ratios, such as the

ratio of exports of low-skilled and technology-intensive manufactures to total primary export products (LOW), the ratio of exports of medium-skilled and technology-intensive manufactures to total primary export products (MEDIUM), and the ratio of exports of high-skilled and technology-intensive manufactures to total primary export products (HIGH). For the full sample, empirical results have shown that the total AfT inflows are associated with an increase in the ratios “LOW” and “HIGH” but no significant effect on the ratio “MEDIUM.” By contrast, over LDCs, total AfT flows increase the ratio “LOW” but decrease the ratios MEDIUM and HIGH.

In addition to the theoretical effects of AfT flows on economic complexity, AfT flows influence countries' level of economic complexity by influencing foreign direct investment (FDI) inflows and the real exchange rate channel. As regards the FDI inflows channel, some studies have reported a positive effect of AfT flows on FDI inflows to AfT recipients (e.g., Donaubauer et al., 2016; Lee & Ries, 2016; Ly-My & Lee, 2019). However, as FDI inflows can be an important vehicle of acquisition and transfer of knowledge, they positively influence economic complexity. FDI inflows can help enhance economic sophistication through (backward) linkages from foreign firms to domestic suppliers (e.g., Görg & Greenaway, 2004; Görg & Srobl, 2001; Gorodnichenko et al., 2020; Hu et al., 2021; Javorcik, 2004; Newman et al., 2015; Smeets, 2008). For example, Gorodnichenko et al. (2020) showed that FDI flows exert positive spillover effects on product and technology innovation by domestic firms in emerging markets, with these effects occurring essentially for domestic firms engaged directly with multinationals and involved in international trade. Hu et al. (2021) have found that FDI inflows from China have contributed to technological progress in Africa, although not for non-Chinese FDI. Interestingly, the authors found that South-South FDI has strongly contributed to technological progress in the host country. Newman et al. (2015) empirically demonstrated that higher FDI inflows are associated with direct transfers of knowledge/technology between foreign-owned and domestic firms along the supply chain. These generate direct productivity gains through forward linkages for domestic firms to which foreign-owned firms provide inputs. Additionally, there are indirect vertical productivity spillovers from FDI inflows in host countries.

Incidentally, Gnangnon (2021b) provided empirical evidence that AfT flows are associated with depreciation of the real exchange rate in recipient countries. As the depreciation of the real exchange rate is likely to be associated with greater export product diversification (e.g., Guzman et al., 2018; Sekkat, 2016; Sekkat & Varoudakis, 2000; Tran et al., 2017), we postulate that increased AfT flows have the same effect.

Therefore, higher AfT flows can be associated with greater economic complexity, with a stronger effect on LDCs among AfT-recipient countries than in others.

III. Empirical Analysis

This section, first, specifies the model for empirical analysis. Second, it presents data analysis of the key variables, namely, the index of overall productive capacities, the indicator of economic complexity, and total AfT flows. Third, it discusses the empirical approach to estimate the model and its variants.

A. Model specification

Contrary to the studies on the macroeconomic determinants of export product diversification, few studies have investigated the macroeconomic determinants of economic complexity (e.g., Chu, 2020; Hausmann et al., 2007; Hausmann & Hidalgo, 2014; Lapatinas, 2019; Lapatinas & Litina, 2019; Nguyen et al., 2020; Nguyen & Su, 2021; Saadi, 2020; Sepehrdoust et al., 2019). Our baseline model specification draws from these studies and includes a set of control variables that influence the effect of these key variables on economic complexity, apart from our main variables of interest (viz., the indicators of productive capacities, i.e., overall productive capacities and its components and total AfT flows). These control variables are development aid flows other than AfT flows, referred to as Non-AfT flows, and denoted “NonAfTTOT;” the real per capita income (“GDPC”) that reflects the economic development level, the level of trade openness (“OPEN”), the population size¹³) (“POP”) (which captures the country's size), and terms of trade (“TERMS”).

The baseline model takes a dynamic form and is as follows.

$$\begin{aligned}
 ECI_{it} = & \beta_1 ECI_{it-1} + \beta_2 PRODCAP_{it} + \beta_3 \text{Log}(AfTTOT)_{it} \\
 & + \beta_4 \text{Log}(NonAfTTOT)_{it} + \beta_5 NoAfTDum_{it} + \beta_6 \text{Log}(GDPC)_{it} \\
 & + \beta_7 OPEN_{it} + \beta_8 \text{Log}(POP)_{it} + \beta_9 TERMS_{it} + \vartheta_t + \mu_i + \epsilon_{it}
 \end{aligned} \tag{1}$$

i and t refer to a country and the time period, respectively. All variables contained in model (1) are described in Appendix 1. The dependent variable “ECI” is the index of economic complexity. It has been computed using the formula for economic complexity developed by Hausmann and Hidalgo (2009). It reflects the diversity and ubiquity of a country’s export structure. Higher values of this index indicate a greater level of economic complexity. The “ECI” indicator has been extracted from the MIT’s Observatory of Economic Complexity

13) We have used the population density variable in replacement for the population size variable (which has been used in the studies on the determinants of export diversification) to capture precisely both the geographic potential of countries and size of labour (e.g., Chu, 2020; Lapatinas & Litina, 2019). We found that results do not change qualitatively and quantitatively.

(<https://atlas.media.mit.edu/rankings>).

The first key regressor of interest “PRODCAP” is the measure of the level of productive capacities, which can be either the overall productive capacities or each of the eight components of the latter. We denote “PCI” as the index of the overall productive capacities. Its components include human capital (denoted “HUMCAP”), natural capital (denoted “NATURAL”), energy (denoted “ENERG”), transport (denoted “TRANSP”), ICTs (denoted “ICT”), the private sector (denoted “PRIVATE”), institutions (denoted “INST”), and the extent of structural change in output (denoted “SCI”). The variable “AftTOT” represents the total real gross disbursements of Aid for Trade flows, expressed in constant prices 2018, US Dollar. Following Cali and Te Velde (2011), the dummy variable “NoAftDum” is introduced in the baseline model specification to account for countries that are not recipients of AfT flows. Thus, we are able to include in our full sample both AfT-recipient countries and non-Aft-recipient countries. Non-Aft-recipient countries include mainly high-income countries, based on the countries' classification by the World Bank; of which, “old-industrialized countries¹⁴)” are considered “developed countries.” Moreover, the inclusion of this dummy variable in the analysis allows examining the effect of productive capacities on economic complexity not over the restricted sample of AfT recipients but over a larger sample comprising both AfT recipients (denoted “AftREC”) and high-income countries, particularly, our so-called old-industrialized countries (denoted “OLDIND”). The “NoAftDum” variable takes the value “1” for countries that do not receive AfT flows, and “0,” otherwise.

The panel dataset used to conduct the empirical analysis covers 126 countries, including AfT-recipient countries and Non-AfT-recipient countries, and the period 2002-2018. The dataset has been averaged over 3-year nonoverlapping sub-periods: 2002-2004, 2005-2007, 2008-2010, 2011-2013, 2014-2016, and 2017-2018 (this last sub-period covers 2 years). β_1 to β_9 are coefficients to be estimated. μ_i represent the countries' time-invariant specific effects. λ_t are the time-period dummies (i.e., period-specific effects) and denote shocks that affect simultaneously all countries' ability to develop complex economies. ϵ_{it} is a well-behaving error term.

Appendices 2A and 2B report descriptive statistics on all variables used in the analysis (i.e., those contained in the baseline model (1) and those used later in the analysis, respectively, over the full sample, and over the restricted sample of AfT recipients. Appendices 3A and 3B contain the list of countries, respectively, in the full sample and the restricted sample of AfT recipients. Appendix 3C displays the list of countries contained in the sub-samples of HICs, OLDIND, and LDCs.

Regarding the expected theoretical effects of control variables, we expect that a rise in the

14) We consider countries that were founding members of the Organisation for Economic Co-operation and Development (OECD) as “old-industrialized countries.”

real per capita income would be positively associated with economic complexity, particularly if the rise in the real per capita income is driven by exports of increasingly sophisticated goods rather than by exports of natural resource products.

Non-AfT flows include humanitarian aid and aid allocated for education and health sectors. Studies have shown that higher development aid to the education and health sectors helps to improve education and health in recipient countries (e.g., Birchler & Michaelowa, 2016; Chauvet et al., 2009; Dreher et al. 2008; Kobayashi et al., 2021; Kotsadam et al. 2018; Lewin, 2020) and, hence, enhances human capital, which is essential for ensuring greater productive capacities and economic complexity. Gnanngnon (2021b) has shown that Non-AfT flows are associated with an appreciation of the real exchange rate (i.e., the relative price of the non-tradables to tradables), which is likely to discourage exports of goods and services (e.g., Eichengreen & Gupta, 2013), notably, manufactured exports, and hamper export product diversification (e.g., Guzman et al., 2018; Sekkat, 2016; Sekkat & Varoudakis, 2000; Tran et al., 2017). Consequently, we conjecture that Non-AfT flows may adversely influence the production and export of complex products. Overall, the net effect of Non-AfT flows on economic complexity could be positive or negative, depending on whether the positive effect of these resource inflows on economic complexity through human capital development channel dominates the eventual negative effect of the resource flows through the real exchange rate channel.

Greater trade openness may positively influence economic complexity by supporting the diffusion of knowledge and transfer of technology through imported goods and services (of which the intermediate goods) at lower costs (e.g., Coe & Helpman, 1995; Grossman & Helpman, 1991; Grossman & Helpman, 2015; Navas, 2015). Moreover, through its positive impact on total factor productivity (e.g., Föllmi et al., 2018; Hübler & Pothén, 2017; Melitz 2003; Miller & Upadhyay, 2000), trade openness can induce greater economic sophistication. Sepehrdoust et al. (2019) reported that trade policy liberalization is conducive to greater economic complexity. However, using trade openness as a control variable, Lapatinas (2019) and Lapatinas and Litina (2019) did not find a significant effect of trade openness on economic sophistication.

Finally, improvement in trade would generate greater economic complexity if the export revenue derived from such an improvement was invested to encourage innovation and the development of new products with high knowledge content. Otherwise, improvements in trade would result in lower economic sophistication.

B. Data analysis

UNCTAD (2020b) and UNCTAD (2021) have documented the long-term development of the index of overall productive capacities and its components across countries and groups of countries. Statistical analysis of the index of overall productive capacities and that of economic

complexity for 126 countries was conducted.

Thus, Appendix 2A shows that the values of “PCI” range between 13.94 and 51.03 over the full sample, with a mean of 31.61 and a standard deviation of 7.57. Over the sub-sample of AfT-recipient countries, which consists of developing countries, including LDCs (see statistics reported in Appendix 2B), the maximum and minimum values of “PCI” were 39.77 and 13.94, respectively. The average value and standard deviation of the index of overall productive capacities over this sub-sample are, respectively, 27.65 and 4.93. Concerning the index of economic complexity, its highest value in the full sample was 2.401, while the lowest value amounted to -2.22 , with the standard deviation and the mean being, respectively, 0.980 and 0.038 (see Appendix 2A). Over the sub-sample of AfT-recipient countries (see Appendix 2B), the values of the index of economic complexity range between -2.22 and 1.198, while the average and standard deviation values of this index are -0.41 and 0.74, respectively. As these statistics are based on the dataset of nonoverlapping sub-periods, we find useful the values of the index of overall productive capacities and economic complexity across countries of the full sample in 2018 (the end year of the period of analysis).

The ranking in the descending order of the index of overall productive capacities for 2018 and across countries in the full sample (see the Appendix labeled “Appendix (Other)”) shows that the top 10 countries (i.e., those that exhibited the highest level of the overall productive capacities with PCI values in brackets) are United States (50.51), Netherlands (48.22), Germany (47.38), United Kingdom (46.18), Hong Kong China (45.81), Ireland (45.54), Japan (45.29), Korea (45.21), Singapore (44.46), and France (44.36). These countries display high values of the index of economic complexity, although they do not appear in the top 10 countries in terms of level of economic complexity. The ranking in the descending order of the index of economic complexity for 2018 across countries in the full sample (see the Appendix labeled “Appendix (Other)”) indicates that the top 10 countries (i.e., the first 10 countries that had the highest degree of economic complexity with ECI values in brackets) are Japan (2.34), Switzerland (2.07), Germany (1.94), Korea (1.91), Singapore (1.78), Sweden (1.66), Austria (1.63), United Kingdom (1.52), Finland (1.47), and United States (1.41). For example, the United States, which is ranked first in terms of productive capacities, is now ranked 10th in terms of economic complexity. Countries ranked among the top 10 in terms of both productive capacities and economic complexity are the United States, United Kingdom, Singapore, Korea, and Germany (which was ranked third in terms of the two indices).

Yet, the category of developing countries is heterogeneous. Among them, countries (values of PCI are in brackets) such as China (40.00), India (30.90), and Vietnam (31.71), which are large recipients of AfT flows and known to be considerably upgrading their export products, are ranked 24th, 75th, and 68th, respectively. In terms of economic complexity for three countries (see the value of the economic complexity index in brackets), China (1.15) is ranked

17th, while India (0.44) and Vietnam (0.11) are ranked 42nd and 56th, respectively. LDCs among developing countries are at the bottom of the ladder in terms of productive capacities (see also UNCTAD, 2020b) and economic complexity. Regarding of productive capacities, the top 5 LDCs (i.e., those that displayed the highest level of productive capacities with PCI values in brackets) are Bangladesh (26.85), Cambodia (26.46), Senegal (26.31), Uganda (24.91), and Myanmar (24.49). Bangladesh is ranked 91th and the other four countries are ranked, respectively, 92th (for Cambodia), 93th (for Senegal), 98th (for Uganda), and 99th (for Myanmar). However, regarding economic complexity, the top 5 LDCs are Tanzania (−0.36), Senegal (−0.46), Uganda (−0.55), Zambia (−0.57), and Togo (−0.67), ranked 78, 81, 85, 86, and 90, respectively.

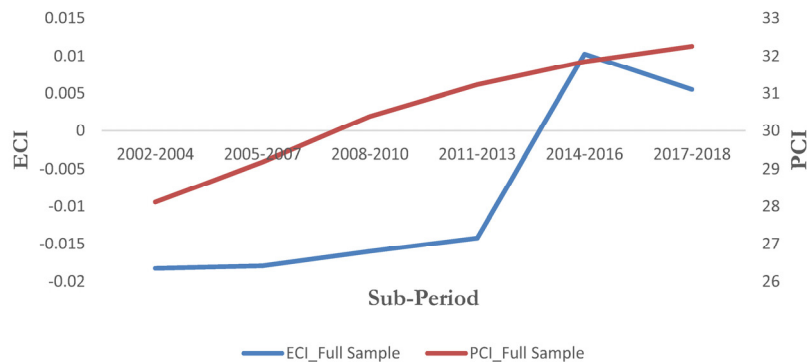
We now explore the behavior of the overall productive capacities, economic complexity, and total AfT flows over several sub-samples.

We display the development of productive capacities and economic complexity over the full sample (Figure 1), the sub-samples of old-industrialized countries (i.e., OLDIND), HICs and AfTREC (Figure 2), and sub-samples of LDCs and the group of “OTHER” countries (i.e., countries among AfT recipients that are not LDCs) (Figure 3). Figure 4 presents the developments of total AfT inflows and that of the share (%) of total AfT flows in the total gross ODA disbursements flows (both being expressed in constant 2018 prices, US\$), denoted “SHAfT,” over the restricted sample of AfT recipients, and the sub-samples of LDCs and Non-LDCs. Figure 5 depicts the cross-plots between the index of overall productive capacity and the indicator of economic complexity over the full sample and the sub-samples “OLDIND,” “HICs,” “AfTREC,” “LDCs,” and “OTHER.” Finally, Figure 6 shows the correlation patterns between the total AfT flows and economic complexity over the restricted sample of AfT recipients and sub-samples of “LDCs” and “OTHER.”

Figure 1 shows that over the full sample, productive capacities displayed an upward trend, that is, they significantly improved over time from an average of 28.12 in 2002-2004 to 32.26 in 2017-2018. The index of economic complexity increased from −0.018 in 2002-2004 to 0.10 in 2014-2016, and then declined to reach the value 0.005 in 2017-2018. These figures reflect various developments of these two indices across sub-samples. Figure 2 shows that while the level of economic complexity of old-industrialized countries exhibited a downward trend (from 1.3 in 2002-2004 to 1.17 in 2017-2018), it remained higher than the average score of economic complexity of HICs taken together (i.e., this group of countries also includes old-industrialized countries) and AfT recipients. For both HICs and AfT-recipient countries, the average scores of the economic complexity index slightly improved from 0.81 in 2002-2004 to 0.92 in 2017-2018 for HICs and from −0.51 in 2002-2004 to −0.41 in 2017-2018 for AfT-recipient countries. On the other hand, the average level of productive capacities steadily increased in both old-industrialized countries and HICs over the entire period but remained slightly higher in old-industrialized countries than in HICs. The level of productive capacities for old-industrialized

countries reached 43.2 in 2017-2018 against 40.2 in 2002-2004 and for HICs, from 36.8 in 2002-2004 to 40.7 in 2017-2018. AfT-recipient countries experience lesser productive capacities than old-industrialized countries and HICs. However, their average level of productive capacities also improved over time from 24.3 in 2002-2004 to 28.6 in 2017-2018.

Figure 1. Developments of productive capacity and economic complexity over the full sample

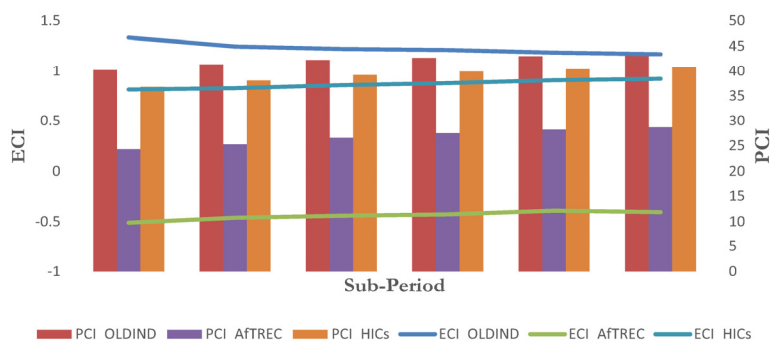


(Source) Author

Figure 3 shows that the index of the overall productive capacities steadily increased over the entire period for both LDCs and the sub-group “OTHER.” The average level of productive capacities in LDCs moved from 19.4 in 2002-2004 to 22.9 in 2017-2018, while for the group “OTHER,” it increased from 26.1 in 2002-2004 to 30.7 in 2017-2018. Both LDCs and Non-LDCs among AfT recipients improved their degree of economic complexity over time, although Non-LDCs enjoyed a higher level of economic complexity than LDCs. The average level of economic complexity increased from -1.26 in 2002-2004 to -1.02 in 2017-2018 for LDCs, and -0.36 in 2002-2004 to -0.19 in 2017-2018 for the sub-group “OTHER.”

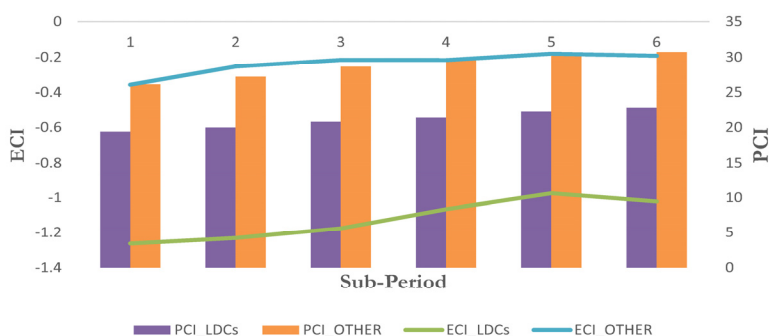
Figures 2 and 3 show that while the level of economic complexity declined in old-industrialized countries, it improved in AfT-recipient countries, and particularly in LDCs, although this level remained higher in old-industrialized countries than in AfT-recipient countries. Meanwhile, the level of productive capacities improved in all three sub-samples, although it was higher in old-industrialized countries than in AfT-recipient countries (it was also lower in LDCs than in AfT-recipient countries).

Figure 2. Developments of productive capacity and economic complexity over the sub-samples of old industrialized countries, HICs and AfT Recipients



(Source) Author

Figure 3. Developments of productive capacity and economic complexity over the sub-samples of LDCs and the group of “OTHER” countries

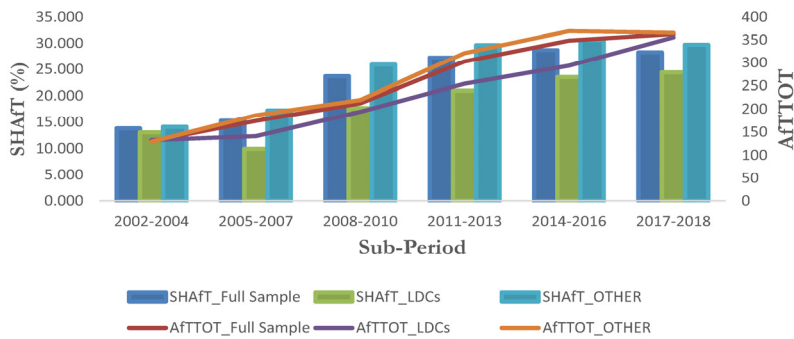


(Source) Author

Note. The sub-sample “OTHER” contains NonLDCs among AfT Recipient countries.

Figure 4 shows that the amounts of total AfT flows consistently increased, on average, over AfT recipients and sub-samples of LDCs and “OTHER.” Over the full sample, the total AfT flows increased from US\$130 million in 2002-2004 to US\$ million 363.2 in 2017-2018. For LDCs, the total AfT flows amounted US\$ million 355.82 in 2002-2004 against US\$ million 132.44 in 2002-2004, while for “OTHER,” these resources inflows reached US\$ million 366 in 2017-2018 against US\$ million 129.1 in 2002-2004. These figures show that the total AfT flows allocated to LDCs increased over time, but remained lower than those provided to AfT recipients that are not LDCs, that is, the sub-group “OTHER.” Concurrently, the share of total AfT flows in total gross ODA disbursements flows (SHAfT) increased from 13.8% in 2002-2004 to 28.25% in 2017-2018 over the full sample. This trend reflects a rise in this share from 13.07% in 2002-2004 to 24.4% in LDCs, while in the sub-group “OTHER,” it increased from 14.1% in 2002-2004 to 30.64% in 2014-2016, but declined to reach 29.7% in 2017-2018.

Figure 4. Developments of total AfT inflows and the share of total AfT flows in total gross ODA flows, over the sample of AfT Recipients, as well as the sub-samples of LDCs and NonLDCs

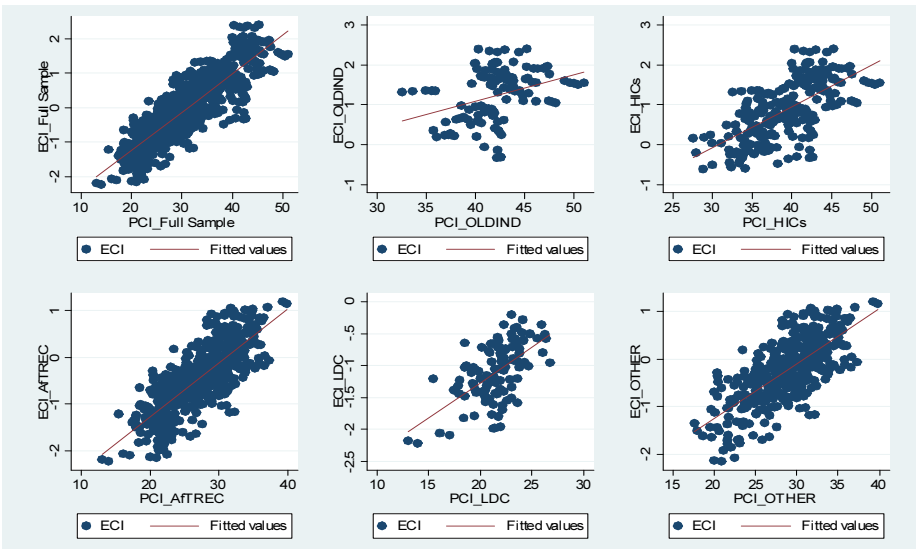


(Source) Author

Note. “AFTTOT” represents the total AfT flows, and is expressed in million US\$, Constant 2018 Prices. “SHAFT” represents the share (%) of total AfT flows in the total gross disbursements ODA flows (both expressed in constant 2018 prices). The sub-sample “OTHER” contains NonLDCs among AfT Recipient countries.

Figure 5 shows positive correlation patterns between the index of economic complexity and that of overall productive capacities over the full sample and all sub-samples, including “OLDIND,” “HICs,” “AfTREC,” “LDCs,” and “OTHER.” Specifically, productive capacities are positively correlated with economic complexity across all sub-samples. Finally, Figure 6 indicates a slightly positive correlation between total AfT flows and economic complexity in the full sample. A similar pattern is observed for the sub-sample “OTHER,” but there is a strong correlation pattern

Figure 5. Cross plot between PCI and ECI over the full sample, HICs, AfTREC, LDCs and OTHER

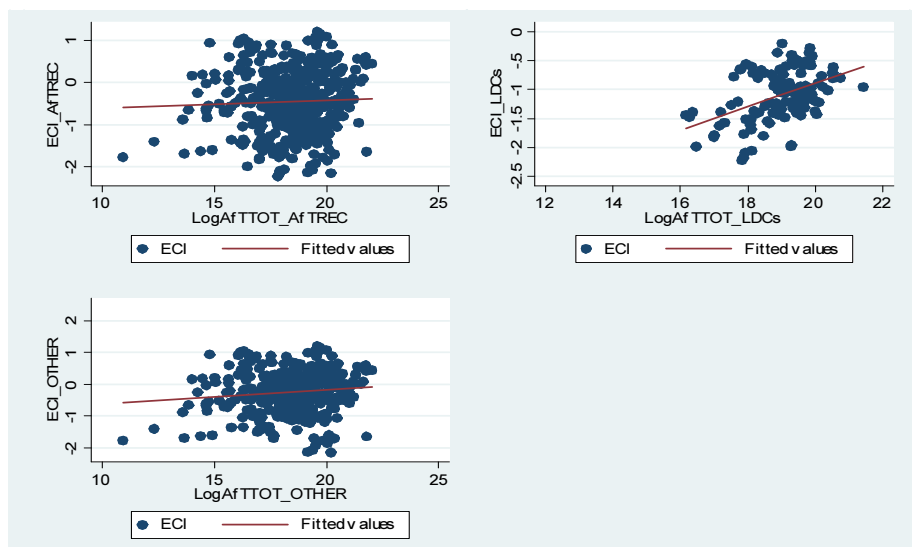


(Source) Author

Note. The sub-sample “OTHER” contains NonLDCs among AfT Recipient countries.

for LDCs between total AfT flows and economic complexity: the slope of the correlation line is higher for LDCs than for the sub-group “OTHER.”

Figure 6. Cross plot between total AfT flows and ECI over AfT Recipients, LDCs and OTHER



(Source) Author

Note. The sub-sample “OTHER” contains NonLDCs among AfT Recipient countries.

C. Econometric approach

This section discusses the econometric approach adopted in the empirical analysis and the method.

1. Econometric approach

This section presents the econometric approach used to address the issues and describes how the empirical analysis is conducted.

Relying on previous studies on the determinants of economic complexity (e.g., Chu, 2020; Lapatinas, 2019) and following previous works on the macroeconomic determinants of export product upgrading (e.g., Agosin et al., 2012; Giri et al., 2019; Gnangnon, 2019a, b; 2020a, b; Gnangnon & Roberts, 2017; Osakwe et al., 2018; Zhu & Fu, 2013), we use the well-known two-step system Generalized Method of Moments (GMM) estimator (see Arellano & Bover, 1995 and Blundell and Bond, 1998) to conduct the empirical analysis. This estimator, which is suitable for dynamics panel datasets featured by a large cross-section and a small-time dimension, allows handling endogeneity problems arising from the correlation between a lagged dependent variable and unobserved time-invariant individual countries’ effects. This estimator

also helps to address the endogeneity bias induced by reverse causality from the dependent variable to the right-hand-side regressors. In this study, this reverse causality can concern the regressors capturing the productive capacities, AfT flows, Non-AfT flows, the real per capita income, trade openness, and financial development (the variables terms of trade and the population size are considered as exogenous). For example, economic complexity can affect productive capacities because countries with less complex economies may be willing to expand their productive capacities to export increasingly complex products to enhance economic resilience to shocks. Donor-countries may also provide higher amounts of AfT and Non-AfT flows to countries having low levels of economic complexity to help improve their degree of economic sophistication. The degree of economic sophistication can also influence countries' level of trade openness. Similarly, less complex economies may wish to deepen domestic financial markets to facilitate access of their domestic trading firms to banks' credit to invest in the production and export of sophisticated goods and services. The two-step system GMM estimator is more efficient than the difference GMM estimator proposed by Arellano and Bond (1991) for persistent series, because with the difference GMM estimator, lagged levels of persistence series are weak instruments for subsequent first-difference series. Employing the two-step system GMM approach entails estimating a system of equations that includes an equation in differences and one in levels. Lagged first differences are used as instruments for the equation in levels, and lagged levels of variables are used as instruments for the first-difference equation. The consistency of the two-step system GMM estimator relies on the nonrejection of the hypotheses of the presence of first-order serial correlation in the error term (denoted AR(1)), the absence of second-order autocorrelation in the error term (denoted AR(2)), and the Sargan test of overidentifying restrictions of the joint validity of instrumental variables. Additionally, the number of instruments used in the regressions should be lower than the number of countries (e.g., Roodman, 2009). To ensure that these conditions are met for the consistency of the two-step system GMM estimator, the regressions use a maximum of three lags of the dependent variables and four lags of endogenous variables as instruments.

2. Conduct of the empirical exercise

Although the two-step system GMM estimator is our preferred estimator for the empirical analysis, we start the latter by running regressions of the static specification of model (1) (i.e., without the lagged dependent variable as a right-hand-side regressor) using the within-fixed-effects estimator. Table 1 contains the results of these regressions performed over the full sample and the restricted sample "AfTREC." It is likely that these results will be biased because of the endogeneity concerns raised earlier (in particular, the concerns arising from the simultaneity bias). However, we presented the outcomes arising from the use of the within-fixed effects to compare those results with those obtained using the two-step system GMM estimator.

The empirical analysis based on the two-step system GMM estimator is conducted as follows. Estimates reported in Table 2 arise from the estimation (over the full sample) of several specifications of model (1) that include, respectively, the index of overall productive capacities and each of its eight components (introduced once in the model). These regressions permit, while controlling for the variable representing total AfT flows, to examine the effect of the index of the overall productive capacities on economic complexity and consider which components of this index significantly influence economic complexity. Results presented in Table 3 are obtained by estimating the same specifications of model (1) but over the restricted sample of AfT-recipient countries.

Results presented in column [1] and columns [3] to [10] of Table 4 allow evaluating how the effect of the overall productive capacities, and its components, on economic complexity varies across countries in the full sample. This involves estimating several variants of model (1) in which the indicator of the overall productive capacities (and alternatively each of its components) is interacted with the real per capita income variable. We additionally present in column [2] of Table 4 the outcomes of the regressions that help investigate whether the effects of both the overall productive capacities and the total AfT flows on economic complexity depend on countries' level of real per capita income. These outcomes are obtained by estimating another specification of model (1) that includes the interaction between the variable capturing the total AfT flows and real per capita income variable on the hand, and on the interaction between the indicator of the overall productive capacities and the real per capita income variable.

While the results in Table 4 show how productive capacities and total AfT flows influence economic complexity across countries in the full sample, it is useful to consider how the overall productive capacities and total AfT flows affect economic complexity over a set of sub-samples.

First, we investigate this effect over HICs versus Non-HICs within the full sample. The outcomes of this estimation (see column [1] of Table 5) are revealed from the estimation of a specification of model (1) that included the dummy "HIC" (it takes "1" for HICs, and "0" for other countries in the full sample) along with the interaction between this dummy and the variable "PCI" (indicator of the overall productive capacities).

Second, within the full sample, we explore the effect of the overall productive capacities on economic complexity over old-industrialized countries versus HICs that are not old-industrialized countries. Thus, we introduce the dummies "HIC" and "HICNOLD" (the latter takes "1" for HICs that are not old-industrialized countries, and "0" for other countries in the full sample) and their respective interaction with the variable "PCI" in model (1). The outcomes of the estimation of this specification of model (1) are reported in column [2] of Table 5.

Third, we examine the effect of the overall productive capacities and total AfT flows (within the full sample) in HICs versus AfT recipients¹⁵⁾ that are not HICs. The specification of model

15) It is important to note that the full sample contains 7 HICs that had been recipients of AfT flows (at least

(1) estimated here is model (1) (without the dummy “NoAfTDum”) in which we introduce the dummy variable capturing AfT-recipient countries that are not classified as HICs (this dummy is denoted “AFTRECIP”) and the interaction of this dummy with the variables “PCI” and “AFTTOT.” The outcomes of the estimation of this model specification are reported in column [3] of Table 5.

Fourth, we consider the sub-sample of all AfT recipients and explore the effect of the overall productive capacities and total AfT flows in LDCs versus Non-LDCs. We estimate another specification of model (1), which is without the dummy “NoAfTDum” in which we introduce the dummy “LDC” (this dummy takes the value “1” for countries categorized as LDCs by the United Nations, and “0,” otherwise) and its interaction with the variable “PCI” and “AFTTOT.” Column [4] of Table 5 contains the estimates arising from the estimation of this specification of model (1). The list of old-industrialized countries, HICs, and LDCs are contained in Appendix 3C.

We conduct a robustness check of results obtained over the full sample by running various regressions of other variants of model (1) yet with the index of overall productive capacities as the measure of “PRODCAP” and total AfT flows, but where the dependent variables are indicators of export product diversification and the quality of existing export products, respectively. These variables represent the key aspects of a country’s economic complexity. We have added the squared term of the real per capita income variable in the model specifications whose dependent variable is the indicator of export product diversification, because the literature has well established a nonlinear relationship between the real per capita income and export product diversification (e.g., Cadot et al., 2011; Imbs & Wacziarg, 2003; Parteka & Tamberi, 2013). Measures of export product diversification used here are the UNCTAD’s Herfindahl-Hirschman index of export product concentration (denoted “EPCUNCT”), and, alternatively, the Theil index of export product concentration (denoted “EPCIMF”) computed by the International Monetary Fund (IMF). Higher values of both indices indicate greater export product concentration, while lower values reflect greater export product diversification. The IMF also computes the index of export quality (“QUALIMF”), with higher values of this index reflecting improved quality of existing export products. The results of the estimation of these specifications of model (1) over the full sample and the restricted sample of AfT-recipient countries are presented in Table 6.

Finally, estimates displayed in Table 7 are related to AfT-recipient countries and help address another key question of the study, that is, whether the effect of productive capacities on economic complexity depends on the amounts of total AfT flows that accrue to recipient countries. We also examine whether the effect of the overall productive capacities on economic complexity depends on the amount of Non-AfT flows that accrue to recipient countries. We obtain these outcomes by estimating a specification of model (1) that includes the interaction between the variable

for some years between 2002 and 2018). These countries are Chile, Croatia, Mauritius, Oman, Panama, Saudi Arabia, and Uruguay.

representing total AfT flows and the index of overall productive capacities and the interaction between the variable representing Non-AfT flows and the index of overall productive capacities.

IV. Empirical Results

In this section, we interpret statistically significant estimates at least at the 5% level. Additionally, for the sake of simplicity, and unless otherwise stated, we henceforth use the expression “productive capacities” in reference to “the overall productive capacities,” “AfT flows” in reference to “total AfT flows,” and “Non-AfT flows” in reference to “total Non-AfT flows.”

1. Results in Table 1

Table 1 shows that improving productive capacities positively and significantly (at the 1% level) influences the economic complexity in the full sample and the sample of AfT-recipient countries. Interestingly, the magnitude of this positive effect is higher for the sub-sample of AfT-recipient countries (0.05) than for the full sample (0.035). Similarly, an increase in AfT flows induces greater economic complexity (the coefficients of the variable “AfTTOT” are positive and significant at the 1% level) with a coefficient of 0.043 in column [1] and 0.036 in column [2] of Table 1. Non-AfT flows negatively and significantly influence economic complexity. We find, about other control variables, that the real per capita income is positively and significantly associated with economic complexity over the full sample and the AfT-recipient countries. Trade openness positively and significantly (at the 1% level) influences economic complexity over the full sample and AfT-recipient countries, and the magnitude of this positive effect is similar across the two samples. Finally, improvements in terms of trade are negatively and significantly associated with economic complexity, and the population size does not significantly (at the 5% level) influence economic complexity over the full sample and the sub-sample of AfT recipients.

Considering the estimates in Tables 2-7, we find that in all columns the lagged dependent variable holds coefficients that are positive and significant at the 1% level. This shows the nature of state dependence of the indicator of economic complexity, and hence the need for considering a dynamic specification when examining the relationship between productive capacities and economic complexity (specifically short-term versus long-term effects of regressors, including used in the analysis). All specifications whose results are presented in Tables 2-7 pass¹⁶⁾ the AR(1) and AR(2) tests and the Sargan test on the joint validity of instrumental

16) The consistency of the two-step system GMM estimator rests on *p*-values related to the AR(1) test being lower than 0.10 (at the 10% level), *p*-values associated with the AR(2) test being higher than 0.10 (at the 10% level), and the Sargan test statistics should be higher than 10% (at the 10% level).

variables. Based on these outcomes, we conclude that the two-step system GMM estimator is acceptable for conducting the empirical analysis.

Table 1. *Effect of productive capacities on economic complexity over the full sample and AfT Recipients Estimator: Within Fixed Effects*

Variables	Full Sample	AfT Recipients
	ECI	ECI
	(1)	(2)
PCI	0.0345*** (0.00497)	0.0493*** (0.0124)
Log(AfTTOT)	0.0431*** (0.0106)	0.0306*** (0.00531)
Log(NonAfTTOT)	-0.103*** (0.0236)	-0.0953*** (0.0185)
Log(GDPC)	0.00173*** (0.000241)	0.00230*** (0.000314)
OPEN	0.127*** (0.0234)	-0.0184 (0.0413)
Log(POP)	-0.0413 (0.0364)	0.123* (0.0710)
TERMS	-0.00187*** (0.000530)	-0.00187*** (0.000686)
Constant	-0.548 (0.464)	-2.304*** (0.766)
Observations - Countries	700 - 126	486 - 90
Within R ²	0.2532	0.2723

Note. **p*-value<0.1; ***p*-value<0.05; ****p*-value<0.01. Robust standard errors are in parenthesis. The dummy variable “NoAfTDum” has not been included in the regressions whose results are reported in column [1] of Table 1 because it is time-invariant..

2. Results in Table 2

Estimates in column [1] of Table 2 show that improvement in productive capacities is positively and significantly associated with economic complexity. Thus, a 1-point increase in the index of overall productive capacities is associated with a 0.06-point increase in the index of economic complexity. The magnitude of this effect is far lower than the one reported in Table 1. Simultaneously, we find no significant effect of AfT flows on economic complexity, which may indicate the existence of a joint effect of productive capacities and AfT flows on economic complexity. This finding does not align with the estimate in column [1] of Table 1 (results are based on the fixed effects estimator), where a positive effect of AfT flows on economic complexity is found. Nonetheless, across all other columns of Table 2 (i.e., when each component of the index of overall productive capacities in model (1) is included), the AfT flows are found exert a positive and significant effect on economic complexity. This contradicts the finding by Kim (2019) that AfT flows exert no significant effect on economic

complexity. While the model specification considered by Kim (2019) did not contain a measure of productive capacities, the baseline model of this study includes an indicator capturing countries' level of productive capacities.

The coefficients of the components of the index of overall productive capacities reported in columns [2] to [10] (with exception of column [5]) are positive and significant, while that in column [5] is not significant. Therefore, we conclude that over the full sample, higher productive resources, including the development of physical infrastructure that enables the provision of energy ("ENERG") and communications ("ICT"), induce greater economic sophistication. Physical infrastructure related to transport ("TRANSP") exerts no significant effect on economic complexity over the full sample. However, dependence on natural resources reduces countries' level of economic complexity, and this may confirm our theoretical hypothesis that natural resource-dependent countries might not invest the rents extracted from natural resources in the production of sophisticated products. Furthermore, human capital enhancement, development of the private sector, and improvement in institutional quality promote economic complexity. Finally, greater structural change in output induces greater economic complexity.

Non-AfT flows negatively and significantly (at the 1% level) influence economic complexity in both column [1] and all other columns of Table 2. This outcome may suggest that the negative effect of Non-AfT flows on economic complexity through the real exchange rate channel likely dominates the potential positive effect of Non-AfT flows on economic complexity through human capital. It may also hide an interaction effect between Non-AfT flows and productive capacities in affecting economic complexity. Regarding the magnitude of this effect, we find (from column [1] of Table 2) that an increase by 100% of the amount of Non-AfT flows is associated with a fall in the value of the index of economic complexity by 0.034 point. Concerning results related to control variables, column [1] of Table 2 shows that countries with a lower real per capita income experience a higher level of economic complexity than those with a higher real per capita income. While this outcome may be surprising, it may reflect the results in Figure 2, whereby the level of economic complexity in old-industrialized countries had been declining while those of AfT-recipient countries and LDCs had been rising. Additionally, this outcome may suggest that the effect of productive capacities, including the components of the latter in recipient countries, on economic complexity depends on the countries' level of real per capita income. This outcome is examined when results presented in Table 3 are considered. Greater trade openness and an increase in the population size positively and significantly influence economic complexity. Finally, improvements in terms of trade negatively and significantly influence economic complexity. The outcomes of control variables in other columns of Table 2 are much similar to those in column [1] of Table 2.

Table 2. Effect of Productive Capacities on Economic Complexity over the Full Sample Estimator: Two-Step System GMM

	Dependent variable: ECI							
	HUMCAP	NATURAL	ENERG	TRANSP	ICT	PRIVATE	INST	SCI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)
ECI _{t-1}	0.520*** (0.0185)	0.641*** (0.0261)	0.726*** (0.0174)	0.591*** (0.0219)	0.729*** (0.0256)	0.690*** (0.0218)	0.656*** (0.0195)	0.666*** (0.0220)
PCI	0.0717*** (0.00563)							
Log(AITTOT)	0.00335 (0.00952)	0.0494*** (0.00939)	0.0449*** (0.00795)	0.0311*** (0.00885)	0.0371*** (0.00835)	0.0515*** (0.00682)	0.0193** (0.00820)	0.0369*** (0.00877)
COMPON		0.0171*** (0.00378)	-0.0195*** (0.00207)	0.0283*** (0.00445)	0.000653 (0.00205)	0.00866** (0.00384)	0.00943*** (0.00126)	0.0567*** (0.00472)
Log(NonAITTOT)	-0.0336** (0.0150)	-0.0823*** (0.0147)	-0.0494*** (0.0157)	-0.0967*** (0.0157)	-0.0737*** (0.0136)	-0.103*** (0.0152)	-0.0885*** (0.0148)	-0.0381** (0.0160)
NoAITDum	-0.735*** (0.276)	-0.824*** (0.276)	-0.0982 (0.251)	-1.237*** (0.291)	-0.708*** (0.256)	-1.107*** (0.229)	-1.281*** (0.262)	-0.533** (0.246)
Log(GDPC)	-0.0981*** (0.0255)	0.0121 (0.0272)	0.0410*** (0.0157)	-0.00151 (0.0297)	0.0710*** (0.0146)	0.0896*** (0.0239)	0.0699*** (0.0235)	0.123*** (0.0215)
OPEN	0.00132*** (0.000380)	0.00205*** (0.000347)	0.00156*** (0.000290)	0.00284*** (0.000356)	0.00210*** (0.000258)	0.00261*** (0.000330)	0.00190*** (0.000307)	0.00290*** (0.000380)
Log(POP)	0.0614*** (0.0163)	0.0291 (0.0179)	0.0418*** (0.0145)	0.0657*** (0.0171)	0.0508*** (0.0107)	0.0954*** (0.0126)	0.0961*** (0.0131)	0.0244** (0.0120)
TERMS	-0.00171*** (0.000212)	-0.00197*** (0.000292)	-0.00155*** (0.000247)	-0.00248*** (0.000282)	-0.00191*** (0.000292)	-0.00222*** (0.000256)	-0.00180*** (0.000229)	-0.00203*** (0.000260)
Observations - Countries	577 - 126	577 - 126	577 - 126	577 - 126	577 - 126	577 - 126	577 - 126	577 - 126
Number of Instruments	85	85	85	85	85	85	85	85
AR1 (p-Value)	0.0132	0.0129	0.0096	0.0112	0.0116	0.0126	0.0105	0.0104
AR2 (p-Value)	0.6805	0.6745	0.5807	0.5932	0.6107	0.5883	0.6161	0.6970
Sargan (p-Value)	0.1463	0.1007	0.1299	0.1076	0.1179	0.1038	0.2078	0.1334

Note. *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables "PCI" and all its components, as well as "AITTOT", "NonAITTOT", "GDPC" and "OPEN" have been considered as endogenous. Time dummies have been included in the regressions. The variable "COMPON" is a component of the index of overall productive capacities.

3. Results in Table 3

Results in Table 3 concerning the effect of overall productive capacities (and the components of the latter), AfT flows, and Non-AfT flows on economic complexity (over the restricted sample of AfT-recipient countries) are consistent with those in Table 2, although with different magnitudes of the effect of these variables. Interestingly, all coefficients related to the variable measuring AfT flows are positive and significant at the 1% level across all columns of Table 3. We conclude that over AfT recipients, economic complexity is positively driven by a higher supply of energy, transport and communications infrastructure, human capital enhancement, development of the private sector, improvement in institutional quality, and greater structural change in production. A higher dependence on natural resources undermines the development of complex export products.

AfT flows do not significantly affect economic complexity in the sub-sample of AfT-recipient countries. This finding contradicts the positive and significant (at the 1% level) effect of AfT flows on economic complexity, as observed in column [2] of Table 1. Moreover, the lack of significant effect of AfT flows on economic complexity over the sub-sample of AfT-recipient countries may reflect an interplay between AfT flows and productive capacities in influencing economic complexity. However, the coefficient of “AfTTOT” is significant in all other columns (except column [7]) of Table 3, although it is negative and significant in column [8] of the same Table. Incidentally, at the 5% level, Non-AfT flows do not significantly affect economic complexity, although the coefficients of this variable are significant at the 1% level in all other columns (except column [8]).

Estimates associated with control variables in Table 3 are, with few exceptions, similar across all columns of this table and are also consistent with those in Table 2.

Table 3. *Effect of Productive Capacities on Economic Complexity over the Sub-Sample of AfT Recipients*
Estimator: Two-Step System GMM

	Dependent variable: ECI								
	HUMCAP	NATURAL	ENERG	TRANSP	ICT	PRIVATE	INST	SCI	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ECI _{t-1}	0.413*** (0.0184)	0.697*** (0.0212)	0.711*** (0.0163)	0.622*** (0.0182)	0.660*** (0.0199)	0.710*** (0.0229)	0.649*** (0.0173)	0.692*** (0.0165)	0.450*** (0.0189)
PCI	0.0952*** (0.00484)								
Log(AfTtOT)	-0.0105 (0.00746)	0.0131** (0.00594)	0.0510*** (0.00486)	0.0144*** (0.00488)	0.0392*** (0.00624)	0.0264*** (0.00444)	0.00841 (0.00787)	-0.0183*** (0.00636)	0.0744*** (0.00424)
COMPON		0.0154*** (0.00213)	-0.0199*** (0.00182)	0.0396*** (0.00258)	0.0185*** (0.00255)	0.0140*** (0.00476)	0.0125*** (0.000937)	0.00984*** (0.00145)	0.0835*** (0.00313)
Log(NonAfTtOT)	-0.0315* (0.0162)	-0.0573*** (0.0115)	-0.0816*** (0.0132)	-0.0843*** (0.0124)	-0.0944*** (0.0128)	-0.113*** (0.0120)	-0.0977*** (0.0129)	-0.0215 (0.0132)	-0.0857*** (0.0128)
Log(GDPC)	-0.132*** (0.0192)	0.0136 (0.0121)	0.0410*** (0.0138)	-0.0667*** (0.0171)	0.0747*** (0.0146)	0.0380* (0.0197)	0.0623*** (0.0153)	0.0486*** (0.0152)	-0.0465*** (0.0178)
OPEN	0.00197*** (0.000390)	0.00223*** (0.000311)	0.00202*** (0.000411)	0.00318*** (0.000560)	0.00286*** (0.000451)	0.00315*** (0.000450)	0.00262*** (0.000374)	0.00234*** (0.000413)	0.00137*** (0.000350)
Log(POP)	0.0846*** (0.0171)	0.0855*** (0.0110)	0.0532*** (0.0170)	0.0692*** (0.0215)	0.103*** (0.0124)	0.114*** (0.0143)	0.133*** (0.0139)	0.106*** (0.0127)	-0.0278*** (0.0101)
TERMS	-0.00166*** (0.000185)	-0.00172*** (0.000153)	-0.00175*** (0.000200)	-0.00230*** (0.000209)	-0.00219*** (0.000235)	-0.00218*** (0.000182)	-0.00155*** (0.000151)	-0.00180*** (0.000172)	-0.000924*** (0.000197)
Observations - Countries	399 - 90	399 - 90	399 - 90	399 - 90	399 - 90	399 - 90	399 - 90	399 - 90	399 - 90
Number of Instruments	75	75	75	75	75	75	75	75	75
AR1 (p-Value)	0.0185	0.0157	0.0150	0.0154	0.0163	0.0164	0.0156	0.0160	0.0125
AR2 (p-Value)	0.7053	0.4760	0.4092	0.3975	0.4552	0.4331	0.4290	0.4703	0.4744
Sargan (p-Value)	0.2883	0.1393	0.3846	0.5128	0.6291	0.2110	0.2583	0.3112	0.5038

Note. *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables "PCI" and all its components, as well as "AfTTOT", "GDPC" and "OPEN" have been considered as endogenous, have been treated as endogenous. Time dummies have been included in the regressions. The variable "COMPON" is a component of the index of overall productive capacities.

4. Results in Table 4

Columns [1] and [2] in Table 4 show that the interaction terms associated with the variable (“PCI*[Log(GDPC)]”) are negative and significant at the 1% level, while the coefficient of “PCI” is positive and significant at the 1% level. These results suggest that over the full sample, there may be a level of the real per capita income above which the effect of productive capacities changes sign and becomes negative. This level of the real per capita income is US\$ 2458 billion [= exponential (0.0893/0.00313)], which is far higher than the maximum value (US\$ 91834.3 - see Appendix 2A) of the real per capita income in the full sample. Thus, on average, over the full sample, productive capacities always exert a positive effect on economic complexity, but the magnitude of this positive effect decreases as countries experience a higher real per capita income. Specifically, lower-income countries experience a higher positive effect of productive capacities on economic complexity than relatively advanced countries in the full sample (Figure 7). Figure 7 shows the development of the marginal effect of productive capacities on economic complexity for different levels of the real per capita income at the 95% confidence intervals.¹⁷⁾ Figure 7 shows that the marginal effect of productive capacities on economic complexity is always positive and significant, but decreases as the real per capita income rises. This confirms the previous finding.

For the sub-sample of AfT-recipient countries, the level of the real per capita income beyond which productive capacities may negatively influence economic complexity is US\$ 1.171 billion [= exponential (0.128/0.00613)], which is also higher than the maximum value of the real per capita income (US\$ 19312.4 - see Appendix 2B) in the sub-sample of AfT-recipient countries. Thus, on average, over the sub-sample of AfT-recipient countries, the overall productive capacities always positively influences economic complexity, but the magnitude of this positive effect decreases as the real per capita income of AfT-recipient countries improves.

Regarding total AfT flows (see column [2] of Table 4), we found that over the sub-sample of AfT-recipient countries, the coefficient of the variable “[Log(AfTTOT)]” is significant at the 5% level, while the interaction variable “[Log(AfTTOT)]*[Log(GDPC)]” has a coefficient that is negative and significant at the 5% level. Together, these two outcomes show, on the one hand, that within the sub-sample of AfT-recipient countries, the effect of AfT flows on economic complexity declines as the real per capita income increases. On the other hand, there seems to be a level of the real per capita income above which the effect of AfT flows on economic complexity changes sign (i.e., becomes negative). This level of the real per capita income is US\$ 3113.4 [= exponential (0.111/0.0138)]. As the values of the real per capita income range are between US\$ 307.45 and US\$ 19312.4 (see Appendix 2B), we deduce that

17) Note that the statistically significant marginal impacts (at the 95% confidence intervals) are determined by the upper and lower bounds of the confidence interval that are either above or below the zero line.

AfT-recipient countries, whose levels of real per capita income range between US\$ 307.45 and US\$ 3113.4, experience a positive effect of AfT flows on economic complexity, with low-income countries enjoying a higher positive effect of AfT flows on economic complexity than relatively advanced countries (among AfT-recipient countries). However, for AfT-recipient countries having a real per capita income higher than US\$ 3113.4, AfT flows negatively and significantly affect economic complexity, and the greater the real per capita income, the higher is the magnitude of the negative effect of total AfT flows on economic complexity. At the first sight, this negative effect of total AfT flows on economic complexity might be surprising. However, it shows that the effect of total AfT flows on economic complexity depends on the concerned country's degree of productive capacities. We analyze this point for verification. Nevertheless, at the 95% confidence intervals, we obtain slightly different findings when we plot the development of the marginal effect of productive capacities on economic complexity for different levels of the real per capita income in the sub-sample of AfT recipients (Figure 8). Particularly, the pattern displayed in Figure 8 is similar to that in Figure 7, whereby the marginal effect of productive capacities on economic complexity is always positive and significant but decreases as the real per capita income rises.

Figure 7. Marginal Impact of “PCI” on “ECI”, for varying levels of real per capita income over the full sample

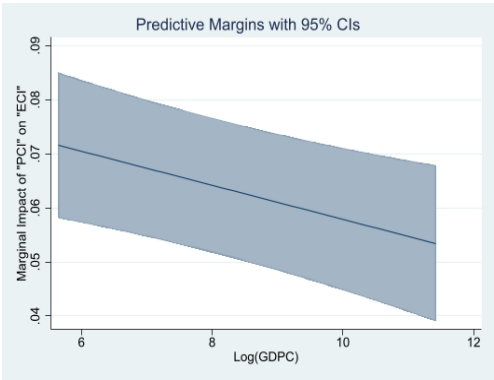
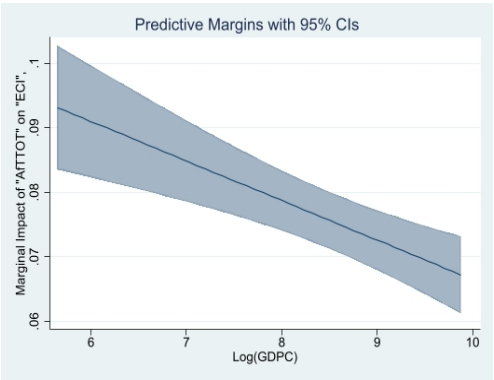


Figure 8. Marginal Impact of “AfTTOT” on “ECI”, for varying levels of “GDPC” over AfT recipients



(Source) Author
Note. The sub-sample “OTHER” contains NonLDCs among AfT Recipient countries.

Regarding the effect of the components of productive capacities on economic complexity for varying levels of the real per capita income (see columns [3] to [10]), we note from columns [4] and [8] that neither the coefficients of the variables [NATURAL] and [PRIVATE] nor the interaction terms associated with the relevant interaction variables are significant at the conventional significance levels, which signify that, on average, there is no significant effect of natural resource dependence and the private sector on economic complexity, although an

analysis on the marginal impact of the natural resource dependence and the private sector on economic complexity for various levels of the real per capita income may show different results.

Regarding the other components of productive capacities, the variables representing human capital, physical infrastructure related to energy, infrastructure for transport, ICTs, and the institutional and governance quality have positive and significant (at the 1% level) coefficients, and their respective interactions with the real per capita income variable display negative and significant coefficients, also at the 1% significance level. Thus, there exists a level of the real per capita income above which the effect of each of these five components of “PCI” changes sign and becomes negative. This turning point of the real per capita income amounts to US\$ 86.52 million [= exponential (0.0318/0.00174)] for the variable “HUMCAP,” US\$ 27352.4 [= exponential (0.0802/0.00785)] for the variable “ENERG,” US\$ 23208.3 [= exponential (0.0577/0.00574)] for the variable “TRANSP,” US\$ 359728 [= exponential (0.0371/0.00290)] for the variable “ICT,” and US\$ 32454.6 [= exponential (0.0536/0.00516)] for the variable “INST.” As the maximum value of the real per capita income in the full sample is US\$ 91834, it follows that physical infrastructure related to energy, transport-related infrastructure, and the institutional and governance quality positive influences economic complexity only when the real per capita income is lower than US\$ 27352.4, US\$ 23208.3, and US\$ 32454.6, respectively. Otherwise, their effect on economic complexity is negative. These outcomes may indicate that what matters for economic complexity is not each component of the index of productive capacities but a joint upward movement of all components of productive capacities, including for countries that are highly dependent on natural resources and with a better use of natural resources rents for the production of sophisticated goods. However, values of the turning point of the real per capita income for “HUMCAP” and “ICT” are higher than the maximum value of the real per capita income in the full sample. This signifies that the human capital enhancement and development of ICTs always have a positive effect on economic complexity, although the magnitude of this positive effect decreases as countries' real per capita income increases.

Estimates related to control variables in Table 4 are consistent with those in Table 2.

Table 4. Effect of the Overall Productive Capacities and its Components on Economic Complexity across Countries in the Full Sample

[illegible]

Table 4. Continued

Variables	Dependent variable: ECI									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Number of Instruments	86	95	86	86	86	86	86	86	86	86
AR1 (P-Value)	0.0116	0.0128	0.0105	0.0098	0.0098	0.0106	0.0120	0.0111	0.0122	0.0098
AR2 (P-Value)	0.6886	0.6014	0.6909	0.5981	0.5800	0.6386	0.6122	0.6156	0.5388	0.6935
Sargan (P-Value)	0.1033	0.6214	0.10	0.1441	0.1583	0.1291	0.1266	0.1195	0.1297	0.1601

Note. *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables "PC1" and all its components, as well as "AfTOT", "NonAfTOT", "GDPC", "OPEN" and the interaction variables have been considered as endogenous. Time dummies have been included in the regressions. The variable "COMPON" is a component of the index of overall productive capacities. Note that the results in column [2] of the Table are obtained from the regression over the sub-sample of AfT recipient countries.

5. Results in Table 5

Considering the outcomes in Table 5, we note from column [1] that at the 5% significance level, productive capacities exert similar effects (in terms of magnitude) on the economic complexity in HICs and Non-HICs, because the coefficient of the interaction variable “HIC*PCI” is not statistically significant at the 5% level, whereas the variable “PCI” holds a positive and significant coefficient at the 1% level. The net effect of productive capacities on economic complexity in both HICs and Non-HICs (i.e., developing countries) amounts to 0.06 (see column [1] of Table 5). Incidentally, results in column [2] of Table 5 indicate that the coefficient of “PCI” is significant at the 1% level, while the interaction terms associated with (“PCI*[OLDIND]”) and (“PCI*[HICNOLD]”) are, respectively, negative and significant at the 1% level, but not at the 10% level. These outcomes suggest that the net effects of productive capacities on economic complexity in old-industrialized countries and HICs that are not old-industrialized amount, respectively, to 0.06 and 0.03 ($= 0.0594 - 0.0286$). Hence, productive capacities exert a higher positive effect (double) on HICs that are old-industrialized countries than on HICs that are not categorized as old-industrialized countries. For old-industrialized countries, including HICs are among the latter, a 1-point increase in the index of productive capacities is associated with a 0.06-point rise in the index of economic complexity. However, for HICs that are not old-industrialized, a 1-point increase in the index of productive capacities is associated with a 0.03-point rise in the index of economic complexity.

In column [3] of Table 5 within the full sample, there is no differentiated effect of productive capacities in HICs versus AfT recipients (notably all AfT recipients, excluding those classified as HICs). The net effect of the overall productive capacities on economic complexity amounts to 0.07 in HICs and AfT recipients alike. However, AfT flows have a higher positive effect on economic complexity in HICs than in AfT recipients (i.e., all AfT recipients not classified as HICs). The net effect of AfT flows on economic complexity in HICs receiving AfT flows is given by 0.035, and the net effect of total AfT flows on economic complexity in AfT-recipient countries that are not HICs amounts to 0.008 ($= 0.0353 - 0.0270$). Overall, HICs receiving AfT flows experienced a much higher positive effect of such AfT flows on economic complexity than other AfT-recipient countries.

Finally, results in column [4] of Table 5 reveal that within AfT-recipient countries, productive capacities exert a positive and similar effect (in terms of magnitude) on the economic complexity in LDCs versus Non-LDCs. Simultaneously, AfT flows exert a greater positive effect on economic complexity in LDCs than in Non-LDCs. The net effects of AfT flows on economic complexity in LDCs and Non-LDCs are, respectively, 0.013 ($= -0.0372 + 0.0500$) and -0.037 . Therefore, AfT flows positively and significantly influence economic complexity in LDCs, but negatively and significantly affect economic complexity in Non-LDCs among AfT-recipient countries. This negative effect of AfT flows on economic complexity in Non-LDCs (among

AfT-recipient countries) is not surprise as we found from column [2] of Table 4 that the negative effect of AfT flows on economic complexity is positive for low-income countries and negative for relatively advanced countries among AfT-recipient countries (i.e., this effect becomes negative for AfT-recipient countries whose real per capita income exceeds US\$ 3113.4, and its magnitude rises as the real per capita income increases). The interpretation of this outcome in column [2] of Table 4 applies here as well.

Table 5. *Effect of the Overall Productive Capacities on Economic Complexity over Sub-samples*
Estimator: Two-Step System GMM

	HICs versus NonHICs	OLDIND versus HICs that are not OLDIND	HICs versus AfT Recipients that are not HICs	LDCs versus NonLDCs (among AfT Recipients)
Variables	ECI	ECI	ECI	ECI
	(1)	(2)	(3)	(4)
ECI _{t-1}	0.537*** (0.0204)	0.545*** (0.0207)	0.528*** (0.0180)	0.447*** (0.0243)
PCI	0.0595*** (0.00581)	0.0594*** (0.00531)	0.0689*** (0.00697)	0.0776*** (0.00540)
Log(AfTTOT)	0.0149* (0.00837)	0.0105 (0.00729)	0.0353*** (0.0103)	-0.0372*** (0.00928)
PCI*HIC	-0.0105* (0.00554)		-0.0167** (0.00759)	
PCI*[OLDIND]		-0.00177 (0.00990)		
PCI*[HICNOLD]		-0.0286*** (0.00475)		
PCI*[AfTRECIP]			-0.00793 (0.00674)	
[Log(AfTTOT)]*[AfTRECIP]			-0.0270** (0.0129)	
PCI*LDC				0.00864 (0.00787)
[Log(AfTTOT)]*LDC				0.0500** (0.0222)
HIC	0.340 (0.216)		0.482 (0.314)	
OLDIND		-0.0716 (0.447)		
HICNOLD		0.992*** (0.198)		
NoAfTDum	-0.605* (0.325)	-0.941*** (0.299)		
AfTRECIP			0.752** (0.340)	
LDC				-1.290*** (0.319)

Table 5. Continued

	HICs versus NonHICs	OLDIND versus HICs that are not OLDIND	HICs versus Aft Recipients that are not HICs	LDCs versus NonLDCs (among Aft Recipients)
Variables	ECI	ECI	ECI	ECI
	(1)	(2)	(3)	(4)
Log(NonAftTOT)	-0.0424** (0.0171)	-0.0601*** (0.0149)	-0.0358*** (0.0120)	-0.0362*** (0.0136)
Log(GDPC)	-0.0584** (0.0253)	-0.0834*** (0.0227)	-0.0591*** (0.0206)	-0.191*** (0.0210)
OPEN	0.00148*** (0.000342)	0.00151*** (0.000326)	0.00136*** (0.000330)	0.00234*** (0.000445)
Log(POP)	0.0610*** (0.0142)	0.0736*** (0.0137)	0.0732*** (0.0151)	0.0952*** (0.0190)
TERMS	-0.00188*** (0.000204)	-0.00185*** (0.000182)	-0.00206*** (0.000193)	-0.00182*** (0.000154)
Observations - Countries	577 - 126	577 - 126	577 - 126	399 - 90
Number of Instruments	86	97	108	76
AR1 (P-Value)	0.0129	0.0125	0.0112	0.0187
AR2 (P-Value)	0.6788	0.6831	0.6840	0.6849
Sargan (P-Value)	0.2845	0.2310	0.5136	0.1816

Note. *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables "PCI", "AftTOT", "NonAftTOT", "GDPC", "OPEN" and the interaction variables have been considered as endogenous. have been treated as endogenous. Time dummies have been included in the regressions. The variable "COMPO" is a component of the index of overall productive capacities. The dummy variable "AftRECIP" represents Aft recipient countries that are not HICs. It, therefore, takes the value "1" for Aft recipient countries that are not HICs, and "0", otherwise. In fact, in the full sample, there are 7 HICs that had been recipients of Aft flows. These countries are Chile, Croatia, Mauritius, Oman, Panama, Saudi Arabia, and Uruguay.

6. Results in Table 6

Robustness of the previous findings can be checked in Table 6, particularly those concerning the effect of productive capacities on economic complexity. We find that greater productive capacities positively and significantly influence export product diversification (based on the UNCTAD's export product concentration index) both over the full sample and the restricted sample of Aft-recipient countries (the coefficient of "PCI" is negative and significant for the regressions whose results are reported in columns [1] and [4] of Table 6). However, while productive capacities positively and significant affect export product diversification (based on the IMF's export product concentration index) over the full sample (see column [2] of Table 5), it exerts no significant effect (at the conventional significance levels) on the same export diversification index over the sub-sample of Aft-recipient countries (see column [5] of Table 5). Finally, fostering productive capacities has no significant on export product quality over the full sample (see column [3] of Table 6), but it helps to improve the export product quality in Aft-recipient countries (see results in column [3] of Table 5).

Aft flows are robustly and positively associated with export product diversification over the full sample and the Aft-recipient countries (see columns [1], [2], [4], and [5], where the coefficients of the variable representing total Aft flows are significant at the 1% level).

Additionally, these resource flows help improve the export product quality in both the full sample and AfT-recipient countries (see columns [3] and [4]).

While Non-AfT flows exert no significant effect on export product diversification (the IMF index) and export product quality over the full sample (see columns [2] and [3], respectively, of Table 6), they appear to be positively and significantly associated with export product concentration (the UNCTAD's index - see column [1] of Table 6) over the full sample. Over the sub-sample of AfT recipients, these capital inflows are positively associated with export product concentration (either the IMF or the UNCTAD indicator) (see columns [4] and [5] of Table 6) and negatively associated with export product quality (see column [6] of Table 6). These outcomes confirm the findings in previous tables that Non-AfT flows are negatively and significantly associated with economic complexity.

The outcomes of the other control variables in Tables 5 and 6 are broadly consistent with the those reported in Table 2.

Table 6. *Effect of Productive Capacities on Export Product Diversification, and Export Product Quality, All of these being Key Aspects of Economic Complexity, over the Full Sample and the Sub-Sample of AfT Recipients*
Estimator: Two-Step System GMM

Variables	Full Sample			AfT Recipients		
	EPCUNCT	EPCIMF	QUALIMF	EPCUNCT	EPCIMF	QUALIMF
	(1)	(2)	(3)	(4)	(5)	(6)
One-Period Lag of the dependent Variable	0.711*** (0.0167)	0.934*** (0.0254)	0.793*** (0.0253)	0.719*** (0.0186)	0.932*** (0.0208)	0.693*** (0.0216)
PCI	-0.0143*** (0.00136)	-0.0339*** (0.0115)	0.00110 (0.00130)	-0.0114*** (0.00111)	0.000149 (0.00688)	0.00550*** (0.00125)
Log(AfTTOT)	-0.00594*** (0.00188)	-0.0365** (0.0160)	0.00715*** (0.00162)	-0.00570*** (0.00195)	-0.0543*** (0.0118)	0.00657*** (0.00171)
Log(NonAfTTOT)	0.00763** (0.00296)	0.0158 (0.0206)	-0.00278 (0.00224)	0.00934*** (0.00218)	0.0780*** (0.0129)	-0.00478** (0.00226)
NoAfTDum	0.121** (0.0589)	-0.119 (0.411)	0.0507 (0.0343)			
Log(GDPC)	0.179*** (0.0284)	0.624** (0.260)	0.0152*** (0.00436)	0.186*** (0.0407)	-1.000*** (0.210)	-0.00219 (0.00409)
[Log(GDPC)] ²	-0.00804*** (0.00178)	-0.0302* (0.0164)		-0.00893*** (0.00250)	0.0669*** (0.0134)	
OPEN	0.000270*** (7.42e-05)	0.000919** (0.000449)	0.000126** (5.02e-05)	0.000160** (7.81e-05)	0.00189*** (0.000313)	0.000192*** (5.98e-05)
Log(POP)	0.0202*** (0.00396)	0.103*** (0.0247)	-0.00361 (0.00277)	0.0151*** (0.00336)	0.122*** (0.0109)	-0.00142 (0.00279)
TERMS	0.000451*** (4.77e-05)	-0.00126*** (0.000324)	-0.000271** (2.65e-05)	0.000477*** (5.46e-05)	-4.56e-05 (0.000209)	-0.000333** (2.33e-05)

Table 6. Continued

Variables	Full Sample			AfT Recipients		
	EPCUNCT	EPCIMF	QUALIMF	EPCUNCT	EPCIMF	QUALIMF
	(1)	(2)	(3)	(4)	(5)	(6)
Observations - Countries	615 - 126	495 - 126	488 - 124	436 - 90	351 - 90	344 - 88
Number of Instruments	94	77	60	78	77	60
AR1 (P-Value)	0.0000	0.0018	0.0175	0.0003	0.0035	0.0315
AR2 (P-Value)	0.1269	0.7896	0.9621	0.1789	0.3094	0.8220
Sargan (P-Value)	0.2478	0.1598	0.1339	0.3710	0.1342	0.7007

Note. * p -value <0.1 ; ** p -value <0.05 ; *** p -value <0.01 . Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables “PCI”, “AfTTOT”, “NonAfTTOT”, “GDPC”, “OPEN” and the interaction variables have been considered as endogenous. have been treated as endogenous. Time dummies have been included in the regressions.

7. Results in Table 7

Considering the estimates in Table 7 obtained over the sub-sample of AfT-recipient countries, we examine whether the effect of productive capacities on economic complexity in AfT-recipient countries depend on the amounts of AfT (and its three major components highlighted earlier) that accrue to these countries. The outcomes presented in column [1] of Table 7 show that the coefficient of “PCI” is not statistically significant at the conventional significance levels, while the interaction term of the interaction variable (“PCI*[Log(AfTTOT)]”) is negative and significant at the 1% level. Taken together, these two estimates indicate that productive capacities and AfT flows are substitutable in positively and significantly influencing economic complexity. Specifically, productive capacities are positively and significantly associated with economic complexity as the amounts of AfT flows reduce, that is, the magnitude of this positive effect rises as countries receive lower amounts of AfT. Similarly, AfT flows positively influence economic complexity in countries having low levels of productive capacities. The lower the levels of productive capacities the greater is the magnitude of the positive effect of AfT on economic complexity, which signifies that by strengthening productive capacities in countries having low levels of overall productive capacities, AfT flows enhance export sophistication in these countries. We deepen our understanding of the interaction between the index of overall productive capacities and the variable measuring AfT flows by presenting in Figure 9 the development of the marginal effect of productive capacities on economic complexity for varying amounts of AfT at the 95% confidence intervals. Alternatively, Figure 10 depicts the development of the marginal effect of AfT flows on economic complexity for varying levels of productive capacities.

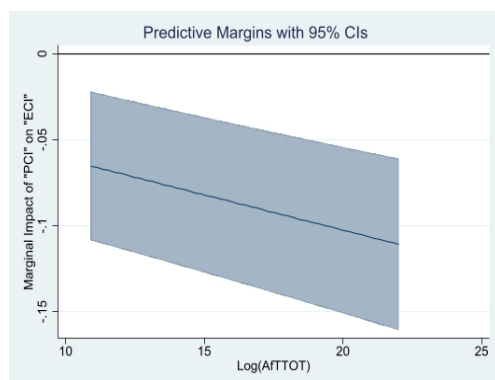
Figure 9 shows that the marginal impact of productive capacities on economic complexity is always negative but decreases as the amounts of the AfT increase. This signifies that while

productive capacities always exert a positive effect on economic complexity (regardless of the amounts of AfT), countries receiving lower (higher) amounts of AfT flows experience the highest (lowest) magnitude of the positive effect of productive capacities on economic complexity. This finding indicates that donor-countries should significantly increase total AfT flows to low-income countries, and particularly LDCs, given that such aid strengthens the productive capacities and helps promote economic complexity in these countries.

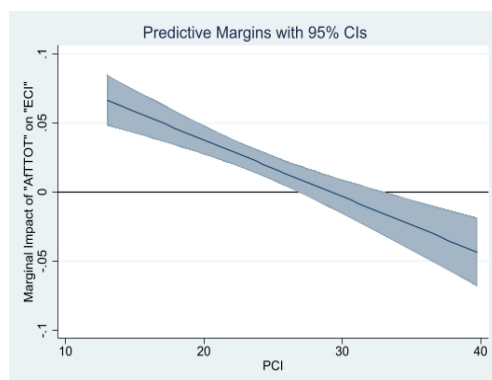
Figure 10 confirms this interpretation of Figure 9, which shows that the marginal impact of total AfT flows on economic complexity can take positive and negative values but not always statistically significant. It is not statistically significant for levels of the (overall) productive capacities comprised between 26.92 and 33.35 (these numbers are obtained from the Stata software when constructing Figure 10). The values of “PCI” range between 13.9 and 39.8 within the sub-sample of AfT-recipient countries (see Appendix 2B). Thus, countries whose levels of productive capacities range between 26.92 and 33.35 experience no significant effect of productive capacities on economic complexity. However, countries¹⁸⁾ among AfT recipients with lower levels (26.92) of the overall productive capacities enjoy a positive effect of AfT flows on economic complexity, and the lower the degree of the productive capacities, the greater is the magnitude of the positive effect of AfT flows on these countries’ economic complexity. Conversely, AfT flows negatively affect economic complexity in countries with higher productive capacities than 33.35, and the magnitude of this negative effect increases as the level of the overall productive capacities improves.

Figures 9 and 10 show that productive capacities and AfT flows are strongly complementary in positively influencing economic complexity in countries with low levels of productive capacities, that is, lower than 33.35. The lower the level of the overall productive capacities, the higher is the degree of complementarity between the effects of overall productive capacities and total AfT flows on economic complexity in AfT-recipient countries. For countries with high levels of productive capacities (i.e., values ranging between 33.35 and 39.8), productive capacities and AfT flows are substitutable in positively influencing economic complexity. These outcomes should be considered jointly with the interaction effect of productive capacities and Non-AfT flows on economic complexity as follows.

18) Please see Appendix (OTHER) so as to have some ideas on the concerned countries for year 2018 (we should bear in mind that the estimates reported here are based on non-overlapping average data).

Figure 9. Marginal Impact of “PCI” on “ECI”, for varying amounts of total AfT

(Source) Author

Figure 10. Marginal Impact of “AfTTOT” on “ECI”, for varying levels of “PCI”

According to results in column [1] of Table 7, we examine how productive capacities interact with Non-AfT flows in affecting economic complexity. We find that the interaction term of the variable “(PCI*[Log(NonAfTTOT)])” is positive and significant at the 1% level), whereas the coefficient of “PCI” is not statistically significant at the 10% level. Taken jointly, these two outcomes suggest that productive capacities induce a greater economic complexity in AfT-recipient countries that receive higher Non-AfT flows, with the magnitude of this positive effect rising as the amounts of Non-AfT inflows increase. Figure 11 shows how the marginal effect of productive capacities on economic complexity changes for varying amounts of Non-AfT. Figure 11 indicates that this marginal impact is always positive and increases as the amount of Non-AfT flows rises. This confirms our previous outcome, whereby regardless of the amount of Non-AfT flows, productive capacities positively influence economic complexity, and the magnitude of this positive effect increases as the amount of Non-AfT flows rises. These results suggest that the negative effects of Non-AfT flows on economic complexity found across Tables 2-6 (and even in Table 1) do not reveal the existence of an interaction effect of productive capacities and Non-AfT flows in influencing economic sophistication. Alternatively, this signifies that the genuine effect of Non-AfT flows on economic sophistication depends on the level of overall productive capacities in the recipient countries, or inversely, the economic complexity effect of productive capacities depends on the amount of Non-AfT flows received by countries.

Overall, the findings in column [1] of Table 7 show that productive capacities are complementary with AfT flows in positively affecting economic complexity in AfT-recipient countries with low levels of productive capacities, and substitutable with AfT interventions in enhancing economic complexity in countries with high levels of productive capacities. Concurrently, productive capacities are complementary with Non-AfT flows in fostering economic sophistication in AfT-recipient countries, with the degree of this complementary becoming

stronger as the amounts of Non-AfT flows that countries receive increase.

Notwithstanding these results, and given the mixed outcomes of the interaction effect of the productive capacities and AfT flows on economic complexity, one could question whether the joint effect of productive capacities and AfT flows on economic complexity should be considered separately from the joint effect of productive capacities and Non-AfT flows on economic complexity. Specifically, some interactions among AfT flows and Non-AfT flows (including their various components) are likely when affecting recipient countries' level of economic complexity. In fact, in AfT-recipient countries, AfT and Non-AfT flows can target different projects yet act together (and not in isolation from one another) in affecting economic outcomes, including the level of economic complexity. For example, the effect of AfT flows on economic complexity (arising from trade costs reduction, enhancement of the capacity to produce exportable goods and services, and the design of suitable trade policies) could not be fully isolated from the effect of Non-AfT flows on economic complexity, for example, in terms of enhancing human capital (health and education).

Thus, it might be useful to examine the joint effect of productive capacities and total development aid flows, including AfT and Non-AfT flows, on economic complexity in AfT-recipient countries by estimating a last specification of model (1), that is, model (1) in which we replace the variables “AfTTOT” and “NonAfTTOT” with the variable “ODA,” which is additionally interacted with the variable “PCI.” “ODA” is the real gross disbursements of total ODA flows (the sum of AfT and Non-AfT flows), expressed in constant prices 2018, US Dollar. The results of the estimation of this model specification are reported in column [2] of Table 7. However, the coefficient of the one-period lag of the dependent variable is positive and significant at the 1% level (as in all other Tables) and the model specification passes the tests that help assess the validity of the two-step system GMM estimator. Concerning the estimates, the coefficient of “PCI” is not statistically significant at the 10% level, but the interaction term of the variable (“PCI*[Log(ODA)]”) is positive and significant at the 1% level. These outcomes suggest the relevance of the total development aid flows for the effect of productive capacities on economic complexity. In fact, regardless of the amounts of total development aid that accrue to countries, their productive capacities always exert a positive effect on economic sophistication. Furthermore, the magnitude of this positive effect rises as the amount of total development aid increases. Figure 12 confirms this finding and shows the development of the marginal effect of productive capacities on economic complexity for different amounts of total development aid at the 95% confidence intervals. The pattern observed in Figure 12 is similar to that in Figure 11 and indicates that the marginal effect of productive capacities on economic complexity is always positive and statistically significant. It also increases as the amount of total development aid increases.

Estimates related to control variables in Table 7 are consistent with those reported in Table 2.

Figure 11. Marginal Impact of “PCI” on “ECI”,
for varying amounts of Total NonAfT flows

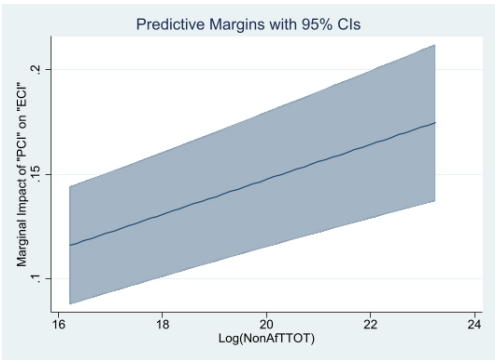
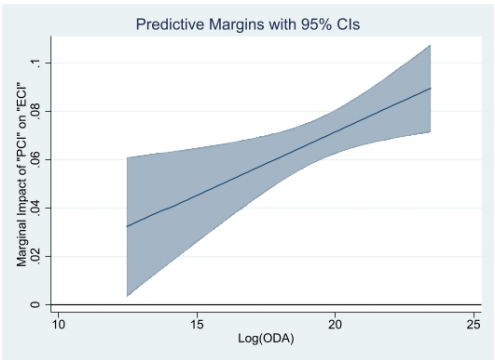


Figure 12. Marginal Impact of “PCI” on “ECI”,
for varying amounts of ODA



Note. Author

Table 7. Interaction Effect between the Overall Productive Capacities, Total Development Aid Flows on Economic Complexity
Estimator: Two-Step System GMM

Variables	ECI	ECI
	(1)	(2)
ECI _{t-1}	0.470*** (0.0143)	0.482*** (0.0205)
PCI	-0.0205 (0.0215)	-0.0331 (0.0394)
PCI*[Log(AfTTOT)]	-0.00411*** (0.000746)	
PCI*[Log(NonAfTTOT)]	0.00840*** (0.00128)	
PCI*[Log(ODA)]		0.00523*** (0.00202)
Log(AfTTOT)	0.120*** (0.0184)	
Log(NonAfTTOT)	-0.295*** (0.0368)	
Log(ODA)		-0.263*** (0.0540)
Log(GDPC)	-0.0814*** (0.0130)	-0.123*** (0.0183)
OPEN	0.00165*** (0.000154)	0.00378*** (0.000605)
Log(POP)	0.0887*** (0.00982)	0.171*** (0.0162)
TERMS	-0.00176*** (0.000111)	-0.00171*** (0.000175)

Table 7. *Continued*

Variables	ECI	ECI
	(1)	(2)
Observations - Countries	399 - 90	401 - 90
Number of Instruments	95	73
AR1 (P-Value)	0.0123	0.0154
AR2 (P-Value)	0.6506	0.5418
Sargan (P-Value)	0.5202	0.5657

Note. * p -value <0.1 ; ** p -value <0.05 ; *** p -value <0.01 . Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables “PCI”, “AftTOT”, “NonAftTOT”, “ODA”, “GDPC”, “OPEN” and the interaction variables have been considered as endogenous. have been treated as endogenous. Time dummies have been included in the regressions.

V. Conclusion

The COVID-19 pandemic has highlighted the structural vulnerabilities of both developed and developing countries to shocks, and therefore, the need for policymakers to adopt measures and policies to enhance economic resilience to future shocks. Strengthening productive capacities has been argued (e.g., by the UNCTAD - see UNCTAD, 2006, 2020b) as a means to make economies more resilient and immune to future shocks. Thus far, studies conducted on the productive capacities were related to the challenges encountered by developing countries (particularly by LDCs among them) and the policies required to overcome these challenges. These studies have been analytical and not based on evidence. On February 8, 2021, the UNCTAD made publicly available the indicator of productive capacities to help the research community conduct evidence-based analyses on issues related to productive capacities and provide policymakers with appropriate recommendations to foster productive capacities.

This study uses UNCTAD's dataset on productive capacities to empirically examine the effect of productive capacities on economic complexity. It additionally assesses whether this effect depends on the amounts of development aid, particularly Aft and Non-Aft flows, received by developing countries. The underlying rationale for this analysis is that complex economies (i.e., those that export complex products) exhibit strong resilience to shocks because they enjoy strong prospects of economic growth, lower output volatility, and lower economic growth cycles.

The analysis has been conducted using a full sample of 126 countries, comprising both developed and developing countries, covering 2002-2018. It has established interesting findings.

First, the strengthening of productive capacities is positively associated with economic complexity over the full sample, but advanced countries experience a lower positive effect of productive capacities than relatively less advanced economies. The same findings apply to the sub-sample of Aft-recipient countries as well. However, different patterns of results are

observed, on average, over sub-samples of the full sample. In fact, fostering productive capacities induces a greater positive effect (double) on HICs that are old-industrialized countries than on HICs that are not. Similarly, productive capacities positively influence economic complexity in HICs and AfT recipients (i.e., those that are not HICs), with both sub-samples enjoying the same magnitude of this positive effect.

Second, AfT flows exert a far higher positive effect on economic complexity in HICs that were recipients of AfT flows than in other AfT-recipient countries. Within AfT-recipient countries, the total AfT flows are positively associated with economic complexity in LDCs but negatively with economic complexity in Non-LDCs.

Third, productive capacities and total AfT flows are strongly complementary in positively influencing economic complexity in countries with low levels of the overall productive capacities. The degree of this complementarity is higher for low-income countries such as LDCs than for relatively advanced countries among AfT recipients. In contrast, productive capacities and AfT flows are substitutable in positively influencing economic complexity. These findings suggest, at least, that AfT flows are effective in enhancing economic complexity in countries with low levels of productive capacities. This finding should be explored in further studies to examine whether donor-countries supply higher amounts of AfT flows to countries that experience low levels of productive capacities to strengthen productive capacities in these countries and, consequently, foster their economic sophistication. They should also be read in conjunction with the findings concerning the interaction between the effect of Non-AfT flows and productive capacities on economic complexity. Productive capacities and Non-AfT flows are complementary in positively affecting economic complexity in AfT-recipient countries and the degree of this complementarity rises as the amounts of Non-AfT increase. Interestingly, productive capacities are complementary with total development aid (i.e., the sum of AfT and Non-AfT flows) in promoting economic complexity in recipient countries, and the degree of this complementarity increases as the total development aid flows increase.

The findings from this empirical analysis have several policy implications. **First**, strengthening productive capacities generates a greater economic complexity in developing countries than in developed countries and in LDCs among developing countries more than in Non-LDCs. This is essential for enhancing the economies' resilience, notably the resilience of developing economies (and least-developed economies) to future shocks, be the latter external health, economic, financial, or eventually environmental shocks. As a result, national and international policies in this direction are important. **Second**, increasing both AfT and Non-AfT flows to developing countries with low levels of productive capacity (in particular, to the poorest among them, such as LDCs) would help enhance their productive capacities and improve their capacity to withstand future shocks while also engaging in sustainable development.

The availability of data on productive capacities can help accurately identify the challenges

faced by developing countries and LDCs when they endeavor to develop their productive capacities. The identification of these challenges can, in turn, help consider relevant policies and measures tailored to each country's circumstances and characteristics to foster productive capacities. Development aid, including Aft and Non-Aft flows, can be instrumental in achieving this objective in developing countries, notably in those (i.e., LDCs) with low levels of productive capacities, that need these resources flows the most.

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Appendix

Appendix 1. Definition and Source of variables

Variables	Definition	Sources
ECI	This is the economic complexity index. It is calculated using Hausmann and Hidalgo's (2009) formula for economic complexity, and reflects the diversity and ubiquity of a country's export structure.	MIT's Observatory of Economic Complexity (https://atlas.media.mit.edu/rankings)
PCI	<p>This is the overall Productive Capacity Index. It measures the level of productive capacities along three pillars: productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop" (UNCTAD, 2006).</p> <p>It is computed as a geometric average of eight domains or categories, namely, Information communication and technologies (ICTs), structural change, natural capital, human capital, energy, transport, the private sector and institutions. Each category index is obtained from the principal components extracted from the underlying indicators, weighted by their capacity to explain the variance of the original data. The category indices are normalized into 0-100 intervals.</p> <p>The components of "PCI" include ICTs (denoted "ICT"), structural change (denoted "SCI"), natural capital (denoted "NATURAL"), human capital (denoted "HUMCAP"), energy (denoted "ENERGY"), transport (denoted "TRANSP"), the private sector (denoted "PRIVATE"), and institutions (denoted "INST").</p>	<p>United Nations Conference on Trade and Development (UNCTAD) Statistics portal: https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx</p> <p>See UNCTAD (2020) for a complete description of the methodology used to compute the indicator "PCI".</p>
AFTTOT	This is the total real gross disbursements of Aid for Trade, expressed in constant prices 2018, US Dollar.	<p>Author's calculation based on data extracted from the database of the OECD/DAC-CRS (Organization for Economic Cooperation and Development/ Donor Assistance Committee) - Credit Reporting System (CRS). Aid for Trade data cover the following three main categories (the CRS Codes are in brackets): Aid for Trade for Economic Infrastructure ("AFTINFRA"), which includes transport and storage (210), communications (220), and energy generation and supply (230); Aid for Trade for Building Productive Capacity ("AFTPROD"), which includes banking and financial services (240), business and other services (250), agriculture (311), forestry (312), fishing (313), industry (321), mineral resources and mining (322), and tourism (332); and Aid for Trade policy and regulations ("AFTPOL"), which includes trade policy and regulations and trade-related adjustment (331).</p>
NonAFTTOT	This is the measure of the development aid allocated to other sectors in the economy than the trade sector. It has been computed as the difference between the gross disbursements of total ODA and the gross disbursements of total Aid for Trade (both being expressed in constant prices 2018, US Dollar).	Author's calculation based on data extracting from the OECD/DAC-CRS database.
ODA	This is the real gross disbursements of total Official Development Assistance (ODA) expressed in constant prices 2018, US Dollar. It is the sum of the variables "AFTTOT" and "NonAFTTOT".	Author's calculation based on data extracting from the OECD/DAC database.
EPCUNCT	This is the index of export product concentration computed by UNCTAD using the Herfindahl-Hirschman index, and relying on products at 3-digit level of SITC, Revision 3. An increase in the values of this index indicates greater export product concentration, while lower values show a tendency for greater export product diversification.	UNCTAD Statistics portal

Appendix 1. Continued

Variables	Definition	Sources
EPCIMF	This is the variable capturing overall export product concentration calculated by the International Monetary Fund (IMF) using the Theil Index and following the definitions and methods used in Cadot et al. (2011). It is the sum of the intensive and extensive components of the "ECI" variable. The computation of this index is based on a classification of products into "Traditional", "New", or "Non-Traded" products categories. A rise in the values of "ECI" signifies an increase in the degree of overall export product concentration, while a decrease in the values of the index reflects a rise in the degree of overall export product concentration (that is, greater export product diversification).	Details on the calculation of this Index could be found online: International Monetary Fund's Diversification Toolkit – See data online at: https://data.imf.org/?sk=3567E911-4282-4427-98F9-2B8A6F83C3B6
QUALIMF	Index of export product quality. Higher values of this index reflect an improvement in export product quality.	Details on the calculation of this Index could be found online: International Monetary Fund's Diversification Toolkit – See data online at: https://data.imf.org/?sk=3567E911-4282-4427-98F9-2B8A6F83C3B6
GDP	Per capita Gross Domestic Product (constant 2010 US\$).	World Bank Indicators (WDI)
OPEN	Measure of trade openness calculated as the share of sum of exports and imports of goods and services in GDP.	Authors' calculation based on data extracted from the WDI
POP	The measure of the total population	WDI

Appendix 2A. *Descriptive Statistics on Variables over the Full Sample*

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
ECI	577	0.019	0.964	-2.221	2.401
PCI	577	31.534	7.533	13.940	51.031
HUMCAP	577	51.119	13.690	23.569	88.501
NATURAL	577	53.252	7.770	36.504	88.946
ENERG	577	27.520	6.474	6.757	47.107
TRANSP	577	15.656	6.098	4.900	47.088
ICT	577	11.672	6.397	2.886	30.782
INST	577	54.696	20.436	10.693	97.584
PRIVATE	577	78.373	9.401	39.145	95.481
SCI	577	20.246	5.559	3.088	40.660
EPCUNCT	577	0.295	0.211	0.052	0.968
EPCIMF	458	3.230	1.249	1.431	6.412
QUALIMF	451	0.824	0.161	0.225	1.061
GDPG	577	14373.650	18544.120	307.452	91834.280
OPEN	577	85.687	52.442	0.247	431.681
POP	577	56,900,000	174,000,000	1045627	1,390,000,000

Appendix 2B. *Descriptive Statistics on Variables over the Sub-Sample of AfT Recipients*

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
ECI	399	-0.418	0.729	-2.221	1.198
PCI	399	27.582	4.872	13.940	39.773
HUMCAP	399	44.144	8.258	23.569	61.217
NATURAL	399	55.438	7.507	40.949	88.946
ENERG	399	24.697	5.438	6.757	35.947
TRANSP	399	13.132	3.878	4.900	30.647
ICT	399	8.295	3.613	2.886	21.627
INST	399	44.078	12.161	10.693	82.580
PRIVATE	399	75.016	9.091	39.145	89.464
SCI	399	17.925	4.434	3.088	39.368
AfTTOT	399	296,000,000	460,000,000	54762.3	3,650,000,000
NonAfTTOT	399	798000000	1,010,000,000	11,000,000	12,500,000,000
ODA	399	1,090,000,000	1,330,000,000	11,000,000	15,300,000,000
EPCUNCT	399	0.345	0.221	0.073	0.968
EPCIMF	315	3.592	1.213	1.665	6.412
QUALIMF	308	0.762	0.148	0.225	0.972
GDPG	399	4436.148	3833.147	307.452	19312.420
OPEN	399	75.728	31.278	0.247	204.346
POP	399	67,100,000	205,000,000	1168674	1,390,000,000

Appendix 3A. *List of Countries Contained in the Full Sample*

Full sample					
Albania	China	Guatemala	Latvia	Nigeria	Spain
Algeria	Colombia	Guinea	Lebanon	North Macedonia	Sri Lanka
Angola	Congo, Dem. Rep.	Haiti	Liberia	Norway	Sudan
Argentina	Congo, Rep.	Honduras	Libya	Oman	Sweden
Armenia	Costa Rica	Hong Kong SAR, China	Lithuania	Pakistan	Switzerland
Australia	Cote d'Ivoire	Hungary	Madagascar	Panama	Tanzania
Austria	Croatia	India	Malawi	Paraguay	Thailand
Azerbaijan	Cyprus	Indonesia	Malaysia	Peru	Togo
Bangladesh	Dominican Republic	Iran, Islamic Rep.	Mali	Philippines	Tunisia
Belarus	Ecuador	Iraq	Mauritania	Poland	Turkey
Benin	Egypt, Arab Rep.	Ireland	Mauritius	Portugal	Uganda
Bolivia	El Salvador	Israel	Mexico	Qatar	Ukraine
Bosnia and Herzegovina	Equatorial Guinea	Italy	Moldova	Romania	United Arab Emirates
Brazil	Estonia	Jamaica	Mongolia	Russian Federation	United Kingdom
Bulgaria	Finland	Japan	Morocco	Saudi Arabia	United States
Burkina Faso	France	Jordan	Mozambique	Senegal	Uruguay
Cambodia	Gabon	Kazakhstan	Myanmar	Serbia	Uzbekistan
Cameroon	Georgia	Kenya	Netherlands	Sierra Leone	Venezuela, RB
Canada	Germany	Korea, Rep.	New Zealand	Singapore	Vietnam
Chad	Ghana	Kuwait	Nicaragua	Slovak Republic	Zambia
Chile	Greece	Kyrgyz Republic	Niger	South Africa	Zimbabwe

Appendix 3B. *List of Countries Contained in the Sub-Sample of AfT Recipients*

AfT Recipients		
Albania	Georgia	Nicaragua
Algeria	Ghana	Niger
Angola	Guatemala	Nigeria
Argentina	Guinea	North Macedonia
Armenia	Haiti	Oman
Azerbaijan	Honduras	Pakistan
Bangladesh	India	Panama
Belarus	Indonesia	Paraguay
Benin	Iran, Islamic Rep.	Peru
Bolivia	Iraq	Philippines
Bosnia and Herzegovina	Jamaica	Saudi Arabia
Brazil	Jordan	Senegal
Burkina Faso	Kazakhstan	Serbia
Cambodia	Kenya	Sierra Leone
Cameroon	Kyrgyz Republic	South Africa
Chad	Lebanon	Sri Lanka
Chile	Liberia	Sudan
China	Libya	Tanzania
Colombia	Madagascar	Thailand
Congo, Dem. Rep.	Malawi	Togo
Congo, Rep.	Malaysia	Tunisia
Costa Rica	Mali	Turkey
Cote d'Ivoire	Mauritania	Uganda
Croatia	Mauritius	Ukraine
Dominican Republic	Mexico	Uruguay
Ecuador	Moldova	Uzbekistan
Egypt, Arab Rep.	Mongolia	Venezuela, RB
El Salvador	Morocco	Vietnam
Equatorial Guinea	Mozambique	Zambia
Gabon	Myanmar	Zimbabwe

Appendix 3C. *List of Countries Contained in the Sub-Samples of HICs, OLDIND and LDCs*

HICs		OLDIND	LDCs
Australia	Norway	Australia	Angola
Austria	Oman	Austria	Bangladesh
Canada	Panama	Canada	Benin
Chile	Poland	Finland	Burkina Faso
Croatia	Portugal	France	Cambodia
Cyprus	Qatar	Germany	Chad
Estonia	Romania	Greece	Congo, Dem. Rep.
Finland	Saudi Arabia	Ireland	Guinea
France	Singapore	Italy	Haiti
Germany	Slovak Republic	Japan	Liberia
Greece	Spain	Netherlands	Madagascar
Hong Kong SAR, China	Sweden	New Zealand	Malawi
Hungary	Switzerland	Norway	Mali
Ireland	United Arab Emirates	Portugal	Mauritania
Israel	United Kingdom	Spain	Mozambique
Italy	United States	Sweden	Myanmar
Japan	Uruguay	Switzerland	Niger
Korea, Rep.		United Kingdom	Senegal
Kuwait		United States	Sierra Leone
Latvia			Sudan
Lithuania			Tanzania
Mauritius			Togo
Netherlands			Uganda
New Zealand			Zambia

Appendix Other. *Ranking (in the descending order) of “PCI” and “ECI” for the year “2018”, over the full sample*

Ranking of “PCI” for the year “2018” over the full sample						Ranking of “ECI” for the year “2018” over the full sample					
Rank	Country	LDC	OLDIND	HIC	PCI	Rank	Country	LDC	OLDIND	HIC	ECI
1	United States	0	1	1	50.51	1	Japan	0	1	1	2.34
2	Netherlands	0	1	1	48.22	2	Switzerland	0	1	1	2.07
3	Germany	0	1	1	47.38	3	Germany	0	1	1	1.94
4	United Kingdom	0	1	1	46.18	4	Korea, Rep.	0	0	1	1.91
5	Hong Kong China	0	0	1	45.81	5	Singapore	0	0	1	1.78
6	Ireland	0	1	1	45.54	6	Sweden	0	1	1	1.66
7	Japan	0	1	1	45.29	7	Austria	0	1	1	1.63
8	Korea, Rep.	0	0	1	45.21	8	United Kingdom	0	1	1	1.52
9	Singapore	0	0	1	44.46	9	Finland	0	1	1	1.47
10	France	0	1	1	44.36	10	United States	0	1	1	1.41
11	Austria	0	1	1	43.97	11	Hungary	0	0	1	1.39
12	Sweden	0	1	1	43.48	12	France	0	1	1	1.34
13	New Zealand	0	1	1	42.77	13	Italy	0	1	1	1.33
14	Australia	0	1	1	42.59	14	Slovak Republic	0	0	1	1.30
15	Canada	0	1	1	42.30	15	Israel	0	0	1	1.28
16	United Arab Emirates	0	0	1	42.30	16	Ireland	0	1	1	1.22
17	Switzerland	0	1	1	42.25	17	China	0	0	0	1.15
18	Finland	0	1	1	41.81	18	Poland	0	0	1	1.11
19	Norway	0	1	1	41.65	19	Romania	0	0	1	1.07
20	Spain	0	1	1	41.02	20	Malaysia	0	0	0	1.05
21	Qatar	0	0	1	40.81	21	Estonia	0	0	1	1.02
22	Estonia	0	0	1	40.26	22	Netherlands	0	1	1	1.02
23	Israel	0	0	1	40.20	23	Hong Kong China	0	0	1	1.01
24	China	0	0	0	40.00	24	Thailand	0	0	0	1.00
25	Cyprus	0	0	1	39.80	25	Mexico	0	0	0	0.97
26	Poland	0	0	1	39.65	26	Lithuania	0	0	1	0.88
27	Portugal	0	1	1	39.37	27	Croatia	0	0	1	0.85
28	Hungary	0	0	1	39.13	28	Belarus	0	0	0	0.81
29	Lithuania	0	0	1	38.04	29	Spain	0	1	1	0.80
30	Latvia	0	0	1	37.96	30	Norway	0	1	1	0.76
31	Greece	0	1	1	37.91	31	Latvia	0	0	1	0.72
32	Slovak Republic	0	0	1	37.48	32	Serbia	0	0	0	0.68
33	Mauritius	0	0	1	37.39	33	Portugal	0	1	1	0.66
34	Chile	0	0	1	36.61	34	Bulgaria	0	0	0	0.60
35	Croatia	0	0	1	36.48	35	Philippines	0	0	0	0.60
36	Uruguay	0	0	1	36.05	36	Turkey	0	0	0	0.58
37	Italy	0	1	1	35.99	37	Canada	0	1	1	0.57
38	Serbia	0	0	0	35.65	38	Bosnia and Herzegovina	0	0	0	0.52
39	Costa Rica	0	0	0	35.48	39	Cyprus	0	0	1	0.52

Appendix Other. *Continued*

Ranking of "PCI" for the year "2018" over the full sample						Ranking of "ECT" for the year "2018" over the full sample					
Rank	Country	LDC	OLDIND	HIC	PCI	Rank	Country	LDC	OLDIND	HIC	ECI
40	Bulgaria	0	0	0	35.09	40	Saudi Arabia	0	0	1	0.49
41	Panama	0	0	1	35.08	41	Ukraine	0	0	0	0.45
42	Thailand	0	0	0	34.99	42	India	0	0	0	0.44
43	Malaysia	0	0	0	34.94	43	Brazil	0	0	0	0.42
44	Saudi Arabia	0	0	1	34.73	44	Russian Federation	0	0	0	0.37
45	Oman	0	0	1	34.60	45	Panama	0	0	1	0.33
46	Belarus	0	0	0	34.39	46	Lebanon	0	0	0	0.27
47	Romania	0	0	1	34.30	47	New Zealand	0	1	1	0.26
48	Turkey	0	0	0	34.29	48	Greece	0	1	1	0.25
49	South Africa	0	0	0	34.05	49	Costa Rica	0	0	0	0.25
50	Kuwait	0	0	1	33.98	50	Uruguay	0	0	1	0.22
51	Georgia	0	0	0	33.89	51	Tunisia	0	0	0	0.21
52	Russian Federation	0	0	0	33.85	52	El Salvador	0	0	0	0.20
53	Lebanon	0	0	0	33.68	53	North Macedonia	0	0	0	0.19
54	North Macedonia	0	0	0	33.32	54	Colombia	0	0	0	0.12
55	Tunisia	0	0	0	33.24	55	United Arab Emirates	0	0	1	0.12
56	Argentina	0	0	0	33.03	56	Vietnam	0	0	0	0.11
57	Moldova	0	0	0	32.87	57	Kuwait	0	0	1	0.10
58	Bosnia and Herzegovina	0	0	0	32.86	58	Jordan	0	0	0	0.06
59	Jamaica	0	0	0	32.63	59	Kyrgyz Republic	0	0	0	0.02
60	Ukraine	0	0	0	32.63	60	Argentina	0	0	0	0.01
61	Colombia	0	0	0	32.45	61	Mauritius	0	0	1	-0.03
62	Dominican Republic	0	0	0	32.45	62	Indonesia	0	0	0	-0.04
63	El Salvador	0	0	0	32.42	63	Egypt, Arab Rep.	0	0	0	-0.08
64	Mongolia	0	0	0	32.29	64	Oman	0	0	1	-0.10
65	Mexico	0	0	0	32.18	65	Moldova	0	0	0	-0.10
66	Armenia	0	0	0	32.16	66	South Africa	0	0	0	-0.11
67	Peru	0	0	0	31.91	67	Chile	0	0	1	-0.15
68	Vietnam	0	0	0	31.71	68	Dominican Republic	0	0	0	-0.17
69	Brazil	0	0	0	31.69	69	Georgia	0	0	0	-0.17
70	Albania	0	0	0	31.65	70	Jamaica	0	0	0	-0.18
71	Sri Lanka	0	0	0	31.44	71	Armenia	0	0	0	-0.19
72	Ecuador	0	0	0	31.38	72	Guatemala	0	0	0	-0.29
73	Nicaragua	0	0	0	31.03	73	Paraguay	0	0	0	-0.32
74	Jordan	0	0	0	31.01	74	Sri Lanka	0	0	0	-0.32
75	India	0	0	0	30.90	75	Qatar	0	0	1	-0.33
76	Iran, Islamic Rep.	0	0	0	30.69	76	Australia	0	1	1	-0.33
77	Morocco	0	0	0	30.51	77	Kenya	0	0	0	-0.35
78	Kazakhstan	0	0	0	30.48	78	Tanzania	1	0	0	-0.36
79	Azerbaijan	0	0	0	30.22	79	Albania	0	0	0	-0.40
80	Indonesia	0	0	0	29.94	80	Honduras	0	0	0	-0.43
81	Philippines	0	0	0	29.88	81	Senegal	1	0	0	-0.46

Appendix Other. *Continued*

Ranking of "PCI" for the year "2018" over the full sample						Ranking of "ECT" for the year "2018" over the full sample					
Rank	Country	LDC	OLDIND	HIC	PCI	Rank	Country	LDC	OLDIND	HIC	ECI
82	Egypt, Arab Rep.	0	0	0	29.39	82	Kazakhstan	0	0	0	-0.48
83	Paraguay	0	0	0	29.16	83	Uzbekistan	0	0	0	-0.49
84	Bolivia	0	0	0	29.08	84	Pakistan	0	0	0	-0.50
85	Guatemala	0	0	0	28.91	85	Uganda	1	0	0	-0.55
86	Honduras	0	0	0	28.04	86	Zambia	1	0	0	-0.57
87	Algeria	0	0	0	27.76	87	Morocco	0	0	0	-0.59
88	Kyrgyz Republic	0	0	0	27.37	88	Iran, Islamic Rep.	0	0	0	-0.61
89	Uzbekistan	0	0	0	27.18	89	Peru	0	0	0	-0.62
90	Ghana	0	0	0	26.90	90	Togo	1	0	0	-0.67
91	Bangladesh	1	0	0	26.85	91	Ecuador	0	0	0	-0.68
92	Cambodia	1	0	0	26.46	92	Cambodia	1	0	0	-0.69
93	Senegal	1	0	0	26.31	93	Nicaragua	0	0	0	-0.75
94	Gabon	0	0	0	26.01	94	Venezuela, RB	0	0	0	-0.81
95	Kenya	0	0	0	25.73	95	Liberia	1	0	0	-0.83
96	Venezuela, RB	0	0	0	25.59	96	Mali	1	0	0	-0.87
97	Pakistan	0	0	0	25.17	97	Myanmar	1	0	0	-0.88
98	Uganda	1	0	0	24.91	98	Zimbabwe	0	0	0	-0.89
99	Myanmar	1	0	0	24.49	99	Azerbaijan	0	0	0	-0.89
100	Cote d'Ivoire	0	0	0	24.43	100	Bangladesh	1	0	0	-0.91
101	Zambia	1	0	0	24.24	101	Congo, Rep.	0	0	0	-0.92
102	Tanzania	1	0	0	24.22	102	Cote d'Ivoire	0	0	0	-0.92
103	Libya	0	0	0	24.16	103	Haiti	1	0	0	-0.99
104	Benin	1	0	0	23.84	104	Gabon	0	0	0	-1.00
105	Zimbabwe	0	0	0	23.70	105	Madagascar	1	0	0	-1.03
106	Guinea	1	0	0	23.66	106	Cameroon	0	0	0	-1.03
107	Cameroon	0	0	0	23.60	107	Algeria	0	0	0	-1.05
108	Mozambique	1	0	0	23.59	108	Congo, Dem. Rep.	1	0	0	-1.06
109	Equatorial Guinea	0	0	0	23.47	109	Mongolia	0	0	0	-1.06
110	Malawi	1	0	0	23.44	110	Bolivia	0	0	0	-1.10
111	Liberia	1	0	0	23.31	111	Ghana	0	0	0	-1.10
112	Mauritania	1	0	0	22.98	112	Mozambique	1	0	0	-1.12
113	Iraq	0	0	0	22.92	113	Mauritania	1	0	0	-1.26
114	Haiti	1	0	0	22.49	114	Equatorial Guinea	0	0	0	-1.33
115	Angola	1	0	0	22.16	115	Sudan	1	0	0	-1.43
116	Madagascar	1	0	0	22.10	116	Libya	0	0	0	-1.43
117	Congo, Rep.	0	0	0	22.06	117	Burkina Faso	1	0	0	-1.50
118	Sudan	1	0	0	22.01	118	Angola	1	0	0	-1.54
119	Togo	1	0	0	21.85	119	Nigeria	0	0	0	-1.60
120	Burkina Faso	1	0	0	21.70	120	Guinea	1	0	0	-1.67
121	Nigeria	0	0	0	21.65	121	Iraq	0	0	0	-1.86
122	Sierra Leone	1	0	0	21.62	122	Chad	1	0	0	-2.42
123	Mali	1	0	0	21.11						

Appendix Other. *Continued*

Ranking of "PCI" for the year "2018" over the full sample						Ranking of "ECT" for the year "2018" over the full sample					
Rank	Country	LDC	OLDIND	HIC	PCI	Rank	Country	LDC	OLDIND	HIC	ECI
124	Niger	1	0	0	20.08						
125	Congo, Dem. Rep.	1	0	0	19.85						
126	Chad	1	0	0	17.14						

Note. There are 122 countries (out of 126 countries) in the full sample for which we rank the values of the economic complexity index "ECI" because data is not available in 2018 for four countries, which are in fact all LDCs. These countries are Benin, Malawi, Niger and Sierra Leone. "LDC", "OLDIND" and "HIC" are respectively dummy variables indicating whether a country is classified respectively as a least developed country, an old-industrialized country, and a high-income country.