IMPACT OF PRODUCTIVE CAPACITIES ON SERVICE EXPORT SOPHISTICATION: EVIDENCE FROM DEVELOPING COUNTRIES

Nguyen Thi Thu Huong[1*], Bui Thi Thanh Nga[2]

Abstract – *This study examines the impact of productive capacities on the sophistication of service exports in 103 developing countries from 2005 to 2022. By employing the fixed effects estimator, the empirical findings reveal that improvements in the overall productive capacities index are positively associated with enhanced service export sophistication. Notably, this study discovers that among the components of the productive capacities index, human capital is the most potent catalyst. Other elements, including natural capital, information and communication technology, and transport, also play a significant, though slightly lesser role. These results offer important implications, suggesting that governments and policymakers in developing countries should prioritize strategic investments aiming to strengthen productive capacities. Specifically, focusing on improving human capital and harnessing natural capital is crucial for fostering sophisticated service exports. Besides, implementing policies to enhance information and communication technology and transport infrastructure development is also necessary to bolster the sophistication of service exports.*

Keywords: developing countries, productive capacities, service exports sophistication.

I. INTRODUCTION

The role of services in global trade has grown significantly, moving from a supporting function to a key driver of economic activity. Service trade has expanded faster than goods trade since 2011, with its share in total global trade increasing from 20% in 2011 to 25% in 2023, reflecting a substantial shift in the structure of the world economy [1]. In fact, the total value of global services exports reached 7.9 trillion US dollars in 2023, with annual growth around 8%, outpacing several goods trade sectors, confirming the rising importance of services in global commerce [2]. This growth has been fueled by technological advancements, particularly digitalization, which has made it easier to deliver services like telecommunications, computer services, and financial services across borders [3, 4]. The expansion of services trade also plays a crucial role in enabling other sectors, as it provides essential intermediate inputs like logistics, finance, and marketing that are vital for the efficient operation of global supply chains [5, 6].

More recently, scholars have turned their attention to understanding the drivers of trade quality, emphasizing that a country's ability to accumulate advanced skills and knowledge in producing increasingly sophisticated products and services is critical for its competitiveness in international markets [7–9]. The level of product or service sophistication indicates a country's capacity to create complex, innovative, and high-value outputs, which are key drivers of productivity growth and a higher standard of living. Producing more sophisticated outputs helps a country's businesses learn and improve, as they gain new skills and technologies during the production process. Furthermore, focusing on improved sophistication of traded products or services can encourage firms to move up the value chain, fostering innovation and making their outputs less susceptible to price volatility in global markets. This strategic shift strengthens an economy's resilience and competitive advantage. Therefore, by prioritizing the sophistication of what a country trades, policymakers can better steer their economies

---

[1,2]Vietnam Maritime University, Vietnam

*Corresponding author: huongntt.ktb@vimaru.edu.vn

toward sustainable, high-income growth rather than simply chasing raw trade numbers.

The United Nations Conference on Trade and Development (UNCTAD) has consistently promoted the idea that developing countries, especially the least developed ones, need to strengthen their productive capacities to achieve structural economic change and sustainable growth. Productive capacities are defined as the collective resources, skills, and connections that enable a country to grow by producing goods and services [10]. These capabilities are developed over time through continuous learning within the production process. This ongoing learning enables firms to develop new, more sophisticated capabilities, which in turn significantly enhance their potential for growth, innovation, and long-term success [11, 12]. Firms with superior capabilities, such as advanced technological knowledge, skilled labor, and efficient management systems, can produce higher-quality goods and services more efficiently than their competitors. These capabilities are often tacit and difficult to imitate, providing a sustainable competitive advantage in both domestic and international markets [13]. At the national level, a country's overall productive capacities dictate its ability to compete in the global economy. Countries that invest in building strong, productive capacities through education, infrastructure, and technology can move beyond simple commodity production and into more complex, high-value-added sectors like advanced manufacturing or technology services. This shift is crucial for achieving sustained economic growth and higher standards of living. Furthermore, strong productive capacities provide a developing country with the resilience to adapt to global economic shocks, as it has a diverse and sophisticated economic base [14].

Several studies have investigated the impact of productive capacities on various aspects of countries' economic performance, such as growth volatility, economic complexity, resilience, and export intensity [12, 14–17]. However, little attention has been paid to how productive capacities influence the sophistication of service exports, despite the rapid expansion of the service sector in developing economies. Since productive capacities are multidimensional, analyzing the components of the productive capacities index (PCI), including structural change, energy, human capital, institutions, natural capital, information and communications technology (ICT), transport, and the private sector, will provide clearer insight into which capacities most effectively enhance service export sophistication. Understanding these component-level relationships is valuable for policymakers in developing countries, as it helps identify targeted strategies for higher service sophistication. Therefore, this study contributes to the literature by examining the overall relationship between productive capacities and service export sophistication and exploring how different components of the PCI influence service export sophistication across 103 developing countries during the period from 2005 to 2022.

II. LITERATURE REVIEW

The literature has explored several factors that influence the sophistication of service exports. Huang et al. [18] examined how foreign direct investment (FDI) in services affects the sophistication of China's service exports by using a time series analysis for the period 1997–2012. The study empirically confirmed a positive, long-term relationship between FDI in services and China's service export sophistication. Kubasáková et al. [19] documented that the decreasing cost of advanced technology promotes the quality of logistics services. This is because it enables logistics managers to handle information more cheaply, increase coordination, and ultimately improve service by providing real-time data and faster responses. Focusing on 149 international logistics firms or service providers in Taiwan, Chang et al. [20] revealed that regulation and integration are key drivers of competitive advantage, which is primarily determined by the quality of services for transport users. By utilizing the structural equation modeling (SEM), the study showed that technology positively influences integration, which in turn acts as a mediating factor between

technology and competitive advantage. Using a two-step GMM estimator on data from 135 countries between 2005 and 2022, Nguyen et al. [7] found that aid for trade (AfT) boosts the sophistication of service exports in recipient countries. Notably, AfT directed at non-service sectors was more effective in promoting service export sophistication than aid for service sectors. The research also highlighted that AfT is especially effective at improving service export sophistication in least developed countries and countries with stronger governance. Ding et al. [21] employed a panel data set of Chinese firms from 2012 to 2022 to discover how fintech impacts the technological sophistication of exports. The findings showed that fintech's positive influence works through several key channels: alleviating financing constraints, correcting financial mismatches, optimizing credit resource allocation, and enhancing firms' innovation capabilities. Moreover, the study noted that this effect is more significant for certain types of firms, specifically non-state-owned enterprises and those operating in environments with less information disclosure, lower industry competition, and less advanced regional financial development.

Previous studies have examined how productive capacities affect multiple facets of countries' economic performance [12, 14–17]. Avenyo et al. [12] analyzed firm-level data from 29 African countries to explore the factors driving export success. Concluding the study with a censored regression model reveals that technological and production capabilities are key determinants of a firm's export ability. This highlighted that when companies have stronger productive capabilities, they become more competitive and efficient, improving their export performance. Using data from 126 countries from 2002 to 2018, Gnangnon [16] demonstrated that improving a nation's productive capacities enhances its economic complexity. Besides, the study identified a complementary relationship between productive capacities and different forms of development aid. Both AfT and Non-AfT flows complement productive capacities in promoting economic

complexity. Interestingly, this complementary effect is more substantial for AfT in low-income countries compared to other nations receiving this type of aid. Examining 118 developing countries from 2000 to 2018, Gnangnon [14] found that strengthening productive capacities leads to greater economic resilience. This effect is especially pronounced in countries that have more open trade and capital accounts, and those with stable macroeconomic policies. The study also revealed a complex role for development aid. While AfT strengthens the positive link between productive capacities and resilience, other forms of aid (Non-AfT) seem to hinder it. Le Clech [15] examined how productive capacities affect international competitiveness in 20 Latin American and Caribbean countries from 2000 to 2018. The findings showed that natural resources, energy, business regulations, and ICT are key drivers of competitiveness. Specifically, the study highlighted that infrastructure, particularly energy, has a positive impact, while the effects of ICT and transport are minor. Focusing on the relationship between productive capacities, economic vulnerability, and growth volatility across 43 sub-Saharan African countries during 2000–2018, Yaya [17] confirmed that economic vulnerability increases the volatility of a country's economic growth. However, countries with high productive capacities showed a greater ability to reduce the negative impact of economic vulnerability on their growth stability.

Productive capacities can enhance service export sophistication in developing countries by providing the foundational and advanced elements necessary for firms to compete globally on quality. First, productive capacities encompass human capital, which is arguably one of the most critical components for the service sector [22]. A well-educated and highly skilled workforce with specialized training in business and technology delivers sophisticated, high-value services to stakeholders. These include information technology, finance, and engineering, which enable a country to become more valuable. Second, good institutions provide the essential framework of

trust and reliability. It consists of a stable legal system, transparent business regulations, and effective contract enforcement, which significantly reduces risks for foreign clients and builds a reputation for reliability. Third, beyond human and institutional factors, physical infrastructure, such as modern telecommunications and reliable energy grids, provides the logistical backbone for service delivery [10]. High-speed internet is particularly vital for digital services, allowing firms to connect with clients worldwide instantly. Finally, access to and effective use of advanced technology, from specialized software to digital platforms, enables firms to enhance efficiency, innovate their offerings, and scale their operations [23]. By developing these interconnected components of productive capacities, developing nations can strategically move up the value chain. They can transition from exporting basic, low-skill services like data entry to more complex and profitable services like consulting, architectural design, or medical tourism. While existing research has highlighted the benefits of productive capacities, it has yet to explore their connection to the sophistication of service exports. Thus, this study addresses that gap by examining the relationship in a sample of 103 developing countries from 2005 to 2022.

III. RESEARCH METHODS

A. Model specification

For empirical analysis, this study applied a panel fixed-effects regression based on Model (1):

$$normalized\_EXPY_{i,t} = \alpha_0 + \alpha_1 \ln(PCI)_{i,t} + \alpha_2 \ln(AfT)_{i,t} + \alpha_3 shock_{i,t} + \alpha_4 ln(openness)_{i,t} \quad (1)$$
$$+ \alpha_5 \ln(FDI)_{i,t} + \gamma_i + \Omega_t + \varepsilon_{i,t}$$

where i identifies each country, and t indicates each year. γ_i reflects country-level fixed effects, Ω_t corresponds to annual dummy variables, and $\varepsilon_{i,t}$ denotes the error term. The dependent variable, $normalized\_EXPY_{i,t}$, represents the service export sophistication of country i in year t. The specific methodology for this measure is based on the approach outlined by Hausmann

et al. [9], which is originally designed to calculate the sophistication of merchandise exports as Equation 2:

$$EXPY_i = \sum_k \frac{x_{ik}}{X_i} \times PRODY_k \quad (2)$$

where '$EXPY_i$' represents country $i's$ export sophistication. x_{ik} captures country $i's$ export value of product k. X_i measures the total export value of country i. $PRODY_k$ indicates the complexity of product k, which can be determined by Equation (3):

$$PRODY_k = \sum_j \frac{x_{ik}/X_i}{\sum_i(\frac{x_{ik}}{X_i})} \times Y_i \quad (3)$$

where Y_i is the real gross domestic product (GDP) per capita of country i.

While the methodology from Hausmann et al. [9] is a popular approach to measure service export sophistication [18, 24, 25], researchers have raised concerns. Yao [26] argued that the index is sensitive to a country's economic size, which can lead to larger countries appearing more sophisticated than they truly are. To address this, Yao [26] recommended using the logarithm of income instead of the raw income value when constructing the PRODY index. Moreover, to minimize the impact of outliers, this study normalized the PRODY value using Equation (4) provided by Nguyen et al. [7] as follows:

$$normalized\_PRODY_{kt} = \frac{PRODY_{kt} - minPRODY}{maxPRODY - minPRODY} \quad (4)$$

where '$minPRODY$' and '$maxPRODY$' represent the smallest and largest PRODY values found across the entire dataset.

Therefore, this study employed Equation (5) to measure the sophistication of country i's service exports in year t (denoted by '$normalized\_EXPY_{i,t}$'):

$$normalized\_EXPY_{i,t} = \sum_k \frac{x_{ikt}}{X_{it}} \times normalized\_PRODY_{kt} \quad (5)$$

where '$normalized\_PRODY_{kt}$' was calculated based on Equation (4) and PRODY was proxied

as Equation (6):

$$PRODY_{kt} = \sum_i \frac{x_{ikt}/X_{it}}{\sum_i(\frac{x_{ikt}}{X_{it}})} \times \ln(Y_{it}) \ (6)$$

with k representing the service sector. x_{ikt} shows the export value of the service sector k by country i in year t. X_{it} measures the total service export value of country i in year t. Y_{it} captures the real GDP per capita of country i in year t.

This study also used the following measure of service export sophistication without normalization of PRODY for a robustness check, presented in Equation 7:

$$EXPY_{i,t} = \sum_k \frac{x_{ikt}}{X_{it}} \times PRODY_{kt} \ (7)$$

where '$PRODY_{kt}$' is calculated based on Equation (6).

Service trade data were downloaded from the WTO-OECD Balanced Trade in Service Dataset [27], which covers over 200 reporters with information for 12 service sectors since 2005. These sectors were classified according to the sixth edition of the IMF Balance of Payments and International Investment Position Manual (BPM6) [28].

The key independent variable, $lnPCI_{i,t}$ is the natural logarithm of the PCI of country i in year t. In February 2021, the UNCTAD [29] introduced a new PCI to measure a country's ability to produce goods and services. This index is calculated as a geometric average of eight key areas: ICT, structural change, natural capital, human capital, energy, transport, the private sector, and institutions.

Building on existing research, this study also considers several factors that moderate the impact of productive capacities on service export sophistication. First, aid for trade (denoted by 'AfT') can boost the service export sophistication of recipient countries by addressing key supply-side and infrastructural deficiencies [7]. By funding investments in crucial physical infrastructure such as advanced telecommunications and transport networks, AfT directly enables the efficient and reliable delivery of services. Additionally, it

provides vital technical assistance and capacity-building programs, helping domestic firms adopt international standards and improving the sophistication of their outputs. Therefore, this study uses the logarithm of AfT's gross disbursements as a variable to assess the quality of service exports. Data for AfT, in constant prices 2022, million US dollars, are taken from the credit reporting system of the OECD statistical database [30].

Second, trade openness (shortened to 'openness') can foster service export sophistication by promoting technology diffusion, enhancing capital efficiency, and boosting global value chain integration [31, 32]. According to Idris et al. [30] and Salik et al. [31], trade openness was measured by the proportion of total exports and imports in GDP. Data for imports, exports, and GDP are taken from the World Development Indicators of the World Bank [33].

Third, foreign direct investment (represented as 'FDI') serves as a channel for transferring advanced technologies and managerial skills, enhancing human capital, and integrating domestic firms into global production networks [34, 35]. Hence, it is expected to play a crucial role in promoting the sophistication of service export. This study includes the natural logarithm of FDI inflows relative to GDP as an explanatory variable, with data obtained from the UNCTAD database [36].

Fourth, external shocks (denoted by 'shock'), capturing external economic and financial shocks, may hinder countries' service export sophistication by reducing access to essential inputs, decreasing firm investment, and a loss of skilled labor [37, 38]. Economic shocks, such as a recession in a major trading partner, can drastically cut demand for a country's services, forcing firms to lower prices and potentially reduce quality to stay competitive. Similarly, financial shocks could limit a firm's access to capital, making it difficult to invest in advanced technology, training, or marketing needed to maintain high-quality service standards. This study applied the approach of Nguyen [39] to

measure the extent of external economic and financial shocks as in Equation (8):

$$shock = sign\,(ERP) * \log(1+|ERP|)\ (8)$$

where ERP is calculated using the following Equation (9):

$$ERP_{i,t} = w_{E,i} * \frac{\Delta E_{i,t}}{E_{i,t-1}} - w_{RES,i} * \frac{\Delta RES_{i,t}}{RES_{i,t-1}}\ (9)$$

$\Delta E_{i,t}$ and $\Delta RES_{i,t}$ represent the difference in the normal effective exchange rate (measured by local currency units per USD) of country i and the difference in the size of foreign reserves (in current US$) of country i between year t and year $t-1$. $E_{i,t-1}$ and $RES_{i,t-1}$ are the normal effective exchange rate of country i and the size of foreign reserves (in current US dollar) of country i in year $t-1$. $w_{E,i}$ and $w_{RES,i}$ reflect country-specific weights and are computed as follows: $w_{E,i} = \sigma_{RES,i}/(\sigma_{RES,i} + \sigma_{E,i})$ and $w_{RES,i} = \sigma_{E,i}/(\sigma_{RES,i} + \sigma_{E,i})$ with $\sigma_{RES,i}$ and $\sigma_{E,i}$ being the standard deviations of $\Delta RES_{i,t}/RES_{i,t-1}$ and $\Delta E_{i,t}/E_{i,t-1}$ over the entire period 2005–2022.

Based on the availability of data, the final sample is an unbalanced panel dataset with 103 developing countries from 2005 to 2022. The descriptive statistics are provided in Table 1.

B. Model validation tests

To identify the most appropriate estimation technique, this study employed several diagnostic evaluations. First, the Breusch-Pagan Lagrange multiplier test was performed to choose between the pooled ordinary least squares and the random effects model. The outcome is reported in Table 2 with a p-value lower than 0.01, suggesting the rejection of the null hypothesis H_0. This result indicates that the random effects specification provides a better fit for the data than the pooled ordinary least squares.

Next, this study conducted the Hausman test to compare the suitability of the random effects and fixed effects estimators. The result presented in Table 3 reveals a p-value of less than 0.01, leading to the rejection of the null hypothesis H_0

and confirming that the fixed effects model is more suitable than the random effects model.

This study further employed the Variance Inflation Factor (VIF) test to assess the presence of multicollinearity among the explanatory variables in the panel dataset and reports the results in Table 4. As shown in Table 4, all control variables exhibit VIF values lower than 10, implying that the estimated model does not suffer from serious multicollinearity issues.

IV. EMPIRICAL RESULTS AND DISCUSSIONS

A. Trends of the productive capacities index and service export sophistication

Figure 1 depicts trends of PCI and service export sophistication across 103 developing countries between 2005 and 2022. The data is presented visually with a bar chart on the right for productive capacities and a line chart on the left for service export sophistication, allowing for a direct comparison of their respective trends.

The analysis of production capacities reveals a general upward trend with incoherent fluctuations. The average PCI for these developing nations shows a steady increase, rising from approximately 35.54 in 2005 to a peak of 42.07 in 2018. This sustained growth indicates significant progress in building the foundational elements for economic output, such as infrastructure, technology, and human capital. However, this trajectory was suddenly halted by the COVID-19 pandemic. It causes a severe and significant reduction in the productive capabilities of these countries. Following this downturn, a period of gradual recovery has been observed in the following years as a result of the great efforts by these nations to rebuild and restore their economies. The data on service export sophistication demonstrates a positive, long-term growth trend, reflecting an increasing ability of developing countries to offer more sophisticated services to the international market. This growth, however, has been highly vulnerable to major global economic shocks such as the 2008–2009 global financial crisis and the COVID-19 pandemic.

Table 1: Descriptive statistics of variables in the study

Variable	Obs	Mean	Std. Dev.	Min	Max	Expected sign	References
Dependent variable							
normalized_EXPY	1568	.429	.068	.033	.639		[7, 9, 26]
EXPY	1568	8.263	.238	6.877	8.997		
Independent variables							
ln_PCI	1568	3.673	.262	2.527	4.105	+	[12, 14, 16]
ln_StructuralChange	1568	3.906	.301	2.081	4.604	+	
ln_Energy	1568	3.699	.593	.687	4.328	+	
ln_Institutions	1568	3.807	.271	2.637	4.361	+	
ln_Naturalcapital	1568	3.738	.286	2.541	4.605	+	
ln_Transport	1568	3.501	.496	.194	4.524	+	
ln_Privatesector	1568	3.738	.336	.327	4.397	+	
ln_ICT	1568	3.394	.598	.736	4.27	+	
ln_Humancapital	1568	3.573	.311	2.392	4.158	+	
ln_AfT	1568	4.368	1.714	-3.335	8.313	+	[7]
shock	1568	.004	.133	-3.223	.878	-	[39]
ln_openness	1568	4.315	.486	3.05	5.852	+	[40, 41]
ln_FDI	1568	1.249	1.245	-6.271	4.039	+	[34, 35]

Source: Authors' elaboration

Table 2: Breusch and Pagan Lagrangian multiplier test

H_0 : PLS is more appropriate

chibar2(01) = 3347.19

Prob > chibar2 = 0.0000

Source: Authors' calculation using Stata 14 software

Table 3: Hausman test

H_0 : difference in coefficients not systematic

chi2(5) = 157.69

Prob>chi2 = 0.0000

Source: Authors' calculation using Stata 14 software

Table 4: Multicollinearity test

Variable	VIF	1/VIF
ln_openness	1.61	0.619765
ln_FDI	1.33	0.751385
ln_PCI	1.25	0.799015
ln_AfT	1.04	0.965307
shock	1.00	0.996329
Mean VIF	**1.25**	

Source: Authors' calculation using Stata 14 software

Fig. 1: Trends of productive capacities and service export quality across 103 developing countries, 2005–2022

Source: Authors' calculation [42, 27]

B. Regression results and discussions

First, this study examined the impact of productive capacities on service export sophistication by applying the fixed effects regressions to Model (1). Column (1) of Table 5 presents the results with the dependent variable measured by 'normalized_EXPY'. For robustness check, 'normalized_EXPY' in Model (1) is replaced by 'EXPY' and display the results in Column

(2) of Table 5. The key independent variable is the natural logarithm of the productive capacities index (denoted by 'PCI').

According to Table 5, the estimated coefficients for 'PCI' are consistently positive and statistically significant across all columns. This outcome suggests that a country's productive capacities have a direct and positive impact on the sophistication of its service exports. This finding is consistent with the research of Avenyo et al. [12], who discovered that production capabilities are crucial for a firm's export success. Furthermore, this study contributes to the existing literature by identifying another driver of export sophistication and complementing the previous works [7, 18, 20, 21].

Regarding the control variables, this study demonstrates that 'AfT', 'openness', and 'FDI' have positive and significant effects on service export sophistication. This result suggests that policies promoting international development assistance, trade liberalization, and foreign investment contribute to a more sophisticated service export sector. Conversely, although the coefficient of the 'shock' variable is negative, its statistical insignificance implies that external and financial shocks do not exert a systematic influence on the sophistication of service exports, possibly reflecting the cross-country heterogeneity in shock exposure. For example, the results align with Nguyen et al. [7], who found that AfT enhances the quality of service exports in a sample of 135 recipient countries from 2005 to 2022. Hu et al. [43] documented that trade facilitation significantly enhances export technological sophistication in European transition economies. Bin et al. [44] provided evidence that Chinese export sophistication increases with greater involvement of OECD-owned and foreign-invested enterprises.

To deeper understand the impact of productive capacities on service export sophistication, this study replaces 'PCI' variable in Model (1) with its components, including structural change (denoted by 'StructuralChange'), energy (denoted by 'Energy'), human capital (denoted by 'Humancapital'), institutions (denoted by 'Institutions'), natural capital (denoted by 'Naturalcapital'), ICT (denoted by 'ICT'), transport (denoted by 'Transport'), and private sector (denoted by 'Privatesector'). Table 6 consists of two panels presenting the regression results. Panel A reports the estimates using 'normalized_EXPY' as the dependent variable, while Panel B displays the results with 'EXPY' as the dependent variable. Column (1)–Column (8) show the outcomes for individual components of the PCI. For robustness, all eight PCI components are jointly included in a single regression, and the corresponding results are reported in Column (9).

The research findings reveal heteroskedasticity in the influence of components of productive capacities on the sophistication of service exports. Among the eight components of the PCI, human capital, natural capital, ICT, and transport exert the most significant influence on service export sophistication, while other components, including structural change, institutions, energy, and private sector development, do not exhibit statistically significant effects. According to the UNCTAD [10], human capital refers to the knowledge, education, and skills of a country's labor force that enable the creation, adaptation, and application of innovative ideas and technologies. The strongest positive association between human capital and service export sophistication suggests that skilled and educated workers play a pivotal role in enhancing the complexity, innovation, and overall quality of its service outputs. Highly trained human resources not only possess the technical expertise and skills necessary for creating and delivering advanced services but also contribute to continuous learning, adaptation, and technological upgrading within the sector. Sophisticated service industries typically depend heavily on human expertise and specialized knowledge,

Table 5: Impact of productive capacities on service export quality (103 countries, 2005–2022)

VARIABLES	(1) normalized_EXPY	(2) EXPY
PCI (in log)	0.119**	0.417**
	(0.0515)	(0.180)
AfT (in log)	0.00220*	0.00768*
	(0.00126)	(0.00441)
shock	-0.0264	-0.0923
	(0.0164)	(0.0572)
openness (in log)	0.0128**	0.0446**
	(0.00641)	(0.0224)
FDI (in log)	0.00258*	0.00901*
	(0.00153)	(0.00535)
Constant	-0.154	6.223***
	(0.178)	(0.621)
Country fixed effects	YES	YES
Year fixed effects	YES	YES
Observations	1,561	1,561
Observations	1,568	1,568
R-squared	0.697	0.697

Note: Robust standard errors are in parentheses; *, **, and *** reflect statistical significance at the 10%, 5% and 1% level, respectively.

which enable firms to differentiate their offerings and move up the global value chain. This result supports the view of Wanigasekara et al. [22] and Mishra et al. [45], who documented that human capital is an essential element for the success of the service sector.

The positive effect of natural capital on service export sophistication aligns with the UNCTAD's view that natural capital can shape development paths, influence structural transformation, and support productive diversification [29]. Having many natural resources often creates a need for complex support services like logistics, engineering, environmental advice, energy planning, and financial services. For example, a country with lots of oil or minerals often develops strong skills in areas like geological surveys, project funding, and environmental tracking. These are all services that require a high level of technical skills. Moreover, revenues and rents from natural capital can be reinvested in education, training, and research and development, which are the foundations for service sector upgrading.

The positive and significant coefficient of the 'ICT' variable highlights the crucial role of digital connectivity in boosting service export sophistication. ICT capacity reflects how widely

communication technologies are available and integrated among the population [29]. This capacity covers indicators such as fixed and mobile phone usage, internet connectivity, and the security of servers. Greater ICT capacity facilitates communication, information exchange, and coordination, which are essential for delivering modern, knowledge-intensive services. Enhanced digital infrastructure allows service providers to participate in global value chains, reduce transaction costs, and access international markets more efficiently. The result of this study is consistent with Asongu et al. [46], who demonstrate that expanding ICT access, particularly through wider use of mobile phones and the internet, can boost value added in the service sectors of Sub-Saharan African countries. Similarly, Atasoy [47] demonstrated that higher levels of digitalization, particularly greater internet user penetration, significantly enhance countries' export sophistication.

Similarly, the positively significant coefficient of transport capacity indicates the importance of physical infrastructure in supporting complex service activities. Particularly, transport capacity captures a country's ability to move people and goods efficiently through its road, railway, and air networks [10]. When a country has strong

roads, railways, and air networks, business travel becomes smoother, allowing service providers to meet clients, explore markets, and deliver specialized support in person when needed. Better connectivity reduces delays and trade costs, making it easier for firms to coordinate complex activities across borders. These improvements help service providers meet higher quality standards, integrate more deeply into global value chains, and expand into knowledge-intensive areas, ultimately raising the overall sophistication of the services they export. The study's outcome complements the findings of Kamguia et al. [48], who documented that better transport infrastructure fosters greater export sophistication in the African countries.

In contrast, other PCI components, namely energy, institutions, private sector development, and structural change, do not show statistically significant relationships with service export sophistication in this study. Although energy capacity may contribute to overall economic efficiency, service sectors are generally less energy-intensive than manufacturing. Thus, variation in energy availability or sustainability may not necessarily lead to measurable differences in service export complexity. Similarly, while institutional quality is essential for long-term development, improvements in governance, regulatory quality, or political stability may affect service exports only indirectly or with substantial time lags. As a result, their short-term impact is more difficult to identify. The private sector component, which captures trade costs, credit access, and contract enforcement, may also have a limited direct association with service export upgrading because many sophisticated services depend more heavily on knowledge, digital capabilities, and skilled labor than on traditional measures of business environment. Finally, the insignificant relationship between structural change capacity and service export sophistication suggests that the overall transformation of the economy does not fully reflect the conditions necessary for upgrading service exports. Structural change indicators mainly reflect the shift to higher productivity activities in manufacturing industries. Moreover,

structural change tends to be influenced by long-term policy reforms, thus its impact on service export sophistication may manifest only with a significant lag.

V. CONCLUSION AND IMPLICATIONS

This study empirically examines how productive capacities in developing countries influence the sophistication of their service exports. Utilizing a methodology for measuring export complexity developed by Hausmann et al. [9], this research analyzes a panel dataset of 103 developing countries over 2005–2022. Furthermore, the employment of fixed effects estimators reveals that productive capacities are critical drivers in upgrading service export sophistication. The most significant component of productive capacities is human capital. Other elements, including natural capital, ICT, and transport, also contribute meaningfully to this improvement, though to a slightly lesser extent.

Given the increasing role of service sectors in driving trade and economic growth in developing nations, the findings of this study provide several important implications. First, policymakers should prioritize long-term investment in human capital, particularly through education, training, and digital skill development, to strengthen the knowledge base required for complex services. Besides, governments must manage resource endowments strategically, using revenues from extractive and agricultural sectors to finance service-sector innovation, environmental management services, and knowledge-intensive supporting industries. Last but not least, improvements in ICT infrastructure and transport systems are essential for enabling firms to access international markets, coordinate cross-border service delivery, and meet the operational requirements of sophisticated services.

Table 6: Impact of productive capacities' components on service export sophistication
(103 countries, 2005–2022)

Panel A: Results with 'normalized_EXPY' as the dependent variable

VARIABLES	(1) normalized _EXPY	(2) normalized _EXPY	(3) normalized _EXPY	(4) normalized _EXPY	(5) normalized _EXPY	(6) normalized _EXPY	(7) normalized _EXPY	(8) normalized _EXPY	(9) normalized _EXPY
StructuralChange	-0.00268								-0.00821
(in log)	(0.0140)								(0.0119)
Energy		0.0109							-0.00342
(in log)		(0.0117)							(0.00738)
Humancapital			0.0877***						0.0567**
(in log)			(0.0292)						(0.0227)
Institutions				-0.0127					-0.0234
(in log)				(0.0155)					(0.0162)
Naturalcapital					0.0321**				0.0473**
(in log)					(0.0142)				(0.0200)
ICT						0.0303**			0.0287**
(in log)						(0.0151)			(0.0124)
Transport							0.0188**		0.0153**
(in log)							(0.00760)		(0.00621)
Privatesector								-0.0161	-0.0297
(in log)								(0.0203)	(0.0232)
Constant	0.227***	0.184**	-0.0349	0.265***	0.0971	0.143**	0.160***	0.274***	-0.00683
	(0.0835)	(0.0727)	(0.121)	(0.0779)	(0.0798)	(0.0603)	(0.0564)	(0.0759)	(0.188)
Country FEs	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FEs	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
R-squared	0.668	0.669	0.686	0.668	0.669	0.681	0.674	0.668	0.702

*Note: Robust standard errors are in parentheses. *, **, and *** reflect statistical significance at the 10%, 5% and 1% level, respectively.*

Panel B: Results with 'EXPY' as the dependent variable

VARIABLES	(1) EXPY	(2) EXPY	(3) EXPY	(4) EXPY	(5) EXPY	(6) EXPY	(7) EXPY	(8) EXPY	(9) EXPY
StructuralChange	-0.00936								-0.0287
(in log)	(0.0489)								(0.0415)
Energy		0.0381							-0.0119
(in log)		(0.0409)							(0.0258)
Humancapital			0.307***						0.198**
(in log)			(0.102)						(0.0795)
Institutions				-0.0445					-0.0818
(in log)				(0.0542)					(0.0565)
Naturalcapital					0.112**				0.165**
(in log)					(0.0496)				(0.0700)
ICT						0.106**			0.100**
(in log)						(0.0529)			(0.0434)
Transport							0.0657**		0.0534**
(in log)							(0.0266)		(0.0217)
Privatesector								-0.0564	-0.104
(in log)								(0.0710)	(0.0811)
Constant	7.554***	7.406***	6.639***	7.688***	7.101***	7.262***	7.320***	7.718***	6.737***
	(0.292)	(0.254)	(0.424)	(0.272)	(0.279)	(0.211)	(0.197)	(0.265)	(0.657)
Country FEs	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FEs	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
R-squared	0.668	0.669	0.686	0.668	0.669	0.681	0.674	0.668	0.702

*Note: Robust standard errors are in parentheses. *, **, and *** reflect statistical significance at the 10%, 5% and 1% level, respectively.*

ACKNOWLEDGMENT

REFERENCES

[1] International Monetary Fund. *Services trade expands at a faster pace than goods trade.* https://data.imf.org/en/news/november%2013-26%20- [Accessed 20 August 2025].

[2] United Nations Conference on Trade and Development. *Trade in services 2023 – annual bulletin.* https://unctad.org/system/files/official-document/statinf2024d4_en.pdf [Accessed 20 August 2025].

[3] Zhang Z. Impact of digital transformation on global services trade flows. *Applied Mathematics and Nonlinear Sciences.* 2024;9(1): 1–15. https://doi.org/10.2478/amns-2024-0879.

[4] World Trade Organization. *Trade in services for development – fostering sustainable growth and economic diversification.* Washington, D.C: World Bank Group. Report number: 185136, 2023. http://documents.worldbank.org/curated/en/099258110092319807.

[5] Miroudot S, Cadestin C. *Services in global value chains: From inputs to value-creating activities.* Paris: OECD Publishing; 2017. https://doi.org/10.1787/465f0d8b-en

[6] Low P. The role of services in global value chains. In: Elms DK, Low P (ed.). *Global value chains in a changing world.* Geneva: World Trade Organization; 2013. p.61–81. https://doi.org/10.30875/8d564dca-en.

[7] Nguyen TTH, Park D. Aid for trade and the quality of service exports in recipient countries. *International Journal of Trade and Global Markets.* 2024;20(3–4): 239–59. https://doi.org/10.1504/IJTGM.2024.145835.

[8] Gabrielczak P, Kuziemska-Pawlak K. The specialisation and sophistication of services exports: the case of the Visegrad countries. *Journal of International Studies.* 2021;14(3): 93–113. https://doi.org/10.14254/2071-8330.2021/14-3/6.

[9] Gabrielczak P, Kuziemska-Pawlak K. The specialisation and sophistication of services exports: the case of the Visegrad countries. *Journal of International Studies.* 2021;14(3): 93–113. https://doi.org/10.14254/2071-8330.2021/14-3/6.

[10] United Nations Conference on Trade and Development. *The least developed countries report 2006: Developing productive capacities.* Geneva: United Nations. Report number: UNCTAD/LDC/2006, 2006. https://unctad.org/system/files/official-document/ldc2006_en.pdf [Accessed 20 August 2025].

[11] Andreoni A. Structural learning: embedding discoveries and the dynamics of production. *Structural Change and Economic Dynamics.* 2014;29: 58–74. https://doi.org/10.1016/j.strueco.2013.09.003

[12] Avenyo EK, Tregenna F, Kraemer-Mbula E. Do productive capabilities affect export performance? Evidence from African firms. *The European Journal of Development Research.* 2021;33(2): 304–329. https://doi.org/10.1057/s41287-021-00364-6.

[13] Bell M, Pavitt K. Technological accumulation and industrial growth: contrasts between developed and developing countries. *Industrial and corporate change.* 1993;2(2): 157–210. https://doi.org/10.1093/icc/2.2.157.

[14] Gnangnon SK. Effect of productive capacities on economic resilience in developing countries. *Asian Development Perspectives.* 2022;13(1): 1–35. https://doi.org/10.22681/ADP.2022.13.1.1.

[15] Le Clech NA. Productive capacity and international competitiveness: evidence from Latin America and Caribbean countries. *Empirica.* 2023;50(3): 695–724. https://doi.org/10.1007/s10663-023-09581-0.

[16] Gnangnon SK. Effect of productive capacities on economic complexity. *Journal of Economic Integration.* 2021;36(4): 626–688. https://doi.org/10.11130/jei.2021.36.4.626

[17] Yaya A. *Productive capacities, economic vulnerability and growth volatility in Sub-Saharan Africa.* Working paper. Washington, D.C.: International Monetary Fund; 2024. https://doi.org/10.5089/9798400286308.001.

[18] Huang S, Chen Y. FDI in services and China's service export sophistication. In: *Proceedings of the 11th International Conference on Service Systems and Service Management.* 25–27 June 2014; Institute of Electrical and Electronics Engineers, Beijing, China. IEEE; 2014. p.1–5. https://doi.org/10.1109/ICSSSM.2014.6874085 [Accessed 20 August 2025].

[19] Kubasáková I, Kampf R, Stopka O. Logistics information and communication technology. *Communications-Scientific letters of the University of Zilina.* 2014;16(2): 9–13. https://doi.org/10.26552/com.C.2014.2.9-13.

[20] Chang CH, Lu CS, Lai PL. Examining the drivers of competitive advantage of the international logistics industry. *International Journal of Logistics Research and Applications.* 2022;25(12): 1523–1541. https://doi.org/10.1080/13675567.2021.1915263.

[21] Ding Y, Sun Y. Does fintech development matter for export technological sophistication? Evidence from Chinese enterprises. *Emerging Markets Finance and Trade.* 2025;41(15): 4579–4597. https://doi.org/10.1080/1540496X.2025.2520885.

[22] Wanigasekara WADKJ, Deshika NPT. Human capital efficiency and employee productivity: a compara-

tive analysis of the manufacturing sector vs. service sector public listed companies in Sri Lanka. In: *Proceedings of the 17th international conference on business management*. 10–11 December 2020; Colombo, Sri Lanka. Colombo: University of Sri Jayewardenepura; 2020. p.373–386. https://doi.org/10.31357/icbm.v17.5155.

[23] Breidbach C, Choi S, Ellway B, Keating BW, Kormusheva K, Kowalkowski C, et al. Operating without operations: how is technology changing the role of the firm? *Journal of Service Management*. 2018;29(5): 809–833. https://doi.org/10.1108/JOSM-05-2018-0127.

[24] Gable SL, Mishra S. *Service export sophistication and Europe's new growth model. Working paper*. Washington, D.C.: World Bank; 2011. https://documents1.worldbank.org/curated/en/9749614 68032339533/pdf/WPS5793.pdf [Accessed 20 August 2025].

[25] Desai FP. Exploring the sophistication in services exports. *Journal of Global Economy*. 2013;9(3): 197–209. https://doi.org/10.1956/jge.v9i3.305.

[26] Yao S. Why are Chinese exports not so special? *China & World Economy*. 2009;17(1): 47–65. https://doi.org/10.1111/j.1749-124X.2009.01130.x.

[27] World Trade Organization, Organisation for Economic Co-operation and Development. *WTO-OECD Balanced Trade in Services Dataset 2023*. https://www.oecd.org/en/data/datasets/oecd-balanced-trade-statistics.html [Accessed 15 September 2025].

[28] International Monetary Fund. *Balance of payments and international investment position manual*. 6th ed. Washington, DC: International Monetary Fund; 2009.

[29] United Nations Conference on Trade and Development. *Productive capacities index: methodological approach and results*. Geneva: United Nations Conference on Trade and Development. Report number: UNCTAD/ALDC/2020/3, 2021. https://unctad.org/system/files/official-document/aldc2020d3_en.pdf [Accessed 20 August 2025].

[30] Organisation for Economic Co-operation and Development. *CRS: Creditor Reporting System (flows)*. https://data-explorer.oecd.org/?tm=Creditor%20Reporting%20 System&pg=0&snb=16 [Accessed 20 August 2025].

[31] Li Y, Zhang H, Liu Y, Huang Q. Impact of embedded global value chain on technical complexity of industry export – An empirical study based on China's equipment manufacturing industry panel. *Sustainability*. 2020;12(7): 1–14. https://doi.org/10.3390/su12072694.

[32] Rigo D. Global value chains and technology transfer: new evidence from developing countries. *Review of World Economics*. 2021;157(2): 271–294. https://doi.org/10.1007/s10290-020-00398-8.

[33] World Bank. *World development indicators*. https://databank.worldbank.org/source/world-development-indicators# [Accessed 20 August 2025].

[34] Sugiharti L, Yasin MZ, Purwono R, Esquivias MA, Pane D. The FDI spillover effect on the efficiency and productivity of manufacturing firms: Its implication on open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*. 2022;8(2): 1–20. https://doi.org/10.3390/joitmc8020099.

[35] Newman C, Rand J, Talbot T, Tarp F. Technology transfers, foreign investment and productivity spillovers. *European Economic Review*. 2015;76: 168–187. https://doi.org/10.1016/j.euroecorev.2015.02.005.

[36] United Nations Conference on Trade and Development. *Foreign direct investment: Inward and outward flows and stock, annual*. https://unctadstat.unctad.org/datacentre/dataviewer/US. FdiFlowsStock [Accessed 12 September 2025].

[37] Amiti M, Weinstein DE. Exports and financial shocks. *The Quarterly Journal of Economics*. 2011;126(4): 1841–1877. https://doi.org/10.1093/qje/qjr033.

[38] Attinasi MG, Balatti M, Mancini M, Metelli L. *Supply chain disruptions and the effects on the global economy*. https://www.ecb.europa.eu/press/economic-bulletin/focus/2022/html/ecb.ebbox202108_01~8cee be51f.en.html [Accessed 20 August 2025].

[39] Nguyen TTH. Impact of exchange rate risks on trade flows: Does regional integration in production matter? *Journal of International Commerce, Economics and Policy*. 2025;16(2): 2550011. https://doi.org/10.1142/S1793993325500115.

[40] Idris J, Yusop Z, Habibullah MS. Trade openness and economic growth: A causality test in panel perspective. *International Journal of Business and Society*. 2016;17(2): 281–290. https://doi.org/10.33736/ijbs.525.2016.

[41] Salik AM, Aras ON. The effects of trade openness, foreign direct investment and exchange rate fluctuations on non-oil gross domestic product growth in Nigeria. *Journal of Management, Economics, and Industrial Organization*. 2022;6(1): 98–117. https://doi.org/10.31039/jomeino.2022.6.1.6.

[42] United Nations Conference on Trade and Development. *Productive capacities index*. https://unctadstat.unctad.org/datacentre/dataviewer/US. PCI [Accessed 12 September 2025].

[43] Hu Y, Jiang M, Sun S, Dai Y. *Does trade facilitation promote export technological sophistication?* Evidence from the European transition countries. Sage Open. 2022;12(2): 1–20. https://doi.org/10.1177/21582440221106675.

[44] Bin X, Jiangyong L. Foreign direct investment, processing trade, and the sophistication of China's ex-

ports. *China Economic Review*. 2009;20(3): 425–439. https://doi.org/10.1016/j.chieco.2009.01.004.

[45] Mishra S, Lundström S, Anand R. *Service export sophistication and economic growth*. Working paper. Washington, D.C.: World Bank; 2011. https://doi.org/10.1596/1813-9450-5606.

[46] Asongu SA, Rahman M, Nnanna J, Haffar M. Enhancing information technology for value added across economic sectors in Sub-Saharan Africa. *Technological Forecasting and Social Change*. 2020;161: 120301. https://doi.org/10.1016/j.techfore.2020.120301.

[47] Atasoy BS. The determinants of export sophistication: Does digitalization matter? *International Journal of Finance & Economics*. 2021;26(4): 5135–5159. https://doi.org/10.1002/ijfe.2058.

[48] Kamguia B, Ndjakwa M, Tadadjeu S. Does infrastructural development foster export upgrading in Africa? *African Development Review*. 2023;35(1): 79–94. https://doi.org/10.1111/1467-8268.12684.