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Productive Efficiency under Economic Integration in the Mercosur and Sica blocs

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ABSTRACT: This paper determined the productive efficiency of Mercosur and Sica economic blocs over the period 2009 - 2022 and compared their productive strategies. Results showed that economic efficiency [EE] was greater and its variation lower in Mercosur [M] bloc compared with Sica [S] bloc. Similar patterns were observed regarding Pure Technical Efficiency [PTE] and Allocative Efficiency [AE]. Overall, EE between the two blocs tended to converge, with that of Mercosur remaining flat over the years.

Regression results showed that in Mercosur countries only credits in the human capital/private sector group and the agriculture sector in the productive sector had a stronger positive impact on economic efficiency than in Sica countries. All other variables, markets size, gross fixed capital formation and access to electricity, in the infrastructure group had a stronger positive impact and tax in the monetary/fiscal policy group, and tax on trade and exchange rate in the trade policy group and the service sector in the productive sector group had a stronger negative impact on EE in Sica countries compared with Mercosur countries.

Keywords: Caribbean, Latin America, pure technical efficiency, allocative efficiency, economic efficiency.

I. INTRODUCTION

Each new wave of trade liberalization brings 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. The countries of Latin America have long been caught up in these waves of change and must face it alone, or in economic blocs.

Economy integration brings about the benefits of economy of scale, cost reduction, and maximizing production capabilities. And many countries have recognized that it is the solution to low productivity, low returns to labor, and poverty. Economic integration not only offers an enlarged marketplace, which motivates specialization, productivity and productive efficiency and fosters the transfusion of technology and managerial skills across countries. And in so doing, enables them to at least catch up and meet the level of productivity and productivity efficiency and trade required, and prosper as a result.

Countries working together, each with a different market specialization, provides a diversified economic basis, which not only ensures self-sufficiency within the bloc, but adds flexibility in facing a diverse and dynamically changing international market.

Within Latin America, countries have come to recognize that competing in the international market alone does not guarantee any kind of protection against already integrated blocs. Together, as an integrated bloc, a buffer against economic downturns is created, and the risk of failing is distributed. There are many economically integrated blocs in Latin America.

But economic integration in Latin America, as it is in other parts of the world, has not actually brought with is made the prosperity the idea promises and many countries in the various economic integrated systems are still faced with low productivity and low returns to labor. And perhaps, this is because these countries have not reached the level of integration needed for prosperity to manifest, and countries must, in the meanwhile, still continue to face the risk of failing (Acosta-Ormaechea, et. al. [1])

Vargas-Alzate [2] has suggested a very plausible reason why, and that is the level of asymmetries amongst countries. Countries vary with regards to natural endowment, stages of development, level of productive infrastructure, levels of specialization or diversification, level of political stability.

A single policy or strategy can have various levels of impact on member countries. A reduction in tariffs, for example, could mean little or a loss of a crucial source of income depending on the economic disposition of the country. A Country's size may be a source of economic disparity. For example, ceteris paribus, seventy percent of a small country's exports may constitute five percent of another country's imports, which opens up the question of economic power. Protecting an infant industry could also lead to disagreements, just as protection an invention could. All these situation signals asymmetry among countries in an economic bloc

The fall-out out of this kind of asymmetry is disharmony among countries is the rate of policy implementation. This is more common in smaller countries with a weaker economic base, and countries that do not stand to benefit much from standing policies. If, for example, the policy is to reduce tariffs, a country will lose irrecoverable revenue, that country is more hesitant to implement that policy.

These kinds of problems reflect within countries in many ways: low productivity, poverty and in a number of other ways. Among the criticisms leveled in this respect pertaining to economic integration in Latin America, apart from the need to further reduce tariffs, and reduce high trade costs, is the need to improve productivity (ECLAC, [3].

The objective of this paper is to examine, as a benchmark exercise, and by way of advising policy, the productive efficiency of two Latin America economically integrated blocs over the period 2008-2022. With asymmetry and unsynchronized policy implementation, it is more than likely that there would be productive inefficiency amount the countries with economic blocs (ECLAC, [4]], which will reflect on the bloc as a whole.

Specifically, the blocs that will be examined are Mercosur and Sica. Mercosur, the South Common Market of South America, and Sica, the Central American Integration System, are two such bodies of economic integration in the Latin America region. Both systems, formed around the same time, and shared, in general, the same kind of pre-independence history, but are in different geographic location, and have, since their independence, pursued different political strategies, towards their goals.

II. BACKGROUND

In many regions of the world Economic integration is underway as countries seek to reduce the barriers to trade and glean the benefits of specialization and economies of scale implicit in merging domestic markets. In Latin American many of such integration are advancing, some at a deeper level than others. Mercosur and Sica are two such bodies of economic integration.

MERCOSUR, the Southern Common Market, was launched by the Treaty of Asunción in 1991. Initially its membership included the countries Uruguay, Brazil, Argentina Bolivia and Paraguay, but later grew as other countries joined.

In the early stage of its formation, the bloc made rapid strids and economic growth and trade with internal trade moving from about 4 billion in the 1990s and quickly reaching $41 billion by 2010 (ECLAC, [4]). This inspired the movement towards economic integration in the region, and motivated other countries to seek to join the bloc. Thereafter, the advent of the 2019 pandemic, and other world problems, trade slowed down, but rose again following the pandemic, and even surpassed its 2010 level. External exports also grew, but subjected to external economic fluctuations at the time there was much fluctuation in external exports.

SICA, also known as Central American Integration System, was initiated the support of the United Nation in 1991, the same year Mercosur, was launched. Initially, membership included Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, later other countries joined as members.

As in Mercosur, in its early stage, the bloc showed substantial progress, and GDP grew by just over 4% by 2010, but in more recent years, amidst problems related to political discordance the bloc has experienced stagnation evidenced by its slow economic growth with GDP moving up by just about 2% (ECLAC,[3]).

On account of its geographic location, the region is prone to setbacks as a result of hurricane, together with flooding, but as was the case with other regions, Sica suffered shocks caused by the 2008 financial crisis and more recently from distractions caused by the rise of China as a trading partner, and the global economic slowdown cause by the 2019 Pandemic. While to bloc has achieves success in agreeing on certain energy policy and financial management, it still faces many logistics problems.

Harmonizing policies, addressing these structural problems, as well as implementing necessary fiscal reforms, are important priorities for the governments of both regions (ECLAC, [4]). As in many other economic blocs, the setbacks appear to stem from asymmetry problems, which frequently is the result of countries in a bloc being at different stages of economic prosperities and facing different challenges. Other contributing problems seems to stem from political instability, protectionist tendencies and trade diversion problems regarding key industries, which together are affecting the synchronizing of institutions and trade policies and are ultimately resulting in low productivity and significant efficiency problems (CFR.org [5]).

III. ANALYTICAL FRAMEWORK

In general, as a measure of productive efficiency, overall efficiency is used as the best estimator. It is the product of pure technical, scale and allocative efficiency. However, in aggregate system such as a 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 frontier, technical efficiency measures how far within the production frontier a country's technology is. Any improvements in the productivity of inputs, such as labour or capital, or in the organization of 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.

IV. 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, Figure 1 is used (Fare and Groskopf, [6]; Farrell [7]). 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 (Farrell [7]) 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 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, 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.:

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

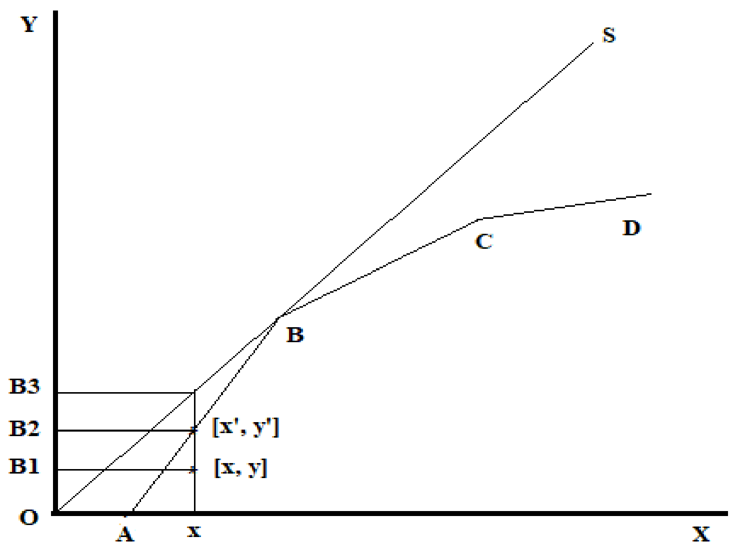

Figure 1: Constant and variable returns to scale.

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 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 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 the revenue maximizing point A [Figure 2], where $MRP_1/MRP_2 = P_1/P_2$.

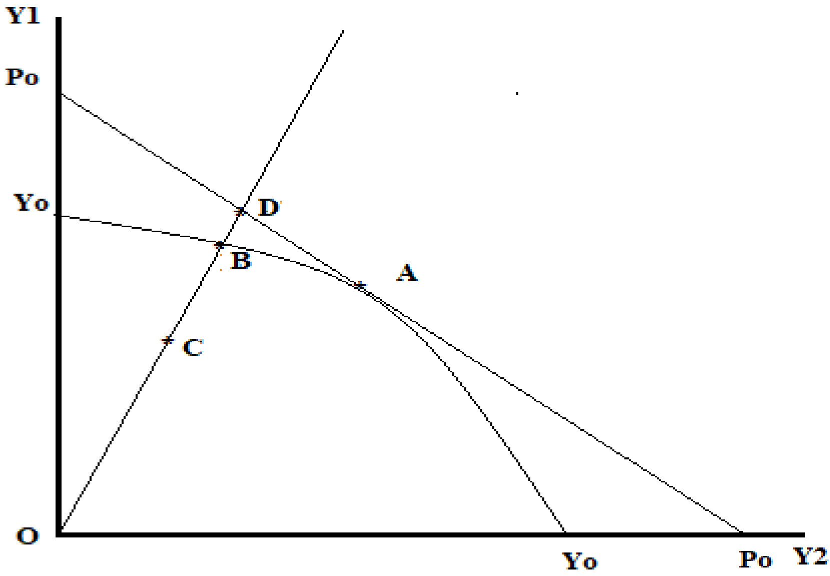

Figure 2: The Measure of Allocative Efficiency.

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 technically efficiency. Unit C, on the other hand, because it is not on the frontier, but within, is technically inefficient.

For Unit C, PTE = OC/OB < 1.

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 = OB/OD < 1.

Economic efficiency (EE), which is the product of pure technical and allocative efficiencies.
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 (Farrell [7]). Pure technical efficiency (PTE) is calculated by solving the following LP:

$$\text{Min } \theta_k \text{ subject to}$$

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

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

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

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

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

$$\sum_{k=1}^{K} z^k y^k_m \geq y^k_m \qquad m=1 \ldots M \qquad (6)$$

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

$$OE_k = P_k Y_k / R_k(p, x, t_c) \qquad (4)$$

where $R_k(p, x, t_c)$ is as defined above, and $P_k Y_k$ represents the actual revenue for observation, k.

Allocative efficiency is calculated from OE as

$$AE_k = (P_k' Y_k / R_k(p, x, t_v)) * (1/\theta_k) \qquad (5)$$

where Rk (p, x, t_v) is the maximum revenue calculated relative to variable returns to scale by adding the restriction shown in Equation (9) to Equation (6) and θ_k is the measure of pure technical efficiency obtained by solving Equation (5).

$$\Sigma z^k = 1 \qquad k = 1 \ldots K \qquad (6)$$

V. REGRESSION EQUATION

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

$$lEE_{ij} = \alpha_o + \alpha_1 lGDP_{ij} + \alpha_2 lEDU_{ij} + \alpha_3 lCR + \alpha_4 lK_{ij} + \alpha_5 lELEC_{ij} + \alpha_6 LlINF_{ij} + \alpha_7 TAX_{ij} + \alpha_8 lEXR_{ij} + \alpha_9 lTTr_{ij} + \alpha_{10} IlAGRI_i + \alpha_{11} lMAN_{ij} + \alpha_{12} LSERV_{ij} + e_{ij} \qquad (7)$$

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. Mercosur countries included Argentina, Bolivia, Brazil, Paraguay and Uruguay. SICA countries included Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. The model is estimated in its log form, indicated by the letter '*l*' in front of each variable. And each coefficient is expressed in percent terms.

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

			M			**S**	
	Variables		Mean	Std. Dev.		Mean	Std. Dev.
Market Related variables							
	Market size [GDPT]	GDP [M]	635208.46	834341.30		29342.37	19626.60
Human capital/ Private sector related variables							
	Literacy rate	LIT	541.98	215.98		316.95	306.22
	Credit/Capita	CR	3934.44	3311.07		2638.23	2547.91

Infrastructure Variables							
	Gross Fixed Capital formation	K	12.89	15.19		4.71	2.23
	Electricity	ELEC	10.69	29.22		5.22	1.33
Monetary/Fiscal Policy Variables							
	Tax [income, profit and capital gains].	TAX	4.40	5.00		0.80	0.33
	Inflation Rate	INF	34.54	98.38		174.90	247.36
Trade Policy Variable							
	Tax on trade	TT	116782.54	162835.80		6106.41	3223.40
	Exchange Rate	EXR	97.60	3.79		90.28	7.66
Productive sector Variables							
	Agriculture [% GDP]	AGR	0.066	0.083		0.054	0.014
	Manufacturing [%GDP]	MAN	0.071	0.051		0.13	0.023
	Service [% GDP]	SERV	0.62	0.164		0.596	0.045
	Other [% GDP]	OTHER	0.243	0.116		0.221	0.028

VI. THE DATA

This study involved observations on the outputs and inputs Mercosur and Sica Countries over the period 2009 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 was obtained from the World Bank Group online data [8]. Because of inconsistencies observed in the 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.

Regression variables:

Many economic factors affect productivity growth. In this study, twelve variables used as proxies for six factors were considered. The variables, their mean and standard deviations are shown in Table 1. Table 2 shows the expected correlation with the productivity variable.

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.	

Market-related variables. Only one variable represents this group, the market size [MARKET]. It is expected that competition in the marketplace will force producers to become more efficient. As more countries enter the international markets, the market size effectively becomes bigger than the domestic market and this provides opportunities for countries to expand production and even gain market share. It follows then that as the market increases in size the competition increases, and this forces participants to invest in measures to become even more efficient. Lin and Weng [9], in their study of market size, firm productive efficiency and product quality, find that as global markets expand, productive efficiency increases. Ding and Niu [10] also support this view. Thus, in this paper as market size increases, economic efficiency is likely to increase.

Human capital/private sector related variables. Two variables proxy for 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, develop digital skills and overall will improve the efficiency of the population. It is expected then that as the of literacy increases in a country this will result in a higher level of productive efficiency in that country. Lall, et. al [11] provided evidence to show this. Gong, et. al [12] in his analysis of digital literacy show a positive correlation between literacy rate and productive efficiency. Thus, LIT is expected to have a positive correlation with productive efficiency.

Access to credit [CR] can access to credit could stimulate ideas and motivate individuals to become more innovative and productive, and as a result productive efficiency at the private level is likely to improve. Fishman, [13] observed a positive correlation between access to credit and capacity utilization. This notion was supported by Manaresi and Pierri. [14]. The variable, CR, is expected to be positively correlated with the productive efficiency measure.

Infrastructure related variable. Gross fixed capital formation [K] and access to electricity [expressed as the percent of the population with access to electricity, ELEC] represent this group.

With regards to K, it is expected that an increase in expenditure fixed capital such as tools, machinery and building, and roads, etc., is likely to result in increased output per capita, and as such it has an impact on technical efficiency, and in so doing, productive efficiency. Gopinath, et. al. [15] and Lambert [16], have provided evidence supporting this relationship. Consequently, the relationship between K and the productive efficiency measure is likely to be positive.

Access to electricity [ELECT] can affect productive efficiency directly as well as indirectly. Many home-produced goods are produced more effectively using electric appliances. If the goods are for the market, more will be produced per unit of labor, if not, the time saved at home will, arguably, enable more to be produced at work. Thus, it is expected that with increased access to electricity, productive efficiency is likely to increase. Even making an electrical switch will further impact their economic efficiency. Kennedy [17] and Lambert [16] 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.

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

Inflation results in higher prices and can discourage investment as a result. With a reduction in capital investment, productivity and efficiency are likely to decrease. Also, because inflation tends to increase interest rates, borrowing is likely to become more expensive. Which in turn will reduce investment of productive capital. The overall effect of inflation on production efficiency then is that is a daunting one; productive efficiency is likely to decrease, at least in the short run. Tommasi [18] 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 [19] provide evidence of this. So, with respect to the correlation between inflation and the productive efficiency measure, it is likely to be positive or negative.

Taxes on income, profit and capital gains [TAX], on the other hand decrease the amount of capital left for investment, which would likely have a deadweight loss on society and a depressing impact of productive efficiency. Alan, et. al. [20] show this effect. Martin and Trannoy [21] provide further evidence to support this view. It in this study, a negative correlation is expected between TAX and the productive efficiency measure.

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

Tax on trade has a discouraging impact on investment and production as it results in higher market prices in the international market and a reduction in demand. This is a disincentive to production. It results in reduced innovation, reduced productivity, and efficiency. It can specifically affect allocative efficiency in that it distorts price difference between the domestic market and the international market. Farhadian-Lorie and Katz [22], and Nasreen [23] 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], the effect on productive efficiency could either be negative or positive. 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 could also be true as well. Mlambo and McMillan [24] have observed a negative correlation between exchange rates and productive efficiency. Morina et. a. [25] supported this correlation. Thus, the expected correlation between EXR and productive efficiency is a negative one.

Productive Sector Variables. 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. It is important to determine how each sector affects productive efficiency as this may help in identifying and eliminating or improving areas of weak productive efficiency. Each is expressed as the percentage they contribute to GDP, altogether making up 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.

The results for the efficiency measures are shown in Table 3. In the table the measures of pure technical efficiency [PTE], allocative efficiency [AE], and economic efficiency EE] from Years 2009 to 2022, for the Mercosur and Sica groups of countries are shown. The mean and standard deviation of each measure is also shown. The US, with efficiency measures of 1.00, is included as a benchmark as its efficiency measure were estimated together with those of the other countries.

Table 3: Pure technical Efficiency, allocative efficiency and economic efficiency.

	Pure Technical Efficiency			Allocative Efficiency			Economic Efficiency			PTE=AE=EE
	M	S		M	S		M	S		US
2008	0.731	0.449		0.988	0.922		0.722	0.414		1.000
2009	0.712	0.492		1.000	0.930		0.712	0.458		1.000
2010	0.669	0.472		1.000	0.949		0.669	0.448		1.000
2011	0.664	0.486		1.000	0.969		0.664	0.471		1.000
2012	0.706	0.503		1.000	0.971		0.706	0.488		1.000
2013	0.673	0.505		1.000	0.991		0.673	0.500		1.000

2014	0.689	0.529		1.000	0.993		0.689	0.525		1.000
2015	0.734	0.517		1.000	0.997		0.734	0.515		1.000
2016	0.749	0.579		0.985	0.976		0.737	0.565		1.000
2017	0.719	0.539		0.979	0.961		0.703	0.519		1.000
2018	0.714	0.505		0.983	0.978		0.702	0.494		1.000
2019	0.715	0.547		0.984	0.965		0.703	0.528		1.000
2020	0.755	0.615		1.000	1.000		0.755	0.615		1.000
2021	0.738	0.597		0.997	0.964		0.736	0.576		1.000
2022	0.624	0.368		1.000	1.000		0.624	0.368		1.000
Mean	0.7104	0.5104		0.9945	0.9683		0.7065	0.4943		1.000
St. Dev.	0.0393	0.0602		0.0079	0.0257		0.0003	0.0015		0.000

M= Mercosur. S - Sica

Based on economic efficiency [EE], which is the product of PTE and AE, the mean for Mercosur [M] is greater compared with Sica [S] countries [0.7065 vs. 0.4943] and the variation in EE measures was also lower in Mercosur countries compared with Sica countries [0.0003 vs. 0.0015].

The trends are shown in Figure 3. Based on the trends shown by the trend lines, there is a tendency for EE between the two blocks to converge.

With regards to Pure technical Efficiency [PTE], a similar pattern is shown in the Mercosur and the Sica block [Mean: 0.7104 vs 0.5104; Standard deviation: [0.393 vs. 0.604]. These trends are shown in Figure 4.

The mean allocative efficiency [EE] measures overall were much higher [0.9945 vs 0.9683] with that of Mercosur being greater, but the variation was lower compared with Sica [0.0079 vs 0.0257].

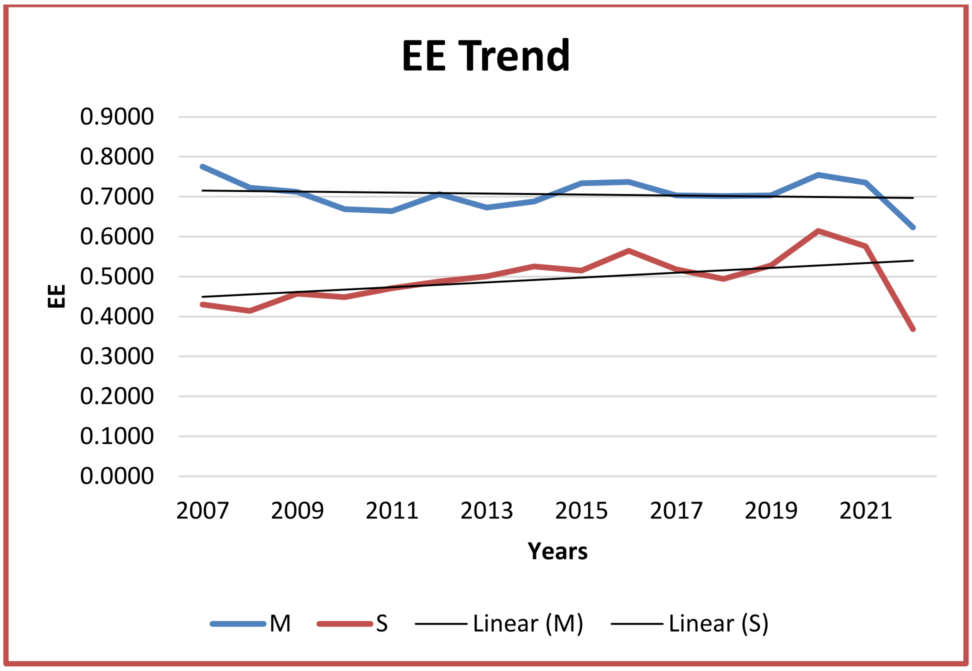

Figure 3: Economic efficiency trend.

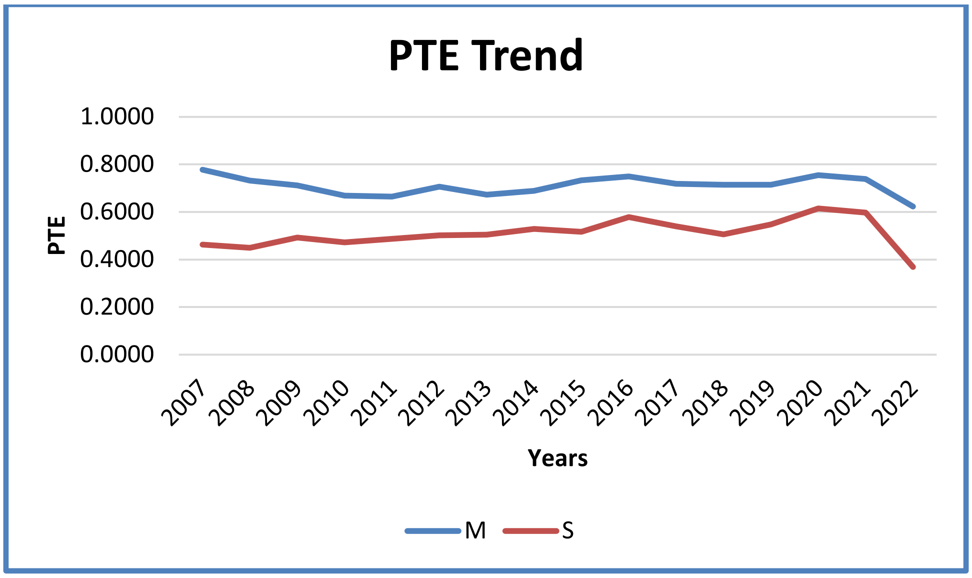

Figure 4: Pure technical efficiency trend.

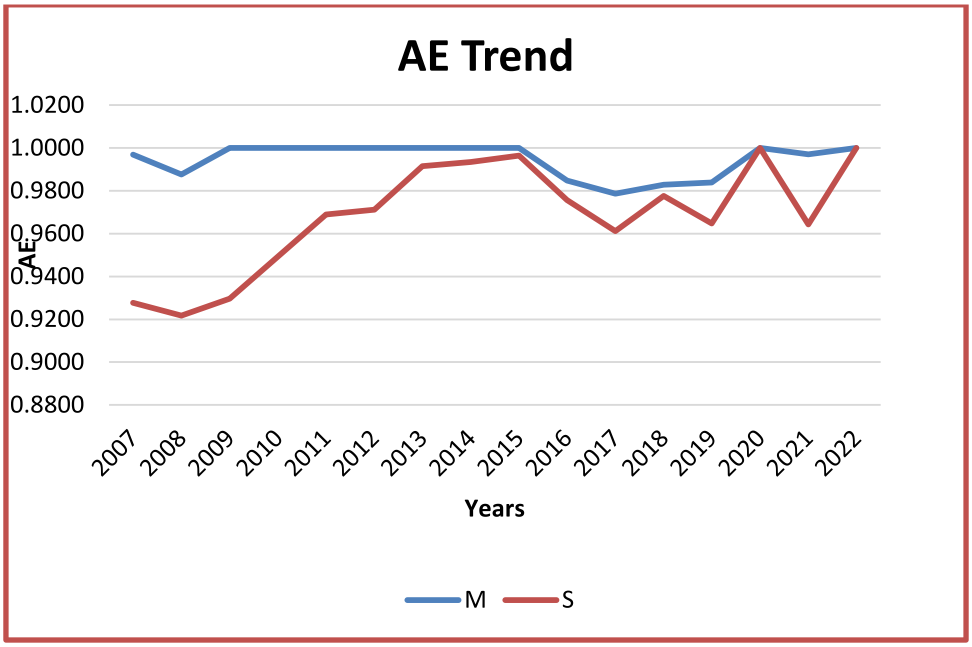

Figure 5: Allocative efficiency trend.

The trends are shown in Figure 5. Beginning in 2013, AE in the two economic blocks became closer, and followed the same relationship thereafter.

Overall, the efficiency measures are lower in Sica compared with Mercosur. But, based on the trend line shown in Figure3, the efficiency measure tends to converge. However, EE in Mercosur appears to be flat over the years and it is Sica that shows that increases, thus accounting for the tendency to converse.

7.2 Regression analysis.

The regression results [Table 4] for Mercosur shows that nine variables in six groups were significant. The groups were the market group, the human capital/private sector group, the infrastructure group, the monetary/fiscal policy group, the trade policy group and the productive group were significant and had the expected signs.

In Sica, variables in the same groups as in the Mercosur were significant, except for the human capital/private sector group in which there was not a significant variable.

Table 4: Regression Coefficient.

			MERCOSUR				SICA		
Variables			*Coefficients*	*P-value*			*Coefficients*	*P-value*	
Market Related variables									
	Market size [GDPT]	GDP(M)	0.469	0.000	***		0.787	0.100	**
Human capital/ Private sector related variables									
	Literacy rate	LIT	0.033	0.806			0.015	0.945	
	Credit/Capita	CR	0.245	0.020	**		0.032	0.880	
Infrastructure Variables									
	Gross Fixed Capital formation	K	0.215	0.025	**		0.689	0.000	***
	Electricity	ELEC	2.103	0.010	**		2.316	0.005	***
Monetary/Fiscal Policy Variables									
	Tax on income, profit and capital gains.	TAX	-0.074	0.028	**		-0.274	0.044	**
	Inflation Rate	INF	-0.004	0.884			-0.027	0.372	
Trade Policy Variable									
	Tax on trade	TT	-0.038	0.043	**		-0.062	0.118	**
	Exchange Rate	EXR	-0.090	0.003	***		-0.229	0.052	**
Productive sector Variables									
	Agriculture [% GDP]	AGR	0.155	0.002	***		-0.142	0.242	**
	Manufacturing [%GDP]	MAN	-0.028	0.410			0.268	0.336	
	Service [% GDP]	SERV	-0.173	0.000	***		-0.261	0.332	
Constant		Intercept	-4.376	0.002	***		-3.914	0.003	***
R Square			0.721				0.688		

** & *** means significant at the 95% and 99 % CI levels.

In the **market group,** there was only one variable, MARKET, for which the GDP was used to represent the size of the market. In the Mercosur economic group, the coefficient for this variable is 0.469, which means that a one percent increase in the Market, the dependent variable, economic efficiency [EE], is likely to increase by 0.469 percent. Lin and Weng [2019] and Ding and Niu [2018] showed a similar correlation between market size and productive efficiency. It is reasonable to expect that if firms are facing a growing market, they are likely to operate more efficiently so as to increase profit and also gain a larger share of the market.

In the Sica economic group, the coefficient for MARKET is 0.787, which is slight larger than in the Mercosur group, which means that a one percent increase in market size in this group is likely to have a greater impact on productive efficiency this group that in the Mercosur group.

The **Human capital/private sector** group consists of two variables, the literacy rate, which is measured as the percent of GDP spent on education, and amount of credit made available to the private sector and the access to credit [CR], measured as the amount of credit made available to the private sector.

In Mercosur, only CR was significant, and it had the expected positive sign [0.245] indicating that productive efficiency is likely to increase with the amount of credit made available to the private sector. Several countries use this strategy as a means of engaging and boosting the involvement of the private sector in production activity or enhancing its efficiency. Fishman, [2001] and Manaresi and Pierri [2018] found this to be effective in their studies.

In Sica, neither variable was significant.

In the **infrastructure group, gross** fixed capital formation [K] and the percentage of the population with access to electricity [ELEC] were used as proxies for infrastructure. In Mercosur, both variables were significant, and both were positive [0.215 & 2.103]. Gopinath, et. al. [2015] and Lambert [2016] supported the impact of K, and Kennedy [2000] and Lambert [2016] provides evidence to support the positive impact of access to electricity on productive efficiency.

ELEC has a greater coefficient showing that an increase in access to electricity is likely to have a greater impact on productive efficiency than K in this region.

In Sica, the correlation and the relative size of the impacts were similar [0.689 & 2.316]. In both Mercosur and Sica, these results support improvement in infrastructure as a way of improving productive efficiency.

In the **monetary/fiscal** group, in Mercosur, tax on income, profit and capital grains [TAX] and the inflation rate [INF]. In Mercosur, TAX was significant and had the expected negative sign [-0.074]. Alan, et. al. [2002] and Martin and Trannoy [2019] provides evidence of this relationship. The negative correlation found in this group suggests that decreasing TAX in is likely to have a positive impact of productive efficiency, quite possibly because it leaves more revenue to be invested in efficiency promoting strategies.

INF was not significant in this block.

In Sica, the results were similar to that in Mercosur with regards to these variables. However, the impact of TAX was somewhat greater [-0.274].

In the **trade policy** group, in Mercosur, both of the variables used, tax on trade [TT] and the exchange rate [EXR], were significant and had the expected negative signs [-0.038 & -0.090], indicating that a decrease in both variables are likely to result in increased productive efficiency in this economic group. Farhadian-Lorie, Z and M. Katz [1989], and Nasreen, N. [2019] found similar relationships for the impact of tax on trade. And, Mlambo and McMillan [2020] and Morina et. a. [2020] supported the relationship between exchange rates and productive efficiency.

In Sica, both variables were likewise significant, and both had the expected negative signs, showing similar measures could result in increased efficiency in this region as well. The impacts, however, were slightly more negative [-0.062 & -0.229] in this region compared with Mercosur.

In terms of which **productive sectors** were more efficient than the other sector [OTHER] [which includes mining, drilling and construction], in Mercosur, both the agriculture [AGR] and the service sectors [SERV] were significant. And which AGR has a more positive impact [0.155] on overall country level efficiency that OTHER, SERC has a greater negative impact [-0.173]. In Sica, AGR was the only significant variable, and it had a more negative impact on efficiency [-0.142] than the other sector [OTHER]. The manufacturing sector [MAN] was not significant in either economic block.

VIII. SUMMARY.

Efficiency measures. Based on economic efficiency [EE], which is the product of PTE and AE, the mean for Mercosur [M] is greater compared with Sica [S] countries and the variation in EE measures was also lower in Mercosur countries compared with Sica countries.

With regards to Pure technical Efficiency [PTE], a similar pattern is shown in the Mercosur and the Sica bloc; pure technical efficiency is higher in Mercosur and the variation is lower compared with Sica.

The mean allocative efficiency [EE] measures and their variation followed the same pattern as with the other measures of efficiency.

Overall, the economic efficiency is lower in Sica compared with Mercosur, the measures tend to converge. However, EE in Mercosur appears to be flat over the years and it is Sica that shows that increases, thus accounting for the tendency to converse.

Regression results: The regression results for Mercosur show that nine variables in six groups were significant.

The groups were the market group, the human capital/private sector group, the infrastructure group, the monetary/fiscal policy group, the trade policy group and the productive group were significant and had the expected signs.

In Mercosur countries, of the variables that were significant, only credits in the human capital/ private sector group and the agriculture sector in the productive sector had a stronger positive impact on economic efficiency than in Sica countries. All other variables, markets size, gross fixed capital formation and access to electricity, in the infrastructure group had a stronger positive impact and tax in the monetary/fiscal policy group, and tax on trade and exchange rate in the trade policy group and the service sector in the productive sector group had a stronger negative impact on economic efficiency compared with Mercosur countries.

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"Economic integration" refers to the process where multiple countries collaborate to reduce or eliminate trade barriers between them, often by aligning their monetary and fiscal policies, creating a more interconnected global economy and allowing for greater trade and economic cooperation between participating nations; a prominent example of this is the European Union, where countries have integrated their economies to a significant degree by removing trade barriers and coordinating policies across borders.

In many regions of the world Economic integration is underway as countries seek to reduce the barriers to trade and glean the benefits of specialization and economies of scale implicit in merging domestic markets. In Latin American many of such integration are advancing, some at a deeper level than others. Mercosur and Sica are two such bodies of economic integration.

MERCOSUR, the Southern Common Market, was launched by the Treaty of Asunción in 1991. Initially its membership included the countries Uruguay, Brazil, Argentina Bolivia and Paraguay, but later grew as other countries joined.

In the early stage of its formation, the bloc made rapid strids and economic growth and trade with internal trade moving from about 4 billion in the 1990s and quickly reaching $41 billion by 2010 [ECLAC, [4]]. This inspired the movement towards economic integration in the region, and motivated other countries to seek to join the bloc. Thereafter, the advent of the 2019 pandemic, and other world problems, trade slowed down, but rose again following the pandemic, and even surpassed its 2010 level. External exports also grew, but subjected to external economic fluctuations at the time there was much fluctuation in external exports.

SICA, also known as Central American Integration System, was initiated the support of the United Nation in 1991, the same year Mercosur, was launched. Initially, membership included Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, later other countries joined as members.

As in Mercosur, in its early stage, the bloc showed substantial progress, and GDP grew by just over 4% by 2010, but in more recent years, amidst problems related to political discordance the bloc has experienced stagnation evidenced by its slow economic growth with GDP moving up by just about 2% [ECLAC,[3].

On account of its geographic location, the region is prone to setbacks as a result of hurricane, together with flooding, but as was the case with other regions, Sica suffered shocks caused by the 2008 financial crisis and more recently from distractions caused by the rise of China as a trading partner, and the global economic slowdown cause by the 2019 Pandemic. While to bloc has achieves success in agreeing on certain energy policy and financial management, it still faces many logistics problems.

Harmonizing policies, addressing these structural problems, as well as implementing necessary fiscal reforms, are important priorities for the governments of both regions [ECLAC, [4]]. As in many other economic blocs, the setbacks appear to stem from asymmetry problems, which frequently is the result of countries in a bloc being at different stages of economic prosperities and facing different challenges. Other contributing problems seems to stem from political instability, protectionist tendencies and trade diversion problems regarding key industries, which together are affecting the synchronizing of institutions and trade policies and are ultimately resulting in low productivity and significant efficiency problems [CFR.org [5].

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