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Technological Disruption, Ease of Doing Business, and Manufacturing Resilience: A Study of Competitiveness and Efficiency in Developing Countries

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Abstract: This research aimed to analyze the determinants of efficiency and competitiveness in the manufacturing sector, encompassing GDP per capita, ease of doing business, technology, and several variables indicative of governance quality, such as corruption control and government effectiveness. Competitiveness in this study is measured using the concept of Revealed Comparative Advantages (RCA) introduced by Balassa (1965) employing Panel Corrected Standard Error (PCSE) estimation technique. Simultaneously, manufacturing efficiency is gauged utilizing the Data Envelopment Analysis (DEA) method, a nonparametric approach applied to compute the efficiency of a group of decision-making units (DMU). The findings reveal that GDP per capita, Technology, Government Governance Index, and Nominal Exchange Rate significantly and positively influence RCA. Conversely, Ease of Doing Business is found to exert a significant negative impact on RCA. Furthermore, the DEA efficiency scores indicate values of 1 for several African countries, including the Democratic Republic of Congo, Eswatini, and Burundi, and also find high efficiency in certain Asian countries such as China, Thailand, Malaysia, and Indonesia. Efficient allocation of capital (Gross Fixed Capital Formation) and labor (Labor Force in the Industrial Sector) optimizes output (Manufacturing Share of GDP). This study holds implications for enhancing the driving factors of competitiveness and optimizing efficiency in the manufacturing sector across developing countries worldwide.

Keywords: manufacturing sector; competitiveness; technology; ease of doing business; developing countries.

JEL classification: L60; C33; O14.

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1. INTRODUCTION

The manufacturing sector plays a crucial role in the economic development of a country. In developing nations, the growth of the manufacturing sector often serves as a primary indicator of economic progress and structural transformation (Mijiyawa, 2017; Haraguchi *et al.*, 2019). With the increasing forces of globalization and economic integration, developing countries are increasingly focusing on the development of the manufacturing sector to achieve sustainable economic growth. Research and development activities within manufacturing enterprises have become vital sources for technological advancement in the global economy (Shen *et al.*, 2007). Therefore, manufacturing stands as a key driver for innovation and technology diffusion. Additionally, manufacturing offers spillover advantages to other economic sectors (Tsai & Wang, 2004; Min *et al.*, 2019).

The evolution of manufacturing in the era of Artificial Intelligence (AI) has significantly transformed production methods and factory operations. By harnessing AI, manufacturing can optimize efficiency, enhance product quality, and reduce production costs. AI enables the development of more sophisticated and flexible automation systems. Industrial robotics equipped with AI can perform tasks requiring high precision, such as product assembly or material processing. They can also learn and adapt to changing production environments. In modern manufacturing, AI can optimize supply chain management by analyzing data from various sources, including suppliers, transportation, and inventory, to provide more accurate predictions of customer demand, reduce delivery times, and prevent stock shortages.

The development of the industrial sector in developing countries has been a focal point in recent decades. For instance, in Asia, a region experiencing rapid economic growth, several developing and emerging nations show potential for manufacturing sector development. Industrial development in Asia has been underway since the end of World War II, with Japan emerging as a global manufacturing powerhouse in the decades following the war, followed by other Asian nations such as South Korea, Taiwan, and Malaysia (Şengör *et al.*, 2023). Certain Latin American countries, such as Brazil (Andreoni & Tregenna, 2020; Contador *et al.*, 2020) and Mexico (Mosk, 2022), have also witnessed significant advancements in the industrial sector. They have engaged in manufacturing, including automotive, technology, and consumer products. Furthermore, regional and national initiatives have been undertaken to drive industrial growth in Africa, such as the African Continental Free Trade Area (AfCFTA), aiming to create a single market for goods and services across the continent, and government initiatives like "Made in Africa" to boost local production (Onwuka Onyinye & Udegbunam Kingsley, 2019; Apiko *et al.*, 2020). These countries, along with other developing nations, have successfully leveraged comparative advantages, such as competitive labor costs, technical expertise availability, and expansive markets, to develop robust manufacturing industries.

Rodrik (2006) argues that sustainable growth requires a dynamic industrial base. Hence, the concept of "industrialization logic" (Nixson, 1990) is introduced, explaining why many developing countries adopt strategies for rapid industrialization. Typically commencing with industries employing relatively simple technology and having the potential for labor-intensive absorption (Felipe & Estrada, 2008). The growth of the manufacturing sector in developing countries can have positive economic, social, and environmental impacts (Abdul-Rashid *et al.*, 2017). Firstly, a strong manufacturing sector

can create new employment opportunities and reduce unemployment rates (Kapoor, 2015; Machado *et al.*, 2020). Secondly, a developing manufacturing sector contributes to the increase in national income and exports (Noviriani *et al.*, 2023), thereby enhancing economic stability and trade balances. Thirdly, an innovation and technology-oriented manufacturing sector can drive productivity improvement and the country's competitiveness in the global market (Sutantio *et al.*, 2023). Lastly, an environmentally sustainable manufacturing sector can promote sustainable growth.

In Lewis' model, the economy of a developing country consists of two sectors: the traditional agricultural sector with surplus rural population characterized by zero marginal labor productivity, and the highly productive and modern urban industrial sector to which labor is gradually shifted from the agricultural sector (Lee, 1995). The basic idea of this theory is that industrial development occurs through the unlimited transfer of cheap labor to the modern sector. Therefore, in a situation of surplus labor, labor-using technologies should be employed for industrialization. Competitiveness and manufacturing efficiency become integral factors in driving growth and economic progress in developing countries. High competitiveness can propel a country's export growth. By becoming more efficient and competitive in the manufacturing sector, a country can enhance its production and exports, contributing to economic growth.

Hence, this research aims to conduct a comprehensive analysis of the factors driving competitiveness in the manufacturing sector in developing countries worldwide. The study will analyze factors influencing manufacturing sector competitiveness, such as GDP per capita, ease of doing business, technology, and several variables reflecting governance quality, such as corruption control and government effectiveness. Competitiveness in this research will employ the concept of Revealed Comparative Advantages (RCA) introduced by Balassa (1965). In addition to GDP per capita, this study will also use the squared term of GDP per capita to observe the possibility of U-shaped phenomena or deindustrialization in developing countries in Asia. Furthermore, this research will identify the level of technical efficiency and whether there are differences in manufacturing efficiency among developing countries.

2. LITERATURE REVIEW

The manufacturing sector assumes various crucial roles in the economy of a nation by significantly contributing to economic growth and employment generation. Within the framework of economic growth, the manufacturing sector is often regarded as a primary driver of innovation and productivity. The production of manufactured goods adds value through the utilization of advanced technology and enhanced efficiency in production processes. Furthermore, the sustainability of long-term economic growth is frequently contingent upon a nation's capacity to maintain a robust manufacturing sector capable of producing high-value goods and products for both domestic and global markets.

The theoretical foundation supporting the importance of the manufacturing sector is rooted in economic development theories, particularly within the concept of economic structuralization. This theory underscores the significance of economic diversification through the development of the manufacturing sector as a means to enhance competitiveness and economic resilience. Economic scholars such as Paul Krugman (Fujita & Thisse, 2009) also endorse this perspective, emphasizing the importance of the manufacturing sector in

improving productivity and creating spillover effects that stimulate overall economic growth. Spillover effects refer to the positive impacts generated by activities or innovations in one economic sector on other sectors. In the context of the manufacturing sector, spillover effects are closely associated with the idea that investments or innovations in manufacturing goods production can stimulate broader economic growth and enhance overall productivity. Several spillover effects in the manufacturing sector include:

a) Improved Productivity: Investments in technology and innovation in the manufacturing sector can lead to increased productivity. When a company or sector achieves higher productivity levels, it can trigger enhanced efficiency in the supply chain and accelerate economic growth, not only in developed countries, as stated in the findings of Hulten and Schwab (2000), but also in developing countries, as evidenced by the research of Khanna and Sharma (2021) indicating that high-tech manufacturing firms are more productive than low-tech counterparts.

b) Job Creation: The development of the manufacturing sector often directly and indirectly creates jobs. Involving a large workforce in the production process and supply chain leads to spillover effects in the form of job creation in related sectors such as logistics, distribution, and other supporting services. Lu *et al.* (2022) referred to this as human-centric manufacturing, believing that in the evolution map of manufacturing in the era of industry 5.0 through 5C, Coexistence, Cooperation and Collaboration to future Compassion, and Coevolution, a reliable human-machine coevolution relationship will be produced.

c) Innovation and Technology: As an innovation hub, the manufacturing sector creates spillover effects by generating new technologies and best practices. These innovations can spread to other sectors, enhancing overall economic competitiveness and driving growth in areas such as research and development (Xu *et al.*, 2019; Gomes *et al.*, 2022).

Optimizing the spillover effects of the manufacturing sector can be a key strategy for the progress of developing countries. Developing nations need to increase investment in research and development, especially in the manufacturing sector. By stimulating innovation and the development of new technologies, there will be opportunities to create spillover effects that enhance productivity and competitiveness throughout the economy. Training and education focusing on skills required in the manufacturing sector can enhance the quality of the workforce. Skilled human resources can maximize the benefits of spillover effects by effectively implementing new technology and innovations in the production process. Additionally, the development of robust infrastructure, such as reliable transportation and energy networks, can help improve connectivity and efficiency in the manufacturing supply chain. Good infrastructure facilitates the movement of raw materials and finished products, supports the growth of the manufacturing sector, and creates spillover opportunities in related sectors. Furthermore, creating a business-friendly environment, including conducive investment policies, tax incentives, and clear regulations, can encourage the growth of the manufacturing sector. Legal certainty and consistent policies are also crucial for attracting investment and ensuring the sustainability of spillover effects from the manufacturing sector.

There are several empirical microeconomic studies on the development of the manufacturing sector and economic growth that can serve as references. The first study by Bigsten *et al.* (2004) examines the impact of exports on the performance of African manufacturing firms (Fafchamps *et al.*, 2008). The second paper utilizes a cross-country empirical approach to identify factors contributing to economic growth in the South Asian region (Maroof *et al.*, 2019). The third paper investigates the factors limiting the success of

African manufacturing firms and their ability to sustain in export markets (Söderbom & Teal, 2003; Söderbom *et al.*, 2006). Subsequently, the fourth paper examines the factors influencing the performance of African manufacturing firms (Biggs & Srivastava, 1996; Söderbom & Teal, 2004).

In contrast to micro studies, macro empirical studies on the factors influencing the development of manufacturing, especially in developing countries in Asia, are relatively scarce. One notable study is by Leon-Gonzalez and Vinayagathasan (2015). The aim of this research is to examine the determinants of economic growth in developing countries in Asia using Bayesian model averaging (BMA) based on data from 27 Asian developing countries from 1980 to 2009. Based on empirical evidence regarding growth determinants, the economic investment ratio is positively related to growth, while government consumption expenditure and trade conditions are negatively related. Leon-Gonzalez and Vinayagathasan (2015) also find evidence of a nonlinear relationship between inflation and economic growth, indicating that inflation hinders economic growth when it exceeds 5.43% but does not affect growth below that level.

Another macro indicator is the influence of the exchange rate on economic growth in the manufacturing sector. A study conducted by Hendro *et al.* (2020) explains the relationship between the Rupiah exchange rate and the economy. This research shows that the Rupiah exchange rate has a significant positive influence on stock prices, while interest rates have a significant negative influence. Strengthening the Rupiah exchange rate indicates an improved economic condition, making stock investments profitable. However, an increase in interest rates can increase the burden on companies to meet obligations or debts to banks, potentially lowering company profits and ultimately reducing stock prices. Inflation does not have a significant influence on stock performance. This study has some limitations, such as being conducted only in Indonesia and analyzing data within a relatively short time period. Nevertheless, the authors emphasize that further research is necessary, involving other countries and extending the time period to understand long-term economic conditions. Future research also needs to compare stable and unstable conditions to determine factors sensitive to stock returns. Dollar and Kraay (2004) and Baldwin and Robert-Nicoud (2014) explain that economic openness through trade liberalization and globalization has played a crucial role in stimulating specific manufacturing growth in developing Asian countries. Highlighting the positive effects of trade reforms, such as tariff reductions and non-tariff barriers, in enhancing competitiveness, promoting exports, and attracting FDI. Access to international markets and participation in global value chains have provided opportunities for technology transfer and increased manufacturing industry.

In their research on technology, Wiboonchutikula *et al.* (2016) investigated the spillover effects of technology on upstream, downstream, and horizontal industries on domestic manufacturing firms in Thailand, utilizing firm-level data observed through total factor productivity (TFP) and estimating stochastic production frontiers to ascertain firm-level technical efficiency. The findings revealed no discernible impact of technology spillovers from Foreign Direct Investment (FDI) in horizontal industries on TFP or the technical efficiency of domestic firms. In a similar vein, Singh (2016) obtained contrasting results. Singh (2016) explored the relationship between technology spillovers and productivity among a group of manufacturing firms in India during the period 2001-2012. Technology spillover impact was defined as the function of technology adoption (R&D and technical knowledge) and technology diffusion (imports and exports). Two productivity

measures, namely total factor productivity (TFP) and labor productivity, were employed in the analysis. The research findings indicated that firms engaged in technology adoption tended to be more productive than others based on TFP. Regarding labor productivity, firms involved in both technology adoption and diffusion through imports exhibited higher productivity compared to others. This confirms that manufacturing firms in India represent the learning-from-importing phenomenon due to their generally labor-intensive production processes. The findings also indicated a weak relationship between technology diffusion through exports and TFP but a strong association between labor productivity, technology diffusion through imports, and R&D.

Moreover, beyond the aforementioned factors, institutional elements, including government policies, regulations, and the business environment, shape the prospects of manufacturing sector growth significantly. Research by Acemoglu and Johnson (2005) indicates that countries with effective governance, transparent and efficient governance structures, well-defined property rights, and supportive business regulations attract investments and foster manufacturing growth. Effective institutions can facilitate industrial clustering, encourage entrepreneurship, and provide a conducive environment for manufacturing development (World Bank, 2019). Morris and Aziz (2011) underscore the importance of ease of doing business in attracting investors and expediting the structural transformation of a country's economy. This study explores the concept of ease of doing business, which generally refers to the business regulatory environment and factors influencing the formation, operation, and growth of businesses in a country. The study covers indicators such as government regulations, governance effectiveness, contract enforcement, property rights protection, access to credit, tax systems, and other aspects affecting the ease with which businesses can operate and thrive.

In the case of several countries, ease of doing business has proven to be a factor capable of enhancing macroeconomic performance, such as economic growth. Ani (2015) research on 29 Asian countries concluded that Singapore exhibited the best regulatory performance, achieving the highest ease of doing business scores in five indicators: Starting a Business, Registering Property, Protecting Investors, Trading Across Borders, and Enforcing Contracts. Conversely, China demonstrated the highest economic growth. Variations in ease of doing business were explained by the handling of construction permits, obtaining credit, property registration, and trading across borders. Handling construction permits and obtaining credit had negative effects on Gross Domestic Product (GDP), while property registration and international trade had positive effects. International trade was found to have a significant impact on GDP among selected Asian countries. This study provides further insight into key factors influencing ease of doing business and economic growth in the region. In conclusion, efficient regulations and ease of engaging in international business can make a significant positive contribution to a country's economic growth.

Another crucial aspect is corruption control, which significantly influences economic growth. Khan (1998) studied the role of patron-client networks in facilitating or perpetuating corruption in Asia. Corruption refers to the misuse or abuse of power for personal gain, often involving bribery, embezzlement, nepotism, or other unethical behaviors. Corruption tends to be rampant in the early stages of capitalist development when capitalists have little legitimacy, and states face an excess of rights and resources. However, the economic consequences of corruption vary significantly across Asian countries. According to this research, the type of patron-client network in which developer corruption occurs is related to

their economic performance. The types of rights exchanged through corruption, as well as the conditions of these exchanges, are determined by the type of patron-client network. This study compares patron-client networks in India, Malaysia, Thailand, and South Korea. Such examinations help explain why corruption accompanies rapid growth in some countries, while in others, corruption results in significant transfers.

Apart from focusing on economic issues, the availability and quality of human resources and structural transformation are also crucial for manufacturing growth. Psacharopoulos and Patrinos (2018) and Nguyen and Nguyen (2019) show that skilled and educated labor produces higher productivity, innovation, and technological progress in the manufacturing sector. Investments in education, vocational training programs, and research and development (R&D) activities have proven to have positive impacts on manufacturing growth in developing countries. Technological advancements and Artificial Intelligence have significant potential in the structural transformation of a country or region.

3. DATA AND METHODOLOGY

3.1 Data

In this empirical study, we consider the secondary data is sourced from the World Bank from 2001 - 2021. The object of this research is 73 developing countries in the world, so the number of observations is 1533. Table no. 1 presents the descriptive statistics on the data used in this study.

Table no. 1 – Descriptive statistics of the data

Variables	Mean	Max	Min	St. Dev
Revealed Comparative Advantage (RCA)				
• 73 Countries	0.3149546	0.9052595	-0.023759	0.2429658
• Africa	0.2310800	0.7822757	-0.023759	0.2168141
• America	0.2730070	0.7440690	0.0175952	0.2045908
• Asia	0.4597916	0.9052595	0.0361010	0.2653739
• Europe	0.3462467	0.5396400	0.0713590	0.1759124
GDP per Capita				
• 73 Countries	3351	9357	202	2586
• Africa	2198	8048	202	2154
• America	5193	9357	1589	2610
• Asia	3504	9011	681	2651
• Europe	4161	6180	2508	1411
Technology				
• 73 Countries	0.9593520	10.02182	-7.712805	2.038854
• Africa	0.3541032	10.02182	-7.712805	2.702101
• America	0.5426009	1.611167	-0.8012477	0.679793
• Asia	1.9648650	3.825119	-0.421419	1.054400
• Europe	1.6090540	3.548967	-1.438686	1.662957
Ease of Doing Business				
• 73 Countries	52.46370	80.10372	-14.35744	16.75705
• Africa	53.22347	77.49374	24.64672	14.13370

Variables	Mean	Max	Min	St. Dev
• America	59.90378	69.29637	42.67968	8.589313
• Asia	50.44499	80.10372	-14.35744	22.41028
• Europe	37.00349	57.56866	20.843330	12.48589
Governance Index				
• 73 Countries	-0.479201	0.7547524	-1.622806	0.451715
• Africa	-.5515212	0.7547524	-1.622806	0.551959
• America	-.3219694	0.5970802	-0.631891	0.332270
• Asia	-.5091987	0.3399206	-1.025248	0.383565
• Europe	-.3936341	0.0636524	-0.814372	0.305850
Nominal Exchange Rate				
• 73 Countries	1235.078	19504.61	0.83324	3564.616
• Africa	513.5727	2562.554	1.77749	659.6081
• America	568.8689	5359.488	1.00000	1476.246
• Asia	3122.217	19504.61	1.10851	6184.27
• Europe	23.38871	109.4732	0.833247	42.62334

Analysis of the manufacturing sector in developing countries has high urgency considering the significant impact it can have on economic growth, job creation and poverty alleviation. The manufacturing sector often becomes the backbone of the economies of developing countries because of its potential to increase added value, transfer technology and diversify the economy. By examining the manufacturing sector, researchers can identify key factors that influence competitiveness and innovation in this industry, help formulate policies that support sustainable growth, and address challenges such as dependence on the agricultural sector and economic inequality. Of the 136 developing countries in the world, 73 developing countries were obtained as research samples, with details of 31 developing countries from the African continent, 15 developing countries from the American continent, 21 developing countries from the Asian continent, and 6 developing countries from the European continent. The selection of the 73 countries was based on the availability of data for each variable in order to obtain balanced data between countries and over time (Balanced Panel Data).

3.2. Methodology

This research uses a quantitative approach with econometric modeling. The author carried out empirical testing on the data obtained, then explained the estimation results accompanied by arguments and justification to answer the research objectives stated previously. The method used in this research is Instrument Variable Panel Data Regression and Data Envelopment Analysis (DEA). There are 2 models that will be estimated in this research. First, the manufacturing industry competitiveness model will be estimated using the Panel Data Regression method with the Panel Corrected Standard Error (PCSE) estimation technique. The estimation technique was chosen to overcome the problems of autocorrelation and heteroscedasticity. Second, the manufacturing industry efficiency model will be estimated using the Data Envelopment Analysis (DEA) method. The operational definitions of variables in the Manufacturing Industry Competitiveness Model can be seen in Table no. 2. The Panel Data Regression model is following.

$$RCA_{it} = \beta_0 + \beta_1 GDP\_Cap_{it} + \beta_2 GDP\_Cap^2_{it} + \beta_3 TFP_{it} + \beta_4 EODB_{it} + \beta_5 GI_{it} + \beta_6 NER_{it} + e_{it} \quad (1)$$

Table no. 2 – Definition of Variables in the Competitiveness Model of the Manufacturing Industry

Variables	Symbol	Definition	Source
Revealed Comparative Advantage	RCA	The performance of a country's manufacturing exports on the export performance of the manufacturing of developing countries in the world. RCA is calculated using the following formula: $$RCA = \frac{XM_i/TX_i}{XMA/TXA}$$ where: XM = State manufacturing export I to the world TX = total country exports I to the world XMA = manufacturing exports of developing countries throughout the world TXA = Total Exports of Developing Countries throughout the World	World Bank (World Development Indicators/WDI)
Per capita GDP	GDP_Cap	The average income of the population in a country. GDP per capita is a gross domestic product divided by the population	World Bank (WDI)
Square of Per capita GDP	GDP_Cap^2	The square value of GDP per capita	World Bank (WDI)
Technology	TFP	Measure the efficiency and level of utilization of input in the production process. TFP is measured using Solow Residual Gy – C * Gk – (1-C) * Gl Where: Gy = Growth Rate of Aggregate Output GK = Growth Rate of Aggregate Capital GL = Growth Rate of Aggregate Labor C = Capital Share	World Bank (WDI)
Ease of Doing Business	EODB	Measuring how the ease of doing business measured in the Ease of Doing Business Index. The score is shown on a scale of 0 to 100, where 0 shows the worst and 100 regulatory performance shows the best regulatory performance	World Bank (WDI)

Variables	Symbol	Definition	Source
Governance Index	GI	Is a governance index for the six dimensions of governance: (1) the effectiveness of government; (2) corruption control; (3) political stability; (4) regulatory quality; (5) rule of law; (6) Democracy and Accountability	World Bank
Nominal Exchange Rate	NER	Relative price of the currency of two countries, namely against the United States	World Bank (WDI)

In this study, the governance index (GI) is an index formed from 6 dimensions namely (1) the effectiveness of government; (2) corruption control; (3) political stability; (4) regulatory quality; (5) rule of law; (6) Democracy and accountability. In this study we calculated the governance index by the average of the six dimensions as carried out by Easterly and Levine (2002); Al-Marhubi (2004); Bjørnskov (2006).

Furthermore, data envelopment analysis (DEA), is one of the nonparametric methods used to calculate the efficiency of a group of decision grafting units (DMU). The DEA method measures efficiency using several output variables and predetermined input variables. DEA calculates the relative efficiency of a group of DMU using linear programming techniques. Efficiency estimation results are used to compare efficiency between DMU, but these results cannot be used to compare with other DMU that are not estimated together. Two common models that are often used in DEA are CCR and BCC. CCR was developed in 1978 and is an abbreviation of the name of the inventor of this model, namely Chanes, Cooper, and Rhodes. CCR has the assumption that the increase from input will make the output more equal. The second model is BCC, the assumption of this model is VRS (Variable Return to Scale), which states that the increase in input will not make the output more equal. This model assumes that DMU has not operated at maximum value. This study will use the DEA method with OUPUT -oriented BCC models. This model was chosen because the comparison of input and output increases was not the same (VRS) and the amount of output increased every year. Assuming that there is n DMU ($DMUj$, j = 1,2, ..., n) which uses input as much as m (xi, i = 1,2, ..., m) to produce output as much as s (yr, r = 1.2 , ..., s) then an output -oriented conventional BCC model can be written, namely:

$$Min \sum_{i=1}^{m} w_i x_{ij} + \mu_0$$

$$s.t. \sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} w_i x_{ij} + \mu_0 \geq 0 \quad j = 1,2,\dots,n$$

$$\sum_{r=1}^{s} \mu_r y_{rj} = 1$$

$$\mu_0 \; bebas$$

$$w_i \geq \varepsilon, \quad i = 1,2,\dots,m$$
$$\mu_r \geq \varepsilon, \quad r = 1,2,\dots,s$$

Furthermore, the output is measured using Share of Manufacturing to PDB (SM) that is percentage of manufacturing industry production value on gross domestic product, while the input consists of Labor in Industrial Sector (LIS) showing the percentage of labor in the industrial sector to the total workforce and Gross fixed capital formation (GCF) measuring the expenditures for the addition of fixed economic assets plus net changes at the inventory level, measured in the percentage of GDP.

4. EMPIRICAL RESULTS

4.1 The Determinant of the Competitiveness of the Manufacturing Sector

Analysis of Determinant Performance of Competitiveness of the Manufacturing Sector is very relevant in the context of international globalization and competition. Developing countries are often involved in the global market, and the competitiveness of their manufacturing sector can be the main determinant of their success in competing with other countries. By understanding the factors that influence competitiveness, countries can identify their strengths and weaknesses in the global market (Garcia Pires, 2012). This analysis helps design policies that support the expansion of international trade, increasing competitiveness, and better integration in the global value chain.

Analysis of determinants of the competitiveness of the competitiveness of the manufacturing sector also has an impact on the efforts of economic diversification and national resilience. Developing countries that are too dependent on certain sectors or commodities are at risk of facing significant economic challenges. With a focus on the manufacturing sector, analysis can help countries plan policies to reduce the risk of economic instability that may arise from fluctuations in commodity prices or global market changes. Economic diversification through the development of a strong manufacturing sector can increase economic resilience and reduce vulnerability to global economic turmoil (Tonuchi & Onyebuchi, 2019).

Table no. 3 – Panel Data Regression Estimation Results (PCSE)

Variabel Dependen: Revealed Comparative Advantage (RCA)						
Independent Variables	Fixed Effect Model (FEM_		Generalized Least Square (GLS)		**Panel Corrected Standard Error (PCSE)**	
	Coeff	Prob	Coeff	Prob	**Coeff**	**Prob**
Per capita GDP	0.000011**	0.015	0.0000174**	0.014	**0.0000174*** **	**0.000**
Square of per Capita GDP	-1.20e-09***	0.000	-1.31e-09**	0.036	**-1.31e-09*** **	**0.000**
Technology	-0.0001281	0.713	0.001499	0.108	**0.001499***	**0.071**
Wase of Doing Business	-0.0001443	0.396	-0.001037***	0.000	**-0.001037*** **	**0.000**
Governance Index	-0.031742**	0.043	0.140228***	0.000	**0.140228*** **	**0.000**
Nominal Exchange Rate	6.37e-06***	0.000	3.84e-06**	0.020	**3.84e-06*** **	**0.000**
Constant	.2863839***	0.000	0.398267***	0.000	**0.398267*** **	**0.000**
Prob (F-Stat)	0.0000		0.0000		**0.0000**	

Note: Signicant Level ***1%, **5%, *10%

Based on the regression estimation of panel data with Panel-Corrected Standard Errors (PCSE), it is found that all independent variables have a significant impact on the competitiveness performance (RCA) at α=1%, except for the Technology variable, which is significant at α=10%. Per Capita GDP, Technology, Government Governance Index, and Nominal Exchange Rate have a significant positive influence on RCA, while Ease of Doing Business is found to have a significant negative impact on RCA.

The Impact of Per Capita GDP on RCA

The positive impact of Per Capita GDP on competitiveness performance (RCA) reflects the close relationship between a country's economic standard of living and its ability to compete in the international market. The increase in Per Capita GDP is often associated with sustainable economic growth, which can drive investment in technology, enhance production efficiency, and diversify the economy. As an indicator of societal well-being, a high Per Capita GDP creates conditions conducive to the development of the manufacturing sector and competitiveness in the global market (Fagerberg *et al.*, 2007). The economic convergence theory supports the idea that countries with low Per Capita GDP tend to grow faster than those with high Per Capita GDP, thus enhancing their relative competitiveness (Varblane & Vahter, 2005).

The increase in Per Capita GDP can also be linked to enhanced production capacity and improved product quality. Countries with a high Per Capita GDP tend to have greater access to capital, technology, and high-quality human resources. This can drive the development of high technology, innovation, and efforts to improve the quality of manufacturing products (Ahmad & Schreyer, 2016). In this context, the beta convergence theory suggests that countries with low expenditure levels will more rapidly adopt and adapt to high technology, thereby enhancing the competitiveness of their manufacturing sector. Per Capita GDP can also be considered a general indicator of a country's economic development. As prosperity levels rise, governments and businesses can focus more on developing sectors with high competitiveness potential, including the manufacturing sector. Higher income allows for further investment in research and development, infrastructure, and education, all of which can strengthen competitiveness in manufacturing production and exports. Furthermore, the relationship between Per Capita GDP and RCA can be reciprocal causality. Improved competitiveness in the manufacturing sector can significantly contribute to economic growth and societal well-being, creating a positive feedback loop that reinforces both variables. Conversely, an increase in Per Capita GDP can also create better conditions for investment in the manufacturing sector, which, in turn, can enhance a country's competitiveness in the global market (Nababan, 2019).

The Impact of Technology on RCA

The positive impact of the Technology variable on competitiveness performance (RCA) reflects the crucial role of technology in enhancing innovation and efficiency in the manufacturing sector. Technology serves not only as a tool to improve productivity but also as a primary driver of innovation in production processes and the development of new products (Moldabekova *et al.*, 2021). Endogenous growth theory suggests that investment in research and technological development can create an environment conducive to long-term growth, thereby enhancing the competitiveness of the manufacturing sector (Howitt, 2010). The positive influence of technology on RCA can also be associated with the adoption of

high technology in the production process. Countries capable of adopting and integrating high technology into their manufacturing sector can experience significant improvements in production efficiency, product quality, and portfolio diversification. The catch-up theory proposes that developing countries can overcome their lag by adopting technology developed by advanced countries, leading to increased competitiveness in the manufacturing sector (Miao *et al.*, 2018; Saghafi *et al.*, 2021).

Besides that, it can also be seen as an indicator of enhancing a country's global competitive ability in the international market. Technology plays a central role in improving a country's competitiveness in facing global competition. By applying high technology, the manufacturing sector can produce goods with better quality, more cost-efficient production, and environmentally friendly processes, all of which can provide a competitive advantage in the international market. The significance of technology in enhancing the competitiveness of the manufacturing sector can also be viewed as a step toward sustainable competitiveness. Technology contributes to minimizing environmental impact, improving resource efficiency, and creating innovative solutions for sustainability challenges. Thus, the positive impact of Technology on RCA reflects an awareness of the importance of sustainable aspects in achieving sustainable competitiveness in the global market.

The Impact of Ease of Doing Business on RCA

The negative impact of Ease of Doing Business on competitiveness performance (RCA) can be elucidated by the limitations in measuring ease of doing business that may not encompass key elements supporting innovation. Some ease of doing business indicators may overly focus on regulatory and administrative aspects without sufficiently emphasizing factors that drive innovation in the manufacturing sector. For instance, indicators overly concentrated on licensing and administrative aspects may not fully reflect a country's ability to create an innovative environment in the manufacturing sector. This impact may also indicate that countries with low ease of doing business may face constraints in infrastructure development and effective management (Morano *et al.*, 2023). Factors such as complex regulations and high bureaucracy can hinder investments in infrastructure and diminish project management quality. This can negatively impact the competitiveness of the manufacturing sector, as its success is often associated with the availability of adequate infrastructure and efficient management (Hurtado, 2018).

The negative impact of Ease of Doing Business on RCA may also reflect structural challenges faced by informal economies in some countries. If business regulations and procedures are overly complicated, informal sectors may become more dominant, while the formal manufacturing sector may struggle to compete. Economic dualism theory suggests that dualism between formal and informal sectors can create barriers to the development of the formal manufacturing sector. Additionally, this impact may also be related to social and labor aspects. If stringent business regulations make it difficult for companies to recruit and retain qualified labor, it can reduce the competitiveness of the manufacturing sector. Moreover, uncertainty in business regulations can create uncertainty in investment and growth planning, hindering competitiveness in the global market.

The Impact of Governance on RCA

The positive impact of the Governance Index on competitiveness performance (RCA) reflects the crucial role of governance in creating a conducive business environment for the

growth of the manufacturing sector. Agency theory emphasizes the significance of effective governance in bridging the relationship between the private and public sectors. Good governance can formulate policies supporting investment, reduce bureaucracy, and provide legal certainty, all contributing to enhanced competitiveness in the manufacturing sector. The improvement in the competitiveness of the manufacturing sector can be linked to the government's ability to manage resources efficiently and control corruption. Effective governance can allocate resources effectively, ensure fairness in business competition, and shape regulations that support innovation. Corporate governance theory is also relevant here, as good government governance can motivate companies to improve performance and transparency, thereby enhancing their competitiveness.

Good governance can foster trust among market participants, both domestic and international. This trust is crucial for encouraging foreign direct investment and domestic investment in the manufacturing sector. Agency theory suggests that when governance has a transparent and accountable structure, market participants are more likely to invest, triggering the growth of the manufacturing sector and enhancing competitiveness in the global market. Good governance can also facilitate innovation and the development of institutions supporting the growth of the manufacturing sector. A responsive government to the needs of the private sector, capable of creating policies supporting research and development, as well as the implementation of innovation in the manufacturing sector, provides a significant boost to competitiveness. Institutional political economy theory underscores the importance of effective institutions in promoting economic development and innovation. Overall, the positive influence of the Governance Index on RCA illustrates how crucial good governance is in shaping an environment that supports and enhances the competitiveness of the manufacturing sector in the economies of developing countries.

The Impact of Exchange Rate on RCA

The positive impact of Exchange Rate on competitiveness performance (RCA) can be explained by the relationship between the national currency exchange rate and a country's export capacity. Expectations theory posits that a strengthening exchange rate can incentivize exporters, as they will receive more foreign currency for each unit of product sold. With a favorable exchange rate, manufactured products from that country become more affordable to international consumers, enhancing competitiveness in the export market. A positive exchange rate can also affect production costs. National currency appreciation can reduce the costs of importing raw materials and components, thereby lowering production costs for manufacturing companies. This helps improve the competitiveness of local products, both in the domestic and international markets. Purchasing power parity theory provides a basis for understanding how changes in the exchange rate can influence production costs and, consequently, the competitiveness of manufactured products.

An increase in the exchange rate can also open doors for foreign direct investment (FDI), which can have a positive impact on the competitiveness of the manufacturing sector. As per the principles of foreign direct investment, a favorable exchange rate can attract the interest of foreign investors to invest their capital in the manufacturing sector. FDI brings new technology, efficient management, and access to global markets, all of which can enhance competitiveness and innovation in the manufacturing sector. A favorable exchange rate can also facilitate the expansion of export markets for manufactured products. Pricing

theory in international trade indicates that with a higher exchange rate, companies can set lower prices for their products in international markets without sacrificing profits. This can help improve the competitiveness of manufactured products in export markets, increasing market share and the contribution of the manufacturing sector to national export performance.

4.2 Analysis of Technical Efficiency in the Manufacturing Sector

Analysis of technical efficiency in the manufacturing sector in developing countries has a large relevance in measurement of productivity and identification of the potential for increasing efficiency. Through methods such as data envelopment analysis (DEA), it can be known the extent to which the input used in the production process can be converted into optimal output. The results of this analysis can provide an overview of the extent to which the company or manufacturing sector as a whole operates at the maximum level of efficiency. Identification of factors that limit efficiency can help the government and industry players take appropriate action to increase productivity.

Table no. 4 – Estimation Results of Envelopment Analysis (DEA)

DMU	Score	Rank	Benchmark (Lambda)
Congo, Dem. Rep.	1.000	1	Congo, Dem. Rep.(1)
Eswatini	1.000	1	Eswatini(1)
Burundi	1.000	1	Burundi(1)
Mozambique	0.964	4	Burundi(0.894838);Eswatini(0.105162)
China	0.960	5	Eswatini(1)
Madagascar	0.924	6	Burundi(0.646476);Congo, Dem. Rep.(0.221462);Eswatini(0.132062)
Thailand	0.883	7	Eswatini(1)
Cote d'Ivoire	0.812	8	Burundi(0.694581);Eswatini(0.305419)
Cambodia	0.794	9	Congo, Dem. Rep.(0.772717);Eswatini(0.227283)
Malaysia	0.775	10	Eswatini(1)
Indonesia	0.766	11	Eswatini(1)
Benin	0.764	12	Congo, Dem. Rep.(0.760142);Eswatini(0.239858)
Philippines	0.741	13	Congo, Dem. Rep.(0.184731);Eswatini(0.815269)
Belarus	0.740	14	Eswatini(1)
Cameroon	0.693	15	Burundi(0.388391);Congo, Dem. Rep.(0.144988);Eswatini(0.466621)
Bangladesh	0.685	16	Congo, Dem. Rep.(0.635501);Eswatini(0.364499)
Lesotho	0.685	17	Congo, Dem. Rep.(0.476279);Eswatini(0.523721)
Pakistan	0.679	18	Congo, Dem. Rep.(0.777354);Eswatini(0.222646)
Kyrgyz Republic	0.593	19	Congo, Dem. Rep.(0.57052);Eswatini(0.42948)
Egypt, Arab Rep.	0.580	20	Congo, Dem. Rep.(0.276664);Eswatini(0.723336)
Guatemala	0.577	21	Congo, Dem. Rep.(0.034575);Eswatini(0.965425)
Honduras	0.575	22	Congo, Dem. Rep.(0.093765);Eswatini(0.906235)
Sri Lanka	0.575	23	Eswatini(1)
India	0.545	24	Congo, Dem. Rep.(0.207826);Eswatini(0.792174)
Vietnam	0.513	25	Congo, Dem. Rep.(0.01243);Eswatini(0.98757)
Dominican Republic	0.509	26	Eswatini(1)
El Salvador	0.508	27	Eswatini(1)
Argentina	0.507	28	Eswatini(1)

DMU	Score	Rank	Benchmark (Lambda)
Senegal	0.502	29	Congo, Dem. Rep.(0.474982);Eswatini(0.525018)
Turkey	0.502	30	Eswatini(1)
Lao PDR	0.501	31	Burundi(0.599361);Eswatini(0.400639)
Mexico	0.494	32	Eswatini(1)
Tunisia	0.492	33	Eswatini(1)
Morocco	0.489	34	Eswatini(1)
Kenya	0.481	35	Congo, Dem. Rep.(0.662209);Eswatini(0.337791)
Uganda	0.477	36	Burundi(0.58972);Congo, Dem. Rep.(0.155619);Eswatini(0.254661)
Mauritius	0.476	37	Eswatini(1)
Ukraine	0.474	38	Eswatini(1)
Peru	0.465	39	Eswatini(1)
Burkina Faso	0.460	40	Congo, Dem. Rep.(0.8666);Eswatini(0.1334)
Nicaragua	0.455	41	Congo, Dem. Rep.(0.132083);Eswatini(0.867917)
Costa Rica	0.450	42	Eswatini(1)
Tanzania	0.444	43	Burundi(0.741861);Eswatini(0.258139)
Nigeria	0.433	44	Burundi(0.302305);Eswatini(0.697695)
Rwanda	0.431	45	Burundi(0.752958);Congo, Dem. Rep.(0.078507);Eswatini(0.168535)
South Africa	0.430	46	Eswatini(1)
Bhutan	0.427	47	Burundi(0.621627);Eswatini(0.378373)
Iran, Islamic Rep.	0.423	48	Eswatini(1)
Bolivia	0.413	49	Congo, Dem. Rep.(0.34688);Eswatini(0.65312)
Ecuador	0.409	50	Eswatini(1)
Togo	0.399	51	Congo, Dem. Rep.(0.860822);Eswatini(0.139178)
Colombia	0.399	52	Eswatini(1)
Nepal	0.391	53	Burundi(0.580534);Congo, Dem. Rep.(0.139655);Eswatini(0.279811)
Brazil	0.383	54	Eswatini(1)
Moldova	0.371	55	Eswatini(1)
Niger	0.370	56	Burundi(0.562514);Congo, Dem. Rep.(0.278807);Eswatini(0.158679)
Namibia	0.370	57	Eswatini(1)
Kazakhstan	0.364	58	Eswatini(1)
Paraguay	0.351	59	Eswatini(1)
Armenia	0.340	60	Eswatini(1)
Bosnia and Herzegovina	0.314	61	Eswatini(1)
Belize	0.294	62	Eswatini(1)
Lebanon	0.250	63	Eswatini(1)
Sudan	0.232	64	Congo, Dem. Rep.(0.494355);Eswatini(0.505645)
Comoros	0.227	65	Congo, Dem. Rep.(0.62538);Eswatini(0.37462)
Albania	0.191	66	Eswatini(1)
Montenegro	0.189	67	Eswatini(1)
Azerbaijan	0.179	68	Burundi(0.069354);Eswatini(0.930646)
Botswana	0.174	69	Eswatini(1)
Congo, Rep.	0.144	70	Eswatini(1)
Gabon	0.143	71	Burundi(0.133639);Eswatini(0.866361)
Algeria	0.114	72	Eswatini(1)

Based on the DEA estimation results, it was found that there are three efficient countries: Burundi, the Democratic Republic of the Congo, and Eswatini. When capital input (Gross Fixed Capital Formation) and labor input (Labor in the Industrial Sector) can be allocated efficiently, it optimizes the output (Share of Manufacturing in GDP). In this context, efficiency refers to a country's ability to maximize the manufacturing sector's output relative to the inputs used. Firstly, Burundi, the Democratic Republic of the Congo, and Eswatini can be considered as countries that successfully manage their capital and labor optimally for the manufacturing sector. This could be attributed to policies supporting investment in capital formation and workforce development in the industrial sector. This capability can strengthen the manufacturing sector as a key driver in their economies.

Secondly, high efficiency may reflect positive factors such as political stability, supportive investment policies, and good access to natural resources or markets. Success in efficiently allocating inputs can significantly contribute to economic growth and the sustainability of the manufacturing sector, which, in turn, can impact the economic well-being of the country.

The efficiency analysis results indicate that some developing countries in Africa have achieved efficiency in their manufacturing sectors, despite facing various challenges on the continent. For example, the Democratic Republic of the Congo has substantial natural resource potential, including minerals like copper, cobalt, and gold. The manufacturing sector related to mineral processing could make a significant contribution to the economy and create opportunities for technical efficiency. However, challenges may include sustainable resource management and environmental security. If the manufacturing sector in the DRC is primarily related to the processing of extractive raw materials, technical efficiency can be reflected in the country's ability to extract added value from its natural resources. Diversifying the manufacturing sector into higher-value activities in the value chain can enhance efficiency. The success of the manufacturing sector is also related to the availability and quality of the workforce. Training and education programs to enhance workforce skills can play a crucial role in technical efficiency. Furthermore, Eswatini, formerly known as Swaziland, is a landlocked country in southern Africa bordered by South Africa and Mozambique. Eswatini has a relatively small economy and depends on specific sectors. Agriculture, especially subsistence farming and livestock, remains an essential part of the economy and employs a significant portion of the rural population. The manufacturing sector, particularly in sugar, textiles, and agricultural processing, also plays a crucial role in Eswatini's economy. The sugar industry, including sugarcane processing, is a key sector and a major contributor to export income. Moreover, efforts to diversify the economy continue to reduce dependence on specific sectors. Burundi is a small landlocked country in Central Africa, bordered by Rwanda, Tanzania, and the Democratic Republic of the Congo. In this context, the manufacturing sector may have a significant impact on the country's economy. The relatively small size of the economy may allow the government and industry players to focus more on supporting the development of the manufacturing sector.

Eswatini is the only absolute monarchy in Africa, where the king holds significant political power. This factor can influence economic policies and national development, playing a role in investment and economic growth. Although some sectors are developing, Eswatini faces economic challenges, including high unemployment rates, a lack of economic diversification, and income distribution inequality. Efforts to address these challenges involve structural reforms and government initiatives to encourage foreign

investment and the development of potential sectors, such as the manufacturing sector. In its development, it is known that the Eswatini government is working to develop infrastructure to support economic growth. This includes investments in transportation, energy, and telecommunications sectors to improve connectivity and economic competitiveness.

In addition to the three African countries mentioned above, several Asian countries such as China, Thailand, Malaysia, Cambodia, and the Philippines have also demonstrated high levels of technical efficiency in their manufacturing sectors, with DEA scores above 0.75. Many successful Asian countries have integrated themselves into global supply chains, leveraging international partnerships to optimize specialization and production efficiency. This provides access to global markets and cutting-edge technology. These countries tend to make significant investments in technology research and development and promote innovation in the manufacturing sector. The adoption of advanced technology and innovation in the production process can enhance efficiency and productivity. Additionally, good infrastructure, including quality transportation and telecommunication networks, supports the efficiency of distribution and supply chains in the manufacturing sector. Good accessibility to ports and export markets also contributes to this efficiency. Furthermore, this research also examines how developing countries position themselves in the mapping of labor input and PMTB, and DEA scores, thus illustrating how these countries leverage inputs to achieve technical efficiency in the manufacturing sector.

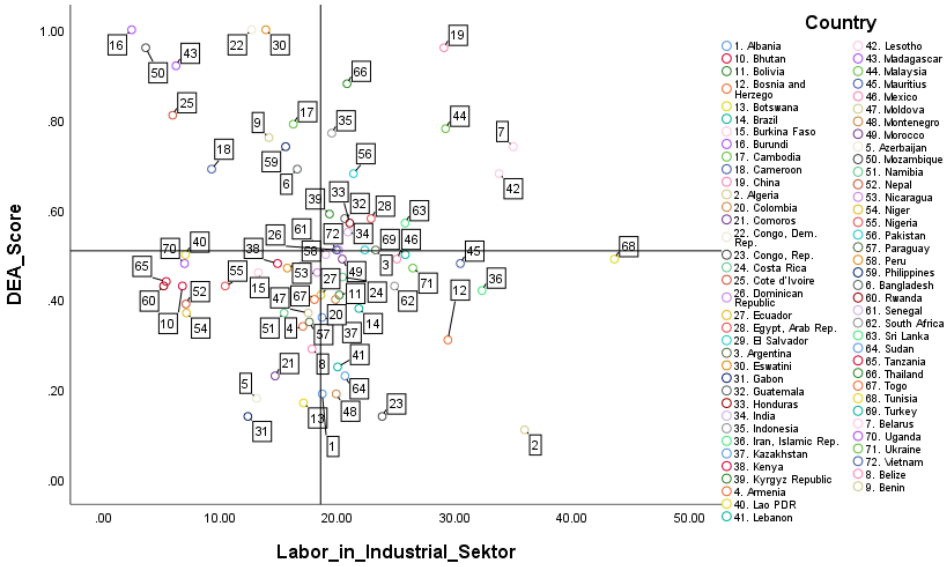

Figure no. 1 – Mapping of labor input inputs in the industrial sector and DEA scores

Information:

Quadrant I (upper right): high industrial sector labor, high efficiency
Quadrant II (Upper Left): Low Labor Industrial Sector, High Efficiency
Quadrant III (Lower Left): Low Manpower Industrial Sector, Low Efficiency
Quadrant II (Lower Right): High Industrial Sector Labor, Low Efficiency

From Figure no. 1 it can be seen that developing countries are scattered in four quadrants, describing the variation in the comparison of labor input with its efficiency achievements shown by DEA scores, but found the number of countries that are more dominating in the quadrant of low DEA scores (quadrant III and IV). It is known that several countries in quadrant III (Low Industrial Sector Labor, Low Efficiency) include Gabon (Code 31), Azerbaijan (Code 5), Nepal (Code 52), and Niger (Code 54). Furthermore, some identified countries are in quadrant IV (high industrial sector labor, low efficiency), including Algeria (Code 2), Bosnia and Herzego (Code 12), and Iran (Code 36). The existence of some developing countries that experience low efficiency in the manufacturing sector despite having a high input number of labor in the industrial sector can be explained with several factors, such as lack of skills and low productivity. Although the number of workers may be high, lack of skills and appropriate training can result in low efficiency. Low labor skills can hamper the ability to utilize input effectively. In addition, the inability to adopt the latest technology and lack of innovation in the production process can cause low efficiency. These countries may be left behind in terms of technology and innovation, which can reduce the productivity of the manufacturing sector.

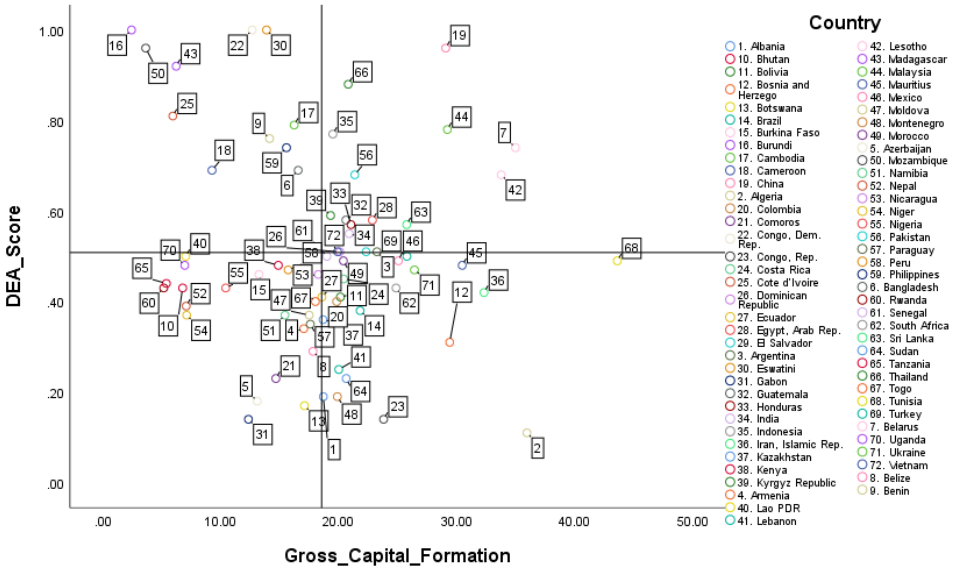

Figure no. 2 – Mapping input Gross Capital Formation and DEA Score

Information:

Quadrant I (upper right): high PMTB, high efficiency
Quadrant II (upper left): low PMTB, high efficiency
Quadrant III (lower left): low PMTB, low efficiency
Quadrant II (lower right): high PMTB, low efficiency

In addition to mapping labor input in the industrial sector, a similar mapping was conducted for Gross Fixed Capital Formation (GFCF) input compared to DEA score achievements, indicating levels of technical efficiency in Figure no. 2. The figure reveals a consistent pattern of diverse variability among countries, with more nations located in the

low-efficiency quadrants (Quadrants III and IV) than in the high-efficiency ones (Quadrants I and II). Some countries demonstrating high efficiency (Quadrant I) include Burundi (Code 16) and Mozambique (Code 50), while those in Quadrant II include China (Code 19) and Thailand (66). Conversely, countries exhibiting low efficiency, such as Azerbaijan (Code 5), Nepal (Code 52), and Niger (Code 54), are found in Quadrant III, and those in Quadrant IV include Algeria (Code 2) and Bosnia and Herzegovina (Code 12). The presence of developing countries with low efficiency in the manufacturing sector, despite high Gross Fixed Capital Formation (GFCF) inputs, may be attributed to investment quality factors. Low efficiency in the manufacturing sector, despite high GFCF, can be influenced by poor investment quality. If investments are not appropriately directed or do not support technology, innovation, and productivity, their impact on efficiency may be limited. Additionally, ineffective management in handling investments can lead to suboptimal fund allocation. The planning, execution, and oversight of investments need enhancement to ensure the efficient utilization of GFCF in creating added value for the industrial sector in developing countries.

5. CONCLUSION, LIMITATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

Per capita GDP, Technology, Government Governance Index, and Nominal Exchange Rate significantly and positively influence RCA, while Ease of Doing Business is found to have a significant negative impact on RCA. The Democratic Republic of the Congo, Eswatini, and Burundi are identified as having technical efficiency in their manufacturing sectors, as indicated by DEA scores of 1. This study also reveals notable efficiency in certain Asian countries, such as China, Thailand, Malaysia, and Indonesia. Efficient allocation of inputs, including Gross Fixed Capital Formation and Industrial Labor, optimizes the output share of manufacturing relative to GDP. In mapping the labor input in the industrial sector and Gross Fixed Capital Formation (GFCF) input against the technical efficiency (DEA scores) of developing countries, a prevalent trend emerges, with more nations situated in the low-efficiency quadrants (Quadrants III and IV) compared to the high-efficiency ones (Quadrants I and II). This depiction underscores the persistent challenges of inefficiency in the manufacturing sector across many developing countries.

While this study provides valuable insights into the factors influencing Revealed Comparative Advantage (RCA) and identifies countries with technical efficiency in their manufacturing sectors, there are certain limitations to be acknowledged. Firstly, the analysis is based on cross-sectional data, limiting our ability to establish causation and observe changes over time. Secondly, the study relies on available data, and the quality and reliability of this data may vary across countries. Additionally, the findings may be influenced by external factors not considered in this study. Furthermore, the efficiency analysis, while informative, does not delve into the specific mechanisms contributing to inefficiencies within the manufacturing sectors of developing countries. Future research endeavors should address these limitations to enhance the comprehensiveness and robustness of our understanding of manufacturing sector dynamics in the context of developing economies.

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