International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(Review Article)

Productive efficiency in the Caribbean and Latin America under free trade

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International Journal of Science and Research Archive, 2025, 14(02), 1482-1494

Publication history: Received on 13 January 2025; revised on 20 February 2025; accepted on 23 February 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.14.2.0529

Abstract

Analysis of the Nonparametric Economic Efficiency Index revealed that measures of economic efficiency were higher in the Caribbean, but the variation in the measure was also greater in this region compared with Latin America. In both regions allocative efficiency contributed more to economic efficiency compared with technical efficiency, with the measure of allocative efficiency being greater in Latin America while measures of technical efficiency were greater in the Caribbean. Both regions showed improved economic efficiency following Covid.

Regression analysis reveals that in the Caribbean, literacy rate, private sector access to credit, fixed capital formation and access to electricity have a positive impact and tax on income and the exchange rate had stronger negative impact. In Latin America, the exchange rate and market size had a stronger impact on economic efficiency.

Keywords: Caribbean; Latin America; Pure Technical Efficiency; Allocative Efficiency; Economic Efficiency

1. Introduction

The Caribbean, like Latin America, is faced with an intense and rapidly changing international market, which is driven by rapidly changing consumers' taste and preferences with supply rapidly adopting new technologies to meet them. But if one was to enters a shopping mall in the region, one would see a multitude of new products, most of which are produced outside of the Caribbean and Latin American region.

This is the challenge the Caribbean and Latin America are forced to meet. Countries that are better prepared, technologically, and more productively efficient have before them an ever-expanding market which signals opportunities to prosper. The Caribbean must effectively match this level of productive efficiency.

But, keeping up with the changes in the international market has been a challenge to the Caribbean on account of many constraining conditions. In particular, Caribbean countries are small and geographically dispersed, which itself posed a challenge to economic integration and reaping the benefits of economics of scale. As a consequence of their economic conditions, they are highly susceptible to economic shocks [Mercer-Blackman and Seerattan,2014] to which they constantly being subject as result of their natural predisposition in the hurricane belt of the Caribbean.

Historically, Caribbean countries have followed a development pattern based largely on a one sector development and traded primary agricultural products or oil or minerals for manufactured goods, technology, and finance. And their productive infrastructure, human capital and institutions are geared toward supporting that pattern of development. Most countries have not managed to break away enough to add enough flexibility to their economic base to face the rapidly changing international markets.

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In addition, the new changes in the international markets bring with them new dimensions to the challenges in the Caribbean. Many of the concessions and preferential markets, and foreign aid to the region which have for so long been key elements in Caribbean development are gradually being withdrawn. And so is tariff revenue, which has been a key source of capital to many Caribbean countries.

Borrowing from developmental banks and wealthier countries has proved to be prohibitively expensive, as evidenced by the huge foreign debts in the region [ECLAC, 2023]. Many have turned to direct foreign investment [DFI for capital, technology and manpower development, and assistance in developing their production capabilities.

Economic integration in the region has so far been challenging, mainly on account of accommodating the great diversity among Caribbean countries and problems arising out of asymmetry that come with the diversity. The process has been slow and coordinating efforts towards meaningful economic outcomes have had limited effects.

Recommendations in the interest of economic advancement to the Caribbean and Latin America [ECLAC, 2023, World Bank, 2023] have consistently been about policies to develop human capital, innovate, develop productive infrastructure, and organize to integrate and compete. In is in this context that this paper tries to assess the capability and readiness among countries and make recommendations in the interest of advising policies to improve productive efficiency in the region.

Reflected in productive efficiency measures is not just the state of productive infrastructure, but also policies, strategies and institutions associated with the productive infrastructure.

Specifically, the objective of this paper is to investigate the status of productive efficiency within the Caribbean regions relative to that in Latin America and determine strategies that would have a comparatively stronger impact on improving productive efficiency in this region compared with Latin America.

2. Analytical Framework

As a measure of productive efficiency, overall efficiency is used as the best estimator. Overall efficiency is the product of purely technical, allocative and scale efficiencies. However, in aggregate cross-county analysis, it is difficult to interpret scale efficiency. Thus, for such analysis, economic efficiency usually provides the best estimator of productive efficiency. Economic efficiency is the product of pure technical and allocative efficiency. Technical efficiency expresses the technical relationship between inputs and outputs. In the context of a production function, technical efficiency measures how far away from the production frontier a country's technology is. Any improvements in the productivity of inputs, such as labour or capital, or in the production process, is likely to improve this measure. Allocative efficiency measures how efficient, in terms of least cost, a country allocates or combines its factors of production to produce outputs. Relevant information, an appropriate institutional framework, and organizational flexibility are some critical elements needed in promoting allocative efficiency.

3. Methodology

Efficiency analysis. Economic efficiency [EE] is the product of pure technical efficiency [PTE] and allocative efficiency [AE]. The problem to be solved is to construct a method to investigate PTE and AE. For these problems a nonparametric estimation method is used. The non-parametric approach is independent of restrictions on functional forms and does not assume the existence of homogenous production technology across countries. Additionally, it allows for easy estimation and comparison of efficiency measures across countries.

To illustrate the concept of pure technical efficiency, Figure 1[Fare and Groskopf, 1994] is used. In this figure, S is a transformation function used to transform input(s) into output(s), i.e., S= (x, y): x can produce y. The variables, x and y, are scalar input (s) and output (s) and each is strictly positive. The transformation function, S, represents a constant return to scale technology and satisfies a set of axioms [Fare and Groskopf, 1994] which allows it to define a meaningful relationship between x and y such that output, y, is feasible. It also allows for strong disposability of inputs and outputs [Fare et al., 1985].

Pure technical efficiency (PTE) is measured under a relative to a variable return to scale frontier, such as the ABCD frontier in Figure 1. Note the constant return to scale frontier as shown by OS. On the ABCD variable returns to scale frontier, if production occurs on the frontier, such as at [x’, y’], the efficiency would at its maximum at 1, as is shown in Equation 1.

$$PTE = OB2/OB2 = 1 \qquad …….. (1)$$

For a production unit that is within the frontier such as [x, y], the PTE is less than 1 as is shown in Equation 2.

$$PTE = OB1/OD2 < 1 \qquad ………… (2)$$

Allocative efficiency, in this study, is calculated using the concept of revenue maximization instead of a cost minimization. In cost minimization, the condition for allocative efficiency is $MPP_1/MPP_2 = W_1/W_2$. In this study, allocative efficiency occurs at revenue maximizing, production occurs at point A, where $P_1/P_2=MRP_1/MRP_2$.

In this context, allocative efficiency measures the responsiveness of technology to changes in output prices instead of input prices. This concept is illustrated using Figure 2.

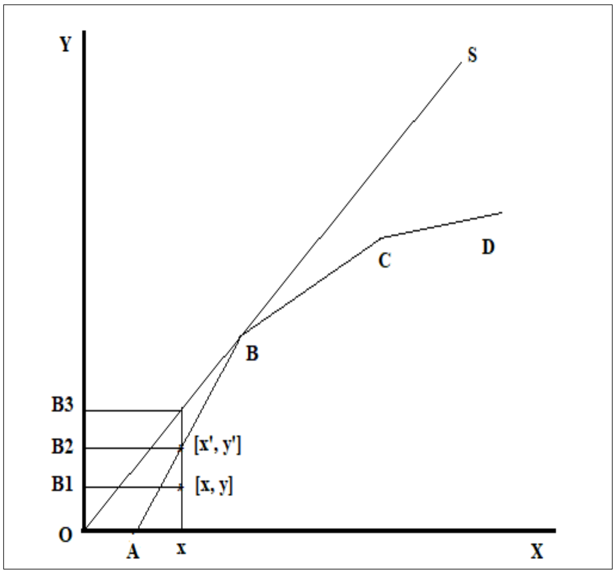

Figure 1 Constant and variable returns to scale.

In Figure 2, The production functions, $Y_1 = f(x)$ and $Y_2 = f(x)$. are characterized by constant returns to scale and strong disposability of input and output. Y_1 and Y_2 are outputs and are strictly positive.

If the transformation curve, YoYo, represents all the combinations of Y_1 and Y_2 which use at least input level x, given the technologies, and the output prices are represented by the slope of Po/Po, then the economically efficient point it Point A, where $P_1/P_2=MRP_1/MRP_2$.

At this point the production unit is allocatively efficient as well as technically efficient. This is so because any production unit operating on the production the transformation curve is considered to be pure technically efficient.

Thus, the unit, B, is efficiency technically. Unit C, on the other hand, which is not on the frontier, but within, is technically inefficient.

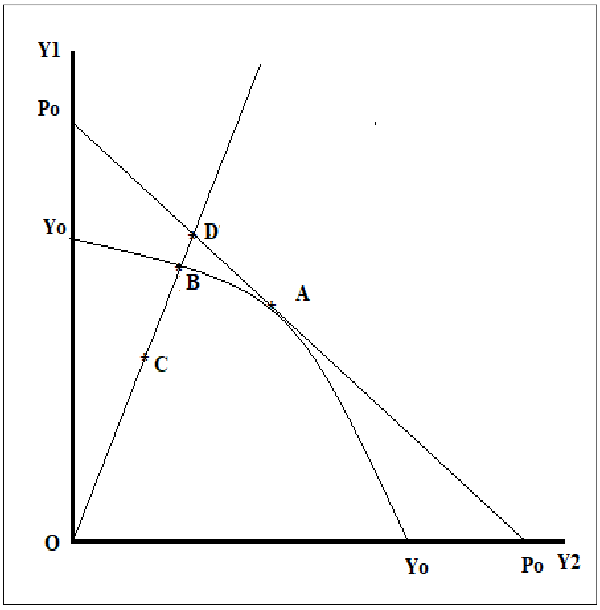

Figure 2 The Measure of Allocative Efficiency**.**

For Unit C, PTE is as shown in Equation 4.

$$PTE = OC/OB < 1 \quad \ldots\ldots\ldots\ldots \quad (4)$$

Unit B, although it is PTE efficient, it is allocatively inefficient since it is not on the price line PoPo. As it is the allocative efficiency of Unit B is as follows: AE of Unit B is as shown in Equation 5.

$$AE = OB/OD < 1 \quad \ldots\ldots\ldots \quad (5)$$

Economic efficiency (EE), which is the product of pure technical and allocative efficiencies.

For Unit C, the EE is as follows, Equation 6:

$$EEc = \{(OC/OB) * (OB/OD)\} = OC/OD < 1 \quad \ldots\ldots\ldots \quad (6)$$

For Unit A, EE = 1

The measures of efficiency are calculated using linear programming (LP). Pure technical efficiency (PTE) is calculated by solving the following LP:

Min θ_k subject to

$$\sum_{k=1}^{K} z^k x^k_n \leq \theta x_n \qquad n=1,\ldots..M$$

$$\sum_{k=1}^{K} z^k y^k_m \geq y_m \qquad m=1\ldots..M$$

$$\Sigma z^k = 1 \quad \ldots\ldots\ldots\ldots \quad (7)$$

where k = 1...K countries using n = 1...N inputs (x) to produce m = 1,...M outputs (y) and z are the intensity variables, which measures factor use intensities in the countries making up the best -practice frontier. The variables, x, y and z are strictly positive, and the technology exhibits variable returns to scale and allows for strong disposability of inputs and outputs.

In order to calculate allocative efficiency, it is important to estimate overall efficiency. To determine the overall efficiency (OE), the maximum revenue, $R(p,x,t_c)$, of producing output for the k^{th} observation, under constant returns to scale, is calculated. Specifically, the following LP is solved:

$$R_k(p,x,t_c) = \text{Max } P_k'Y_k \text{ subject to}$$

$$\sum_{k=1}^{K} z^k x^k_n \leq x^k_n \qquad n=1, \ldots\ldots N$$

$$\sum_{k=1}^{K} z^k y^k_m \geq y^k_m \qquad m=1\ldots\ldots M \qquad (8)$$

In this problem, k, m, n, x, y and z are as defined as in Equation (5) and p = 1...P are the output prices for m = 1...M outputs. The solution to Equation (6) represents the maximum revenue for the k^{th} observation. Overall efficiency is determined as shown on Equation 7.

$$OEk = PkYk/Rk(p,x,tc) \qquad \ldots\ldots\ldots (9)$$

where $R_k(p, x,t_c)$ is as defined above, and P_kY_k represents the actual revenue for observation, k. Allocative efficiency is calculated from OE as in Equation 8.

$$AE_k= (P_k'Y_k/R_k(p, x,t_v))*(1/\theta_k) \qquad \ldots\ldots (10)$$

where Rk (p, x,t_v) is the maximum revenue calculated relative to variable returns to scale by adding the restriction shown in Equation (11) to Equation (8) and θ_k is the measure of pure technical efficiency obtained by solving Equation (7).

$$\Sigma zk = 1 \qquad k = 1\ldots\ldots K \qquad \ldots\ldots (11)$$

Regression Analysis. OLS was used to determine the relationship between the explanatory variables and the efficiency measures is as shown in Equation 12. Each variable was expressed in logarithmic form and each parameter is interpreted as the percentage change in efficiency as a result of a one percent change in the parameter estimate.

$$lEEi\,j = \alpha o + \alpha 1lGDPij + \alpha 2lEDUij + \alpha 3lCR + \alpha 4lKij + \alpha 5lELECij + \alpha 6LlINFij + \alpha 7TAXij + \alpha 8lEXRij + \alpha 9lTTrij + \alpha 10IlAGRIi + \alpha 11lMANij + \alpha 12LSERVij + eij \qquad \ldots\ldots\ldots (12)$$

where: i and j represent the country and year, respectively; lEE_{ij} the economic efficiency measures; the independent variables are as defined in Table 1, and each was formulated similarly to EE. The error term, e_{ij}, represents unexplained random errors. The countries involved in this study are as shown in Table 3.

The Data . This study involved observations on the outputs and inputs for 9 Caribbean Countries and 12 Latin American Countries over the period 2008 to 2022. Caribbean countries are defined as all Caribbean islands and countries in South and Central Americas that are members of the Caribbean Common Market [CARICOM], and they include the followings: the Bahamas, Dominical Republic, Guyana, St Vincent, and the Grenadines, Barbodos, Jamaica, Belize, St. Lucia and Trinidad and Tobago. The Latin American countries are as shown in Table 3.

The measures of output were calculated as the GDP (measured as Constant 2015 US Dollars) for the agricultural sector, the manufacturing sector, the service sector, and the 'other' sector, which includes mining, drilling, and construction, divided by the real price. The real price was obtained by dividing the constant GDP by the current GDP for each sector and standardized by the price index. Inputs included labor and capital. Labor was measured as the number in the Labor

Force. Capital was calculated from the gross fixed capital formation expressed in percentage of real GDP divided by the price index, expressed in real terms.

The data used in this study were obtained from the World Bank [2024]. Because of inconsistencies observed in the World Bank data set with respect to some countries in the Caribbean and Latin America, these countries were omitted from the study. Also, in determining the relationship between productivity change and specific policy variables, several observations for some countries [Paraguay and Guatemala] were not available, so, these countries were also not included in the regression analysis.

4. The Regression variables:

In this study, 12 variables used as proxies in 6 groups are investigated. The variable, their means and standard deviation are shown in Table 1. Table 2 shows the expect correlation between the dependent variable and each variable studied.

Market-related variables. The market size [MARKET] is the only variable in this group. It is expected that competition in the marketplace will for countries become more efficient. On a larger scale as more countries enter the international markets, the market size of the participating country effectively becomes bigger than their domestic market and this provides opportunities for countries to expand their production and even gain market share. It follows then that as the market increases in size the competition increases, and this forces participants to become even more productive and competitive. Lin and Weng [2019], in their study of market size, firm productive efficiency and product quality find that as global markets expand, productive efficiency increases. Ding and Niu (2018) also support this view. Thus, in this paper as market size increases, economic efficiency is likely to increase.

Table 1 The mean and standard deviation of variables studied in the Caribbean and Latin America.

			Caribbean			**Latin America**	
Variables			**Mean**	**Std Dev**		**Mean**	**Std Dev**
Market Related Variables							
	Market size	GDP(M)	394709.87	598802.99		17576.22	23913.29
Private sector Related Variables							
	Literacy [Edu. Exp/Capita]	LIT	428.26	249.44		459.98	245.39
	Credit /Capita [Private Sector]	CRED	4162.55	4301.34		6392.48	5330.20
Infrastructure Related Variables							
	Fixed capital formation	K [M]	80917.56	120821.93		3361.08	6714.64
	Access to electricity [% of Pop.].	ELEC	95.84	5.72		96.58	4.69
Monetary/Fiscal Policy Related Variables							
	Inflation Rate	INF	7.36	9.87		3.06	6.31
	Tax on Income, profit & capital gain [Value],	TAX	8.63	17.84		6.27	3.74
Trade Policy Variable							
	Tax on trade [% of Rev.]	TT	332.75	784.25		49.26	72.16
	Exchange Rate	EXR	2.04	3.39		3.06	1.90
Productive Sector Variables							
	Agriculture [% GDP]	AGR	0.071	0.056		0.072	0.060
	Manufacturing [% GDP]	MON	0.103	0.043		0.120	0.057
	Service [% GDP]	SERV	0.593	0.111		0.604	0.077
	Other [% GDP] Ref. Var.	OTHER	0.233	0.079		0.204	0.055

4.1. The variables are as follows:

Human capital/private sector related variables. In this group, literacy rate [LIT] and access to credit, measured in per-capita terms [CR] are examined. It is expected that a higher level of literacy in a country [LIT] will reflect on the ability to read and follow direction, and communicate, and develop digital ability and on the overall skills in a population. It is expected then that as literacy increases in a country this will result in a higher level of productive efficiency in that country. Lall, et.al [2000] provided evidence to show this. Gong, et. al. [2024] in his analysis of digital literacy show a positive correlation between literacy rate and productive efficiency. This variable, LIT, is expected to have a positive correlation with productive efficiency.

Table 2 The variables, their acronym, hypothesis of relationship with efficiency and rationale.

Variables	Description	Acronym	Ho	Rationale
Market Related Variables				
	Market size	GDP(M)	+	Greater the market size, greater the potential to increase efficiency
Private sector Related Variables				
	Literacy [Edu. Exp/Capita]	LIT	+	Higher literacy means higher potential to be efficient.
	Credit /Capita [Private Sector]	CR	+ or -	Higher credit to private sectors, more investment in capital. Increased efficiency.
Infrastructure Related Variables				
	Fixed capital formation	K [M]	+	Greater capital formation means greater technical and allocative efficiency.
	Access to electricity [% of Pop.].	ELEC	+	Access to electricity means access to power. Increased efficiency
Monetary/Fiscal Policy Related Variables				
	Inflation Rate	INF	-	The impact, negative impact on technology acquisition.
	Tax on Income, profit & capital gain [Value],	TAX	-	Higher tax means less investment, less investment in productive capital. Lower efficiency.
Trade Policy Variable				
	Tax on trade [% of Rev.]	TT	-	Higher taxes [higher cost] on trade, trade restrictions, less benefit from market size
	Exchange Rate	EXR	-	Lower ER means increased foreign demand. More incentive to increase efficiency.
Productive sectors				
	Agriculture [% GDP]	AGRI	+	Expected to be more efficient than Other.
	Manufacturing [% GDP]	MAN	+	Expected to be more efficient than Other.
	Service [% GDP]	SERV	+	Expected to be more efficient than Other.
	Other [% GDP].	OTHER	Ref	

Access to credit [CR] can motivate private firms to invest and become more innovative and acquire technology to boost productive efficiency, or would certainly, in general, stimulate ideas in that direction. Fishman [2001] found a positive correlation between access to credit and capacity utilization. This notion was supported by Manaresi and Pierri [2018].

The variable, CR, is expected to be positively correlated with the productive efficiency measure.

Infrastructure related variables. Two variables are examined in this group, gross fixed capital formation [K] and access to electricity [percent of the population with access to electricity], ELEC.

An increase in fixed capital such as tools, machinery, and building, is likely to result in increased output per unit time and as such it has a positive impact on technical efficiency, and in so doing, productive efficacy. Gopinath, et. al. [2017] and Lambert [2016], have provided evidence supporting this relationship. Consequently, the relationship between K and the productive efficiency measure is likely to be positive.

It is expected that with access to electricity [ELEC], as a source of power, the private sector would first, be likely to engage in commercial production, and second, if they are already in commercial production, would be motivated to invest in technology and increase production as well as efficiency in production. Kennedy [2000] and Lambert [2016] have provided support that productive efficiency increases with access to electricity. In this study, the correlation between access to electricity is expected to be positive.

Monetary/fiscal policy variable. Two variables are studied in this group, inflation rate [INF] and Tax on income, profit, and capital gains [TAX].

Inflation results in higher prices and can discourage investment as a result. With a reduction in capital investment, productivity is likely to decrease, and technical efficiency and even allocative efficiency could be decreased, depending on the kind of impact inflation has on prices. Also, because inflation tends to increase interest rate, borrowing is likely to become more expensive. The overall effect of inflation on production efficiency then is a daunting one; productive efficiency is likely to decrease, at least in the short run. Tommasi [1999] shows this. However, in the long run, the economy becomes accustomed to inflation and firms try to become more efficient to stave off the inflationary effect. Tarkom and Ujah [2023] provide evidence of a negative correlation between inflation and economic efficiency. So, in this study, the correlation is expected to be negative.

Taxes on income, profit, and capital gains [TAX], on the other hand decrease the amount of capital left for investment and would likely have a depressing impact of productive efficiency. Alan, et. al. [2002] provided evidence of this effect. Martin and Trannoy [2019] provide further evidence to support. It in this study, a negative correlation is expected between TAX and the productive efficiency measure.

Trade Policy Variables. Tax on trade [TT] and the exchange rate [EXR] are the variables examined to reflect this group.

Tax on trade results in higher market prices in the international market and a reduction in demand. It thus results in reduced innovation and a disincentive to production and productive efficiency. It can also directly affect allocative efficiency as it results in a price difference between the domestic market and the international market. Farhadian-Lorie, Z and M. Katz [1989], and Nasreen, N. [2019] found the impact of tax on trade on productive efficiency to be negative. In this paper, the correlation is likewise expected to be negative.

The exchange rate [EXR] could either have a negative effect or a positive effect on productive efficiency. Low exchange rates increase international demand as it makes the home-good cheaper. This provides an incentive for firms to become more productive and efficient, to take advantage of the gains from international trade. The opposite is likewise true. This impact on the exchange rate could either be negative or positive. Mlambo and McMillan [2020] have observed a negative correlation between exchange rates and productive efficiency. Morina et. al. [2020] supported this correlation. The expected correlation between EXR and productive efficiency is a negative one.

Productive Sector Variables. It is important to determine the effect of the productive sectors on productive efficiency as this may help in identifying and eliminating or improving areas of weak productive efficiency. There are four sectors, the agricultural sector [AGRI], the manufacturing sector [MAN], the service sector [SERV], and the other sector [OTHER], which includes mining and drilling. Each is expressed as a percentage of GDP. To avoid estimation error, the OTHER sector is dropped from the regression, and each sector variable is interpreted with reference to the other sector.

5. Results and Discussion

5.1. Efficiency measures. Table 3 shows the efficiency results obtain from the estimation procedures. For each country, the efficiency measures are shown for Years 2008-2018, and leaving out 2019, the worse Covid Year, Years 2020-2022, and the overall estimation for Years 2009-2022.

The United States is included in the estimate as a benchmark. Each of the measures in the each of the periods is consistently at the maximum, which is 1.

Based on the mean of Economic Efficiency [EE] for the entire period, 2009-2022, the mean in the Caribbean is greater than that in Latin America [0.748 vs 0.612]. St. Vincent and the Grenadines is the only country in the Caribbean and Latin America that shows this level of efficiency levels of 1, with Trinidad and Barbados [0.984 & 0.907] in the Caribbean, and Argentina Brazil [0.995 & 0.937] in Latin America following closely.

In terms of Technical Efficiency, the periods for the entire period, the mean for the Caribbean was higher than that of

Latin America [0.774 vs 0.618]. St. Vincent and the Grenadines was again the only country in both region with a Technical Efficiency rating of 1. This was followed by Trinidad and Barbados [0.986 & 0.932] and Argentina and Brazil 0.996 & 0.937] in Latin America.

Table 3 The efficiency measure in the Caribbean and Latin America between 2008 and 2022.

	PTE				**AE**				**EE**		
2009-2022	2008-2018	2020-2022	2009-2022		2008-2018	2020-2022	2009-2022		2008-2018	2020-2022	2009-2022
United States	**1.000**	**1.000**	**1.000**		**1.000**	**1.000**	**1.000**		**1.000**	**1.000**	**1.000**
Colombia	0.631	0.729	**0.631**		1.000	1.000	**1.000**		0.631	0.729	**0.631**
Mexico	0.765	0.976	**0.765**		1.000	0.994	**1.000**		0.765	0.970	**0.765**
Costa Rica	0.716	0.752	**0.716**		0.997	0.996	**0.997**		0.714	0.749	**0.714**
Brazil	0.937	1.000	**0.937**		1.000	1.000	**1.000**		0.937	1.000	**0.937**
Honduras	0.397	0.466	**0.397**		0.940	0.986	**0.940**		0.374	0.458	**0.374**
Nicaragua	0.366	0.365	**0.366**		0.911	0.968	**0.911**		0.333	0.351	**0.333**
Argentina	0.996	1.000	**0.996**		1.000	1.000	**1.000**		0.995	1.000	**0.995**
Chile	0.620	0.721	**0.620**		1.000	1.000	**1.000**		0.620	0.721	**0.620**
Bolivia	0.398	0.416	**0.398**		0.974	0.972	**0.974**		0.387	0.403	**0.387**
Ecuador	0.477	0.480	**0.477**		1.000	1.000	**1.000**		0.477	0.480	**0.477**
Guatemala	0.545	0.613	**0.545**		0.988	1.000	**0.988**		0.538	0.613	**0.538**
Paraguay	0.486	0.448	**0.486**		0.998	1.000	**0.998**		0.485	0.448	**0.485**
Uruguay	0.697	0.663	**0.697**		0.993	1.000	**0.993**		0.692	0.663	**0.692**
Mean	**0.618**	**0.664**	**0.618**		**0.985**	**0.994**	**0.985**		**0.612**	**0.660**	**0.612**
Std. Deviation.	**0.201**	**0.226**	**0.201**		**0.028**	**0.011**	**0.028**		**0.208**	**0.228**	**0.208**
Bahamas, the	0.777	0.873	**0.777**		0.967	0.904	**0.967**		0.754	0.790	**0.754**
Dominican Republic	0.558	0.588	**0.558**		0.996	0.997	**0.996**		0.556	0.585	**0.556**
Guyana	0.518	0.558	**0.518**		0.906	0.769	**0.906**		0.470	0.431	**0.470**
St. Vincent and the Grenadines	1.000	1.000	**1.000**		1.000	1.000	**1.000**		1.000	1.000	**1.000**

Barbados		0.932	0.900	**0.932**		0.972	0.961	**0.972**		0.907	0.867	**0.907**
Jamaica		0.463	0.663	**0.463**		0.957	0.980	**0.957**		0.443	0.651	**0.443**
Belize		0.894	0.741	**0.894**		0.960	0.837	**0.960**		0.862	0.644	**0.862**
St. Lucia		0.835	0.902	**0.835**		0.906	0.955	**0.906**		0.759	0.865	**0.759**
Trinidad and Tobago		0.986	1.000	**0.986**		0.998	1.000	**0.998**		0.984	1.000	**0.984**
Mean		**0.774**	**0.803**	**0.774**		**0.963**	**0.934**	**0.963**		**0.748**	**0.759**	**0.748**
Std. Deviation.		**0.209**	**0.170**	**0.209**		**0.036**	**0.082**	**0.036**		**0.214**	**0.194**	**0.214**

Latin America however shows to tendency to be more Allocatively Efficient than the Caribbean [0.985 vs. 0.963], with Argentina, Chile, Columbia, Ecuador, Brazil and Mexico on the frontier [scores = 1].

All other countries had indexes of at least 0.9 In the Caribbean, St. Vincent and the Grenadines was the only country on the frontier [score= 1]. All other countries in the Caribbean had indexes of at least 0.9.

For the Caribbean, many countries show very low technical efficiency. This kind of result show need for more output per individual, perhaps in the form of more training and human aided technology. The results for allocative efficiency indicate that the responsiveness to market changes is lagging, and investment in technology, human capital as well as strategic planning might help. But overall, what is clear, there need to be more access to data, on the performance of countries with the region and outside of the region. There also needs to be more access to information, about technological changes and strategic planning.

In Latin America, very much the same could be said.

5.2. **Regression results** Table 4 shows the regression results for the Caribbean and Latin America. The regression results for the Caribbean show that seven variables in six groups were significant. No variable was significant in the monetary policy group, but variables in the market group, the human capital and private sector group, the infrastructure group, the trade policy group, and the productive group were significant and had the expected signs.

In Latin America, variables in the same groups as in the Caribbean were significant. With respect to individual variables, the impact on economic efficiency is as follows:

In the Caribbean, **the market size**, MARKET, with a coefficient of 0.174, indicates that as the market size increases, by one percent, economic efficiency will increase by 0.17 percent. Firms are likely to interpret the increase in size of the market as an opportunity to increase sales and market share and are likely to invest in measures, such as training and using advanced technology, to increase the productive efficiency of their operations. Lin and Weng [2019] and Ding and Niu (2018) support this view.

In Latin America, MARKET has a similar effect of productive efficiency; the impact was larger in Latin America [0.1817].

Looking at the **Human Capital/Private Sector** group, both the Literacy Rate [LIT] and Access to Credit by the Private Sector [CR] were significant and had the expected signs, with the coefficients being 0.4440 for LIT, and slighter smaller for CRD [0.190], indicating as shown in Gong, et. al (2024) for LIT and Fishman, (2001) and Manaresi and Pierri. (2018) for CR that productive efficiency is likely to improve if the workforce is more literate and capital is made more available to the private sector.

In Latin America LIT was significant and has the expected positive sign [0.2810] showing that in this region as well, literacy in the workforce can result in greater efficiency. CR was also significant, [0.1150], but has a slightly smaller effect in this region than in the Caribbean,

With respect to the **infrastructure group**, both variables, Gross Fixed Capital Formation [K] and Access to Electricity [ELEC] are both significant and have positive coefficients [0.5467 & 1.4899] indicating that with an increase in K and ELEC have significant positive impacts on productive efficiency. In particular, economic efficiency is likely to increase by 0.55 and 1.48 percent for a one percent increase in each K and ELEC. Gopinath, et. al. [2015] had similar results for K and the result for ELEC matched those of Kennedy [2000] and Lambert [2016]. With regard to Latin America, only K was significant and the expected positive sign [0.1686], suggesting here again that investment in productive infrastructure results in increasing productive efficiency.

In the **Monetary/Fiscal policy group**, of the tax on income, profit and capital gains [TAX] and the inflation rate [INF], only TAX was significant in the Caribbean [-0.5575], but both variables were significant in Latin America [-0.1870 & -0.1939]. Taxes in the Caribbean are likely to have a stronger effect than a similar policy in Latin America. Alan, et. al. [2002] found a similar effect for TAX and Martin and Trannoy [2019] found additional evidence to support the negative correlation between Tax and productive efficiency.

Of the **trade variables**, the Exchange Rate [EXR] was significant and had the expected negative sign in both the Caribbean and Latin America [-0.1731 & -0.1801] indicating the inverse relationship between EXR and productive efficiency as also found in Mlambo and McMillan [2020] and Morina et. a. [2020]. It would appear that a lower exchange rate induces increased competition for domestic goods, which itself induces efforts to increase productivity, and productive efficiency in particular. The impact was slightly stronger in Latin America compared with the Caribbean. Tax on Trade [TT] was not significant in either region.

In the **productive sector group**, agriculture [AGR] and Service [SERV] were significant [-0.4576 & 0.3016] in the Caribbean. These coefficients, interpreted relative to the Other [OTHER] sector, indicate that AGR is likely have less effect and SERV is likely to have a greater effect than the OTHER sector on the productive efficiency in this region. The impacts of both variables were similar in Latin America, however, AGRI is likely to be less strong effect than in the Caribbean [-0.3368], and MAN is likely to have a stronger effect [0.5343] compared with the OTHER sector.

Table 4 Regression Coefficient for the Caribbean and Latin America

			Caribbean			**Latin America**		
Variables			*Coefficients*	*P-value*		*Coefficients*	*P-value*	
Market Related variables								
	Market size [GDPT]	GDP(M)	0.1417	0.0021	***	0.2087	0.0053	***
Human capital/ Private sector related variables								
	Literacy rate	LIT	0.0904	0.0128	**	-0.0221	0.0163	**
	Credit/Capita	CR	0.0264	0.0370	**	0.0178	0.0743	*
Infrastructure Variables								
	Gross Fixed Capital formation	K	0.2101	0.0200	**	0.2447	0.0012	***
	Electricity	ELEC	0.0185	0.0283	**	0.0184	0.0150	
Monetary/Fiscal Policy Variables								
	Inflation Rate	INF	-0.0104	0.9886		-0.0208	0.2008	
	Tax [	TAX	-0.0129	0.0398	**	-0.0670	0.0142	**
Trade Policy Variable								
	Tax on trade	TT	-0.0855	0.3946		-0.0297	0.2084	
	Exchange Rate	EXR	-0.0464	0.0023	**	-0.0030	0.0324	**
Productive sector Variables								
	Agriculture [% GDP]	AGR	-0.0464	0.0010	***	0.0327	0.0655	
	Manufacturing [%GDP]	MAN	0.0756	0.0418	**	0.1505	0.0010	***
	Service [% GDP]	SERV	-0.0160	0.0588		-0.1662	0.0288	**
Constant		Intercept	-0.204	0.0000	***	-0.23863	0.029	***
R Square			0.671			0.584		

6. Conclusion

- **Efficiency results:** Between the Caribbean and Latin, the measure of economic efficiency was higher in the Caribbean, but the variation in the measure was also greater in the Caribbean compared with Latin America.

  In both regions allocative efficiency contributed more to economic efficiency compared with technical efficiency, with the measure of allocative efficiency greater in Latin America than in the Caribbean. Technical efficiency was greater in the Caribbean. The results further indicate that following the Covid crisis in 2019, both regions showed improved economic efficiency.

- **Regression results:** Regression analysis reveals that in the Caribbean, eight variables in six groups were significant and had the expected sign. These variable were the followings: market size groups in the Market Size group, Literacy Rate and Access to Credit, in the Human Capital/Private Sector Group, Fixed Capital Formation and Access to Electricity in the Infrastructure Group, and Exchange Rate in the Trade Policy Group had a significant effect on productive efficiency both in the Caribbean and Latin America: market size, human capital/private sector, monetary/fiscal policies, infrastructure, trade policy. In the productive sector group, agriculture and manufacturing were significant.

In Latin America, variables are each of these groups, except for Access to Electricity, were also significant and had the expected signs. In the productive sector, agriculture and manufacturing were also significant.

Variables that had a stronger impact in the Caribbean were literacy rate, private sector access to credit, fixed capital formation and access to electricity and each has a positive relationship with productive efficiency. Tax on income and the exchange rate had a stronger negative correlation with economic efficiency, suggesting the need for policies to decrease each. In Latin America, the exchange rate and market size had a stronger impact on productive efficiency.

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