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Productive Efficiency under Economic Integration in Guyana and the Rest of CARICOM

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ABSTRACT*: Measures of Economics Efficiency [EE], Pure Technical Efficiency [PTE] and Allocative Efficiency [AE] in Guyana and the rest of Caricom [ROC], represented by six countries, over the period 2008-2022, determined using nonparametric methods, showed that each measure of efficiency was higher in ROC than in Guyana each year over the period. Neither bloc showed an increase in Economic Efficiency over the period and the EE trend lines showed a divergent trajectory from Year 2008 onwards.*

Regression results shows that market size in the market group, tax on income, profit and capital gains in the monetary/fiscal policy group, tax on trade and the exchange rate in the trade policy group, literacy rate and access to credit in the private sector/human capital group, gross fixed capital formation in the infrastructure group, each had a greater impact on efficiency gain in Guyan compared with ROC. On the other hand, access to electricity in the infrastructure group had a greater impact on efficiency in ROC. Efficiency gain was greater in the agriculture sector in Guyana, and in ROC, the service sector showed higher efficiency gains.

Keywords: *Caribbean, Rest of Caricom, pure technical efficiency, allocative efficiency, economic efficiency.*

I. INTRODUCTION:

Each new wave of free trade has brought with it significant structural changes to countries worldwide. Countries are required to make the necessary changes and become more efficient and productive as they strive to meet the needs of the new international order and avoid trade deficits. Countries in the Caribbean have long been caught up in these changes. Guyana is no different.

Relative to other Caribbean countries, Guyana has been facing serious developmental challenges, And, even before 2014, in Guyana, measures have been underway to bring about efficiency in public expenditure, through a program administered by the 'Strategy and Action Plan' for Institutionalizing, Monitoring and Evaluating public expenditure in Guyana (M&E Action Plan, Cuesta. et. al., [1]).

But the problem is an historic one. As is the case with other countries of the Caribbean, Guyana has followed the pre-colonial, and after independence in 1966, a post-colonial plan of development that focused heavily on a mono-sectors economy in which it produced and traded primary agricultural product such sugar and rice, and to some extent, minerals as well, for manufactured goods, capital and technology. The economy has never been strong on the internation market, except in the 1970s when sugar rose, and after that, fell. In fact, Guyana has always been on the defense with regards to the internation market and practiced self-sufficiency through a program of import substitution to stave off trade deficits and conserve on foreign exchange.

Although it is not in the hurricane belt, as are the island states of the Caribbean, it is prone to flooding, which has on several occasions tested the economic resilience of the Country. And like other Caribbean countries, Guyana benefitted from foreign aid, trade concessions, and preferential markets, benefits which are gradually being withdrawn in the new international order of trade liberalization, and historically, has always been heavily financially indebted. Like other Caribbean countries, Guyan has sought the help of DFI [Direct Foreign Investment] and IFI [indirect Foreign Investment] making the tradeoff choice between exploitation of its resources and repatriation of revenue, for capital, technology and manpower development, and in developing its production capabilities. DFI also helps with providing employment, increasing exports, and managing foreign indebtedness.

In more recent years, remittance has played an important role managing Guyana's economy. In 2019, Guyana entered the international oil market, as an oil producer, and since them, its per capital GDP has increased, and it has since embarked on a program of physical infrastructure and human capital development. But, despite this being the case, Guyana remains financially indebted and has a life expectance and an education index well below the median of the Caribbean region (IMF, [2]). Guyana still remains on its course action in the M & E Action Plan (Cuesta. et. al., [1]) and is being guided to a program of developing and following policies to increase public sector efficiency.

As a benchmarking exercise, and by way of advising policy development, it is important to examine how Guyana's performance has improved in its productive efficiency and productivity since being on this

course of action. The objective of this study is to examine this issue and see how Guyana differed from the rest of the Caribbean in these regards. Specifically, the objective of this paper is to is to determine productive efficiency in Guyana between 2009-2022 against the background of this indicator for the rest of the Caribbean countries, and to examine the differential impact of factors affecting productivity in Guyana and the Caribbean.

II. ANALYTICAL FRAMEWORK

As a measure of productive efficiency, overall efficiency is used as the best estimator. Overall efficiency is the product of pure 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, 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.

III. METHODOLOGY

Economic efficiency [EE] is the product of pure technical efficiency [PTE] and allocative efficiency [AE]. The problem at hand is to construct a method to investigate PTE and AE. In this paper a nonparametric estimation procedure 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, Fig.1 is used (Fare and Groskopf, [3]; Farrell [4]). 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 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.

Pure technical efficiency (PTE) is measured relative to a variable return to scale frontier, such as the ABCD frontier in Fig. 1. Note the constant return to scale frontier as shown by OS in Fig. 1.

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, i.e.:

$$PTE = OB2/OB2 = 1 \quad (1)$$

For a production unit that is within the frontier such as [x, y], the PTE is less than 1, i.e.:

$$PTE = OB1/OD2 < 1 \quad (2)$$

In Fig. 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 price slope, Po/Po, then the economically efficient point is 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.

In this study, allocative efficiency is calculated using the concept of revenue maximization instead of cost minimization. In cost minimization, the condition for allocative efficiency is $MPP_1/MPP_2 = W_1/W_2$.

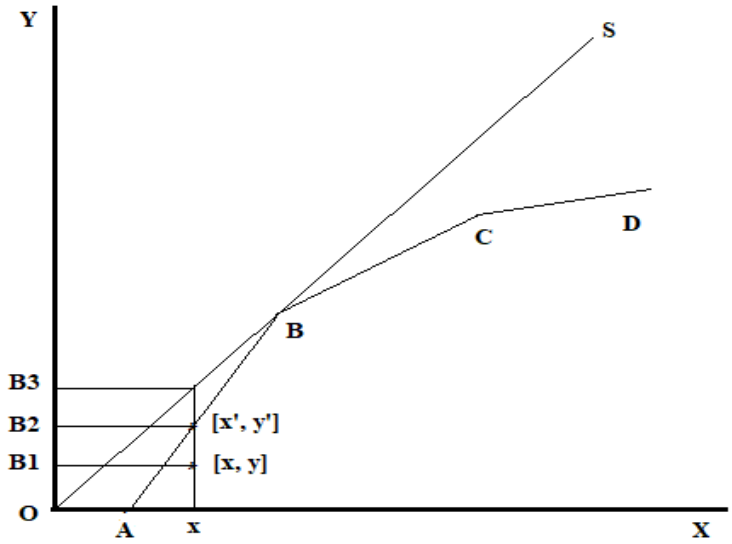

Figure 1: Constant and variable returns to scale.

In this case [Fig. 2] allocative efficiency occurs at the revenue maximizing point A, where $MRP_1/MRP_2 = P_1/P_2$. This is so because it is also on the production transformation curve, and any production unit operating on the production transformation curve is considered to be pure technically efficient.

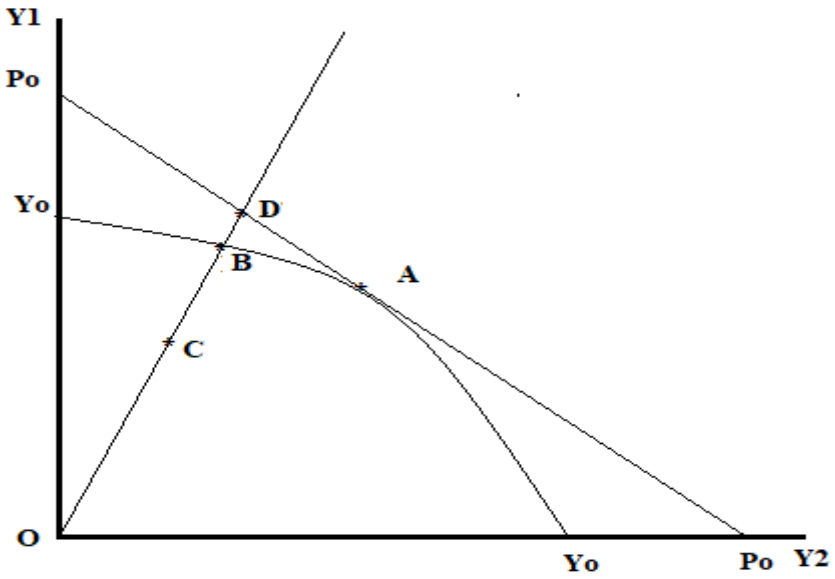

Figure 2: The Measure of Allocative Efficiency.

If we consider the unit, B, it is pure technically efficiency, but not allocatively efficient.

PTE for Unit B = OB/OB=1

AE for Unit B = OB/OD < 1.

For it to be allocatively inefficient it must be on the price line PoPo, as Unit A is.
Unit C, on the other hand, because it is not on the frontier, but within, is pure technically inefficient.
For Unit C, PTE = OC/OB < 1.
With regards to economic efficiency, for Unit C, the EE is as follows:

EEc = {(OC/OB) * (OB/OD)} = OC/OD < 1

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

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

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

$$\Sigma z^k = 1 \qquad (3)$$

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, tc), of producing output for the k^{th} observation, under constant returns to scale, is calculated. Specifically, the following LP is solved:

$R_k(p,x,t_c)$ = Max $P_k'Y_k$ subject to

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

$$\sum_{k=1}^{K} z^k y^k_m \geq y^k_m \qquad m=1.....M \qquad (4)$$

In this problem, k, m, n, x, y, and z are as defined as in Equation (3) and p = 1...P, are the output prices for m = 1...M outputs. The solution to Equation (5) represents the maximum revenue for the k^{th} observation. Overall efficiency is determined as

$$OE_k = P_kY_k/R_k(p,x,t_c) \qquad (5)$$

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

$$AE_k = (P_k'Y_k/R_k(p, x,t_v))*(1/\theta_k) \qquad (6)$$

where R_k (p, x,t_v) is the maximum revenue calculated relative to variable returns to scale by adding the restriction shown in Equation (7) to Equation (4) and θ_k is the measure of pure technical efficiency obtained by solving Equation (3).

$$\Sigma z^k = 1 \qquad k =1....K \qquad (7)$$

IV. REGRESSION ANALYSIS

The methodology used to determine the relationship between the explanatory variables and the efficiency measures is the log-log regression model (Equation 8). Each parameter coefficient is interpreted as the percentage change in efficiency because of a one percent change in the parameter estimate.

$$lEE_{ij} = \alpha_o + \alpha_1 lGDP_{ij} + \alpha_2 lEDU_{ij} + \alpha_3 lCR + \alpha_4 lK_{ij} + \alpha_5 lELEC_{ij} + \alpha_6 LlINF_{ij} + \alpha_7 TAX_{ij} + \alpha_8 lEXR_{ij} + \alpha_9 lTTr_{ij} + \alpha_{10} IlAGRI_i + \alpha_{11} lMAN_{ij} + \alpha_{12} LSERV_{ij} + e_{ij} \quad \ldots\ldots (8)$$

where: i and j are the country and year, respectively; lEE_{ij} is the variable representing the Economic Efficiency Index of each country in each year. The other variables are as defined in Table 1; and $e_{ij,}$ represents unexplained random errors. The letter '*l'* in front of each variable indicate that model is in the log form. The countries included for the rest of the Caribbean involved in this study are the Bahamas, Belize, Barbados, the Dominican Republic, Jamaica, and Trinidad and Tobago.

Table 1: Mean and standard deviation of variables [2008-2022]

			Guyana		**Rest of Caribbean**	
Variables		Guy	Mean	Std Dev	Mean	Std Dev
Market Related variables						
	Market size [GDP]					
		MARKET	5310.83	2897.71	19383.75	25101.80
Monetary/Fiscal Policy Variables						
	Inflation Rate.	INF	2.45	10.44	3.15	5.48
	Taxes on income, profits and capital gains (% GDP)	TAX	5.73	2.44	6.35	3.89
Trade Policy Variable						
	Tax on trade [% Rev.]	TT	2.16	0.41	3.20	2.00
	Exchange Rate	EXR	198.07	31.16	27.33	45.39
Private sector related variables						
	Literacy [Exp. Edu/Capita]	LIT	265.94	182.37	488.58	240.77
	Credit/Capita	CR	2079.79	725.09	7028.03	5421.13
Infrastructure Variables						
	Gross Fixed Capital Formation	K	16.08	10.48	3854.03	7063.24
	% of population with access to electricity.	Elec	87.91	4.31	97.86	3.13
Productive sector variables						
	Agriculture [% GDP]	AGRI	0.029	0.050	0.035	0.030
	Manufacturing [% GDP]	MAN	0.035	0.053	0.195	0.200
	Service [% GDP]	MAN	0.733	0.793	0.618	0.626
	Other [% GDP]	OTHER	0.203	0.104	0.152	0.144

V. THE DATA

This study involved observations on the outputs and inputs Guyana and 6 Caribbean Countries [ROC] over the period 2008 to 2022. The measures of output were calculated as the GDP (measured as Constant 2015 US Dollars) divided by the real price. The real price was obtained by dividing constant by the current GDP and standardizing it 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 [5]. Because of inconsistencies observed in the World Bank data set with respect to some countries, these countries were omitted from the study. Also, in determining the relationship between efficiency and specific policy variables, several observations for some countries were not available, so these countries were not included in the regression analysis.

VI. THE POLICY VARIABLES.

In the study, 13 variables that proxied for 6 groups are studied. The variable, their means and standard deviation are as shown in Table 1. Table 2 shows the expect correlation between the dependent variable and each variable studied.

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 restriction, 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 that other.	
		Manufacturing [% GDP]	MAN	+	Expected to be more efficient that other.	
		Service [% GDP]	SERV	+	Expected to be more efficient that other.	
		Other [% GDP].	OTHER	Ref.		

To avoid the error due to degree of freedom and overfitting problems that occurs when too many variables are estimated with a limited number of observations, the number of variables was split, and the regression estimation was done in two parts [with 2 R Squares are reported]

In Regression # 1, the groups investigated are the market size, the monetary/fiscal policy group, the trade policy group and in Regression # 2, the human capital and private sector group, the infrastructure group, and the productive group were investigated.

Market-related variables. The market size [MARKET] is the only variable in this group. Competition in the marketplace will force countries to become more efficient. As the market size, this will provide more opportunities for producers to become even more competitive in order gain market share. It follows then that as the market increases in size increases, this will force participating countries to invest and become even more efficient to become more competitive. Lin and Weng [6], in their study of market size, firm productive efficiency and product quality find that as global markets expand, productive efficiency increases. This view was supported by Ding and Niu [7]. In this paper as market size increases, economic efficiency is expected to increase.

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

Inflation is likely to increase prices, which has the effect of discouraging investment. If investment in productive capability decreases, productive efficiency is likely to decrease, the extent of which 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 effect of inflation then is that productive efficiency is likely to decrease, at least in the short run. Tommasi [8] has shown this. 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 [9] provide evidence of the negative relationship between efficiency and inflation. So, with respect to the correlation between inflation and the productive efficiency measure, a negative correlation is expected.

Taxes on income, profit and capital gains [TAX], have the effect of decreasing the amount of capital left for investment and is likely to have decreasing impact of productive efficiency. Alan, et. al. [10], in his analysis of the impact of tax on profit, show this effect. Further evidence of this negative relationship between taxes and productive efficiency is provided by Martin and Trannoy [11]. Thus, a negative correlation is expected between TAX and the productive efficiency measure in this study.

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

Tax on trade is a disincentive to production as it results in higher market prices in the international market and a reduction in demand. This discourages investment in production capabilities. It results in reduced innovation and reduced production, which itself results in reduced technical efficiency. It can also have an effect on allocative efficiency as it results in a price difference between the domestic market and the international market. Farhadian-Lorie and Katz [12], and Nasreen, N. [13] found the impact of tax on trade on productive efficiency to be negative. In this paper, the correlation is likewise expected to be negative.

With regards to the exchange rate [EXR], this variable could either have a negative or a positive impact on productive efficiency. A high EXR means the home goods become more expensive to foreign buyers, and demand decreases. This decreases the grains from internation trade and discourages efforts to increase, provides a disincentive to increase productive efficiency. The opposite is likewise true. This the impact on the exchange rate could either be negative or positive. Mlambo and McMillan [14] have observed a negative correlation between exchange rates and productive efficiency. Morina et. a. [15] provides evidence to support this correlation. Thus, a negative correlation is expected correlation between EXR and productive efficiency.

Human capital/private sector related variables. Literacy rate [LIT] and access to credit, measured in per-capita terms [CRED] are the variables examined in this group

With regards to LIT, as the population within a country improved in their ability to read and follow direction, and communicate, develop digital ability, it is expected that their productive efficiency will improve as well. Lall, et. al [16] provided evidence to show this. Gong, et. al [17] 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.

With regards to access to credit [CR], if credit becomes available, firms are likely to become incentivized to invest in become more innovative and productive and productively efficiency assuming that the market would allow for the investment. But in general, access to credit could motivate efforts in that direction. Fishman, [18] found a positive correlation between access to credit and capacity utilization. This notion was supported by Manaresi and Pierri. [19]. The variable, CR, is expected to be positively correlated with the productive efficiency measure.

Infrastructure related variable. In this group, two variables are examined, 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, and bridges and roads, is likely to result in increased output per unit labor, and as such it has an impact on technical efficiency, and in so doing, productive efficacy. Gopinath, et. al. [20] and Lambert [21], have provided evidence supporting a positive relationship between capital and productive efficiency. Accordingly, the relationship between K and the productive efficiency measure is likely to be positive.

Access to electricity [ELEC] means a more efficient energy source. This is likely to incentivize the private sector to become engaged in commercial production, or for that part that is already in it to invest more to increase their productive efficiency, and so increase their production. Kennedy [22] and Lambert [21] have provided support that productive efficiency increase with access to electricity. In this study, the correlation between access to electricity is expected to be positive.

Productive Sector related Variables. The productive sector comprises of four sectors, the agricultural sector [AGRI], the manufacturing sector [MAN], the service sector [SERV] and the other sector [Other], which includes mining and drilling. It is important to determine the effect of each sector on productive efficiency as this may help in identifying and eliminating or improving areas of weak productive efficiency. Because each sector is expressed as the percentage it contributes to GDP, which together adds up to 100%, to avoid estimation error, the OTHER sector is eliminated from the regression, and each is interpreted with reference to the other sector.

VII. RESULTS AND DISCUSSION:

7.1 Efficiency measures.

Based on the means [Table 3], each measure of efficiency ROC is higher than that of Guyana. Based on the trends in EE over the period, although there were periods in which EE appears to converge, based on the trend line, over the entire period the trajectory between the two appears to be diverging [Fig. 3]. But neither shows an upward trend.

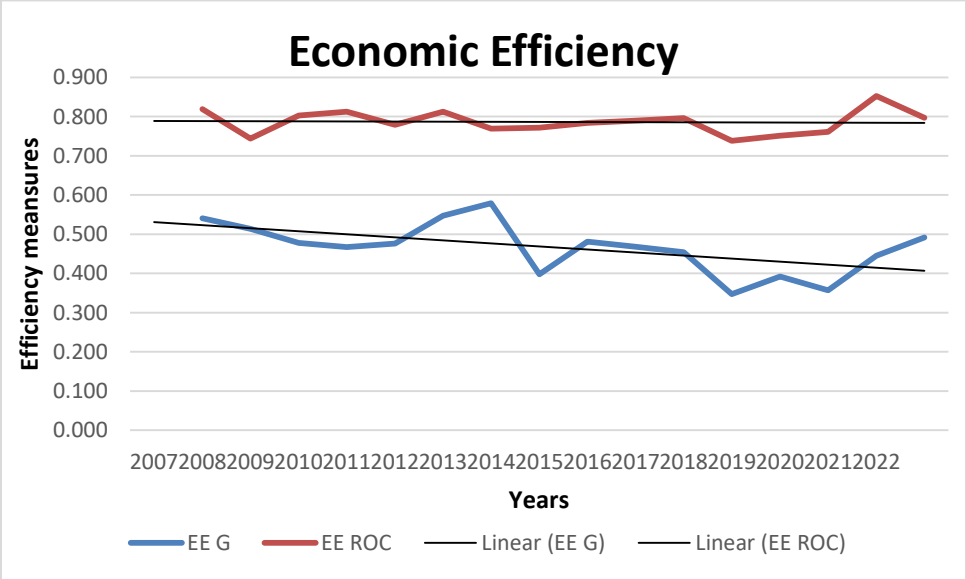

Figure 3: Economic Efficiency.

Similar patterns are observed in both PTE and AE [Figs. 4 and 5].

Although these trends are alarming, Guyana, in spite of it, as of 2019, being an oil producing country, with a quickly rising GDP per capita, it is still an emerging economy and is still in the process of establishing production foundations, in both physical as well as human capital, to support higher levels of PTE, AE and EE (World Bank [23]).

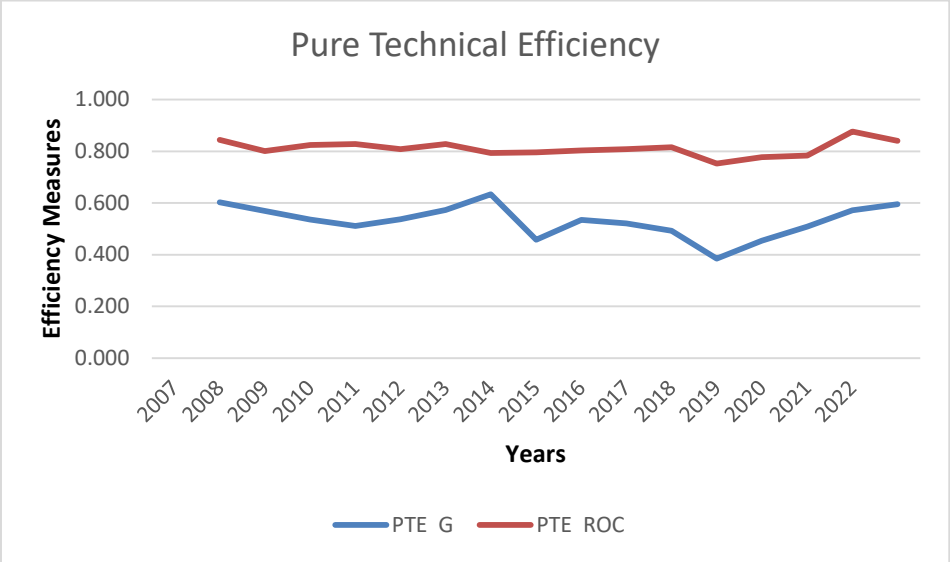

Figure 4: Pure Technical Efficiency

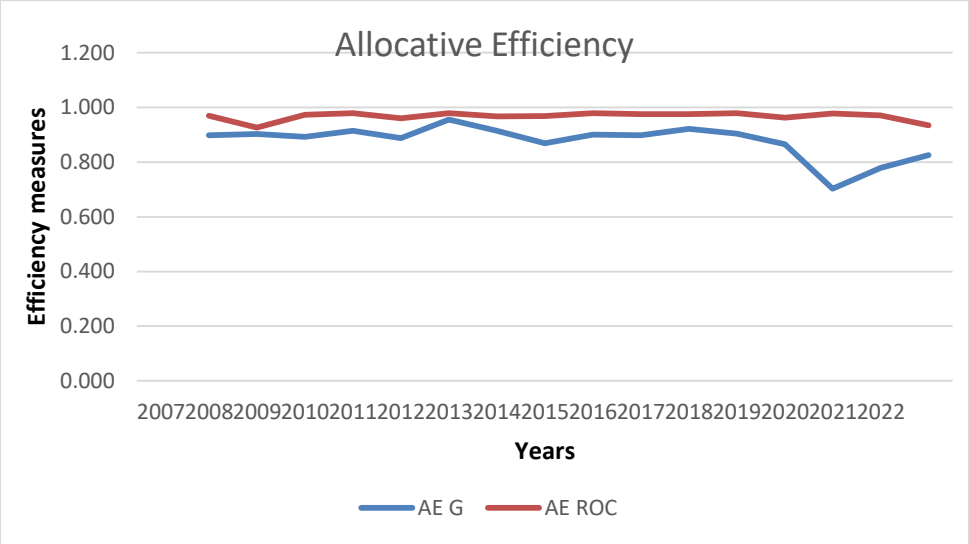

Figure 5: Allocative Efficiency.

7.2 Regression results.

The regression results for Guyana and the Rest of the Caribbean [ROC] are shown in Table 4. The results show that nine variables in six groups are significant. The groups in question are the market size, the monetary/fiscal policy group, the trade policy group in Regression # 1 and the human capital and private sector group, the infrastructure group, and the productive group in the other. Each significant variable had the expected signs.

In ROC, eight variables are the same groups as in Guyana were significant.

In Guyana, the **market size** variable [MARKET] was significant and positive coefficient. This positive correlation was also observed by Lin and Weng [6], Ding and Niu [7]. The variable had a stronger coefficient in the Guyana compared with the Rest of the Caribbean [ROC],0.735 and 0.027, indicating that for a one percent increase in MARKET, economic efficiency is likely to increase by 0.735 percent in Guyana, and 0.027 percent in ROC.

In the **monetary/fiscal** policy group two variables were tested, the inflation rate [INF} and tax on income, profit and capital gain [TAX]. TAX was the only variable that was significant in Guyana, as well as ROC, and it had the expected sign. Tarkom and Ujah [9] supported this result.

Table 3: Pure technical efficiency, Allocative Efficiency and Economic Efficiency [1908-2022]

	Pure Technical Efficiency		Allocative Efficiency		Economic Efficiency		PTE; AE; EE
	G	ROC	G	ROC	G	ROC	US
2007	0.602	0.844	0.898	0.969	0.541	0.819	1.000
2008	0.569	0.800	0.902	0.927	0.514	0.744	1.000
2009	0.536	0.824	0.892	0.973	0.478	0.803	1.000
2010	0.511	0.828	0.914	0.979	0.467	0.813	1.000
2011	0.537	0.808	0.887	0.960	0.477	0.779	1.000
2012	0.573	0.828	0.955	0.979	0.547	0.813	1.000
2013	0.634	0.794	0.914	0.967	0.579	0.769	1.000
2014	0.458	0.795	0.869	0.968	0.398	0.771	1.000
2015	0.535	0.803	0.901	0.978	0.481	0.784	1.000
2016	0.521	0.809	0.899	0.976	0.468	0.790	1.000
2017	0.493	0.816	0.922	0.975	0.454	0.796	1.000
2018	0.384	0.752	0.904	0.979	0.347	0.739	1.000
2019	0.454	0.777	0.865	0.963	0.392	0.751	1.000
2020	0.508	0.784	0.703	0.977	0.357	0.761	1.000
2021	0.572	0.876	0.778	0.971	0.445	0.852	1.000
2022	0.595	0.840	0.826	0.934	0.492	0.797	1.000
Mean	0.530	0.811	0.877	0.967	0.465	0.786	1.000
Std. Dev.	0.063	0.029	0.062	0.016	0.066	0.030	0.000

The variable had a stronger negative coefficient in the Guyana compared with ROC [-2.329 & -0.19], which suggest that decreases in TAX in Guyana is likely to boost productive efficiency, very likely because of TAX decreases the amount of capital earned from income, profit and capital gain that is likely to be reinvested into efficiency enhancing projects.

With respect to the **trade policy** group, two variables, tax on trade [TT] and exchange rate [ER], were examined and in Guyana, both were significant in Guyana, and both had the expected signs. In the ROC, only TT was significant. Farhadian-Lorie and Katz [12] and Nasreen, N. [13] also found the same correlation between efficiency measures and tax on trade.

TT had a stronger negative impact on efficiency in Guyana compared with ROC, suggesting that the economic efficiency measure is likely increase more in Guyana compared with ROC as TT deceases.

ER was significant only for Guyana and had the expected negative sign suggesting that productive efficiency is likely to increase as the exchange rate decreases.

Regarding the **Human capital/Private Sector variables**, the literacy rate [LIT] and access to credit by the private sector [CR], both variables were significant in Guyana, and both had the expected positive signs [1.007 & 1.599 indicating that economic efficiency is likely to increase by over 1 percent for a one percent increase in either variable. CR seems to have a bigger impact on economic efficiency that LIT. Gong, et. al (2024) also found that LIT had a positive impact of efficiency. And, Fishman, [18] and Manaresi and Pierri. [19] showed the same relationship between access to credit and efficiency measures. In ROC, only LIT was significant and it had the positive sign, but its coefficient was smaller than in Guyana [0.165].

Gross fixed capital formation [K] and access to electricity [ELEC] were the proxies used for the impact of infrastructure on efficiency. Both variables were significant and had the expected positive signs in both Guyana and ROC. This substantiates and is substantiated by the results Gopinath, et. al. [20] and Lambert [21] for K and Kennedy [22] for ELEC. The impact of K was greater in Guyana [0.420 vs 0.034], but that of ELEC was greater in ROC [2.294 vs 1.293].

In the productive sector group, only MAN was significant in Guyana, and it was negative indicating that economic efficiency in the manufacturing sector in the country was less efficient that in the other sector [OTHER]. In ROC, both MAN and SERV were significant, and while MAN had a negative sign, suggesting that this sector is less efficiency that OTHER, SERV had a positive sign, indicating the opposite.

Table 4: Regression results, Guyana and the Rest of the Caribbean [ROC].

			GUYANA			R O C		
Variables			*Coefficients*	*P-value*		*Coefficients*	*P-value*	
Market Related variables								
	Market size [GDP (M)]	MARKET	0.735	0.049	**	0.027	0.034	**
Monetary/Fiscal Policy Variables								
	Inflation Rate	INF	-0.101	0.032		-0.010	0.653	
	Tax on income, profit and capital gains	TAX	-2.329	0.012	**	-0.190	0.001	***
Trade Policy Variable								
	Tax on trade [% of Rev]	TT	-1.060	0.044	**	-0.136	0.000	***
	Exchange Rate	EXR	-0.488	0.033	**	-0.038	0.388	
Human capital/ Private sector related variables								
	Literacy rate	LIT	1.007	0.019	**	0.165	0.015	**
	Credit/Capita	CR	1.599	0.001	***	0.014	0.826	
Infrastructure Variables								
	Gross Fixed Capital formation	K	0.420	0.013	**	0.034	0.033	**
	Electricity: % Pop Access to Elect.	ELEC	1.293	0.008	**	2.294	0.010	**
Productive Sector Variables								
	Agriculture	AGRI	0.166	0.411		0.017	0.802	
	Manufacturing	MAN	-0.820	0.026	**	-0.099	0.030	**
	Service	SERV	0.206	0.206		0.171	0.010	**
Constant			0.942	0.012	**	-0.279	0.027	**
			2.012	0.293		-6.056	0.001	***
R Square 1			0.476			0.433		
R Square 2			0.330			0.352		

**** & ***** significance at the 95 & 99 % CI.**

VIII. SUMMARY

Efficiency measures.

The results for the efficiency measures from 2007 to 2022 are shown in Table 3 and the trends of Pure Technical Efficiency [PTE], Allocative Efficiency [AE] and Economic Efficiency [EE] are illustrated in Figure 1- 3. The measures obtained for the US are included, year by year, as a benchmark in the study.

Based on the means shown in the table, each measure of efficiency each measure in ROC is higher than that of Guyana. For EE, it is 0.786 vs 0.465, ROC: Guyana. The trend and trend line for the entire period studied [2009-2022] is shown in Figure xxx. Although there were periods in which EE appears to converge, based on the trend line, EE between the Guyana and ROC appear to be diverging; the trajectory between the two appears to be widening from 2007 to 2022.

Similar patterns are observed in both PTE and AE [Table XXX and the Figures xxx for PTE and AE]. Although these trends are alarming, Guyana is an emerging economy, even though it is said to be the fastest growing economy, based on its GDP per capita, the evidence shows that it still has now quite established the production foundation, in both physical as well as human capital, to support higher levels of PTE, AE and EE.

Regression results.

The results indicated that nine and variables in six groups in Guyana and the rest of the Caribbean were significant. The groups concerned were the market size, the monetary/fiscal policy group, the trade policy group, the human capital and private sector group, the infrastructure group, and the productive group. Each significant variable had the expected signs.

Market size, tax on income, profit and capital gains in the monetary/fiscal policy group, tax on trade and the exchange rate in the trade policy group, literacy rate and access to credit by the private sector in the human capital/private sector group, gross fixed capital formation in the infrastructure group, each had a greater impact on efficiency gain in Guyan compared with the rest of the Caribbean. On the other hand, access to electricity in the infrastructure group had a greater impact on efficiency in the rest of the Caribbean.

In the productive sector group, the agriculture sector in both areas had a lower impact on economic efficiency that the other sector, which includes mining, drilling and construction, while the service sector in the rest of the Caribbean had a greater impact on economic efficiency that the other sector.

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