*Article*

# Use of Fuels in the Productivity of Ecuadorian Companies: Assessment of Their Impact on Climate Change

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**Abstract:** This article aims to analyze the relationship between fuel consumption (gasoline, diesel, and Liquid Petroleum Gas (LPG) and total production in Ecuadorian companies that use some fuel in their processes, in addition to quantifying the $CO_2$ emissions generated by these fuels in 2019. For this purpose, a correlational study of these variables (Pearson's correlation coefficient) has been made, using statistical data from the ENESEM 2019 Structural Enterprise Survey, prepared by the National Institute of Statistics and Census (INEC). The results show that the relationship between the consumption of Extra gasoline and Ecopais with total production is not significant, while it is in the case of consumption of Super gasoline, Diesel, and LPG. As for $CO_2$ emissions, it is observed that the largest generator is diesel, with almost 4.5 megatons per year, second to gasoline, with a little less than 2 megatons, and finally is LPG, with less than 0.5 megatons. In conclusion, LPG fuel, whose association with total production is the most significant, is the least polluting and in total these business sectors generate almost 7 megatons of $CO_2$ per year of the total 40 megatons generated by the country.

**Keywords:** consumption; fuels; total production; business sectors; correlation; $CO_2$ emissions

## 1. Introduction

The global Agenda, known as "Agenda 2030", sets out 17 Sustainable Development Goals (SDGs), which are the continuation of the Millennium Development Goals (MDGs), set by the United Nations in 2000 and which were already in force for 15 years [1]. In the 2030 agenda, climate change is considered a cross-cutting issue that affects the achievement of many other SDGs, making it one of the main challenges facing humanity today. Although there is a Sustainable Development Goal (SDG 13) entitled Climate Action, which simply points to the process of formulating policies on climate change, this goal is related to the vast majority of the other Goals, as all of them consider environmental protection in some way or another [2].

This climate action focuses on the reduction of Greenhouse Gases (GHG), which are "those gaseous components of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation". (United Nations, 1992) The United Nations Framework Convention on Climate Change recognizes six: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and hexafluoride of sulfur ($SF_6$). Their abundance retains heat in the atmosphere, progressively increasing the planet's temperature [3].

The Paris Agreement aims to strengthen the global response to the threat of climate change. In addition, to "enhance the ability of countries to address the impacts of climate change and to ensure that financial flows are consistent with low greenhouse gas (GHG) emissions", the Paris Agreement aims to "enhance the capacity of countries to address the impacts of climate change and to ensure that financial flows are consistent with low greenhouse gas (GHG) emissions [3]". According to the report of the United Nations Intergovernmental Panel on Climate Change (IPCC), global warming is directly attributed

to human activities, to greenhouse gas emissions as a result of dependence on fossil fuels such as carbon dioxide and methane, This has generated an increase of 1.2 degrees Celsius in the planet's temperature, with fossil fuels being considered the most polluting sources of energy (diesel and gasoline), as they are major generators of greenhouse gas (GHG) emissions.

Therefore, as a commitment in the context of "The United Nations Convention on Climate Change", the document entitled Nationally Determined Contribution (NDC), published in 2019, "which incorporates more than 150 institutions from the public sector, private sector, academia, civil society and other cooperation agencies with more than 1000 participants", was prepared [4].

The massive use of fossil fuels constitutes the bulk of the exosmotic energy used by humans (and the obtaining of endosomatic energy -that of food-) [5]. For this reason, since the end of the 20th century, there has been growing concern about the environmental impacts of the massive burning of fossil fuels and, above all, their effects on climate change. "The activities that generate greenhouse gases are diverse, but today the most important factor is undoubtedly the emission of $CO_2$ associated with energy production" [5].

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Gasoline, diesel, and LPG are used in human activities. These fuels are expressed in units of measurement according to the time it takes for each fuel to detonate, i.e., the anti-knock capacity of the fuel in the engine and, to a certain extent, the quality of the fuel. These units of measurement can be octane in the case of gasoline and LPG and cetane in the case of diesel.

In Ecuador, the octane rating of extra gasoline is between 85 and 87 octanes, while super registers between 90 and 92 octanes. By mixing gasoline with different octane ratings, an average octane rating of 88 octane is obtained [7]. According to experts, there is no major difference between extra and Ecopaís. Both have 85% octane, but Ecopaís has 5% ethanol and Ecopaís does not, and the latter is more polluting [8]. Gas is also measured in octanes, and has an octane rating of 110 octanes, both LPG and NGV [9]. Likewise, diesel is expressed in cetanes, being of better quality the higher the octa-nage or cetane rating of the fuel [10].

Hence, the energy sector is the largest contributor to the carbon footprint through GHG emissions from power generation. In fact, around 78–80% of the annual $CO_2$ emitted on the planet originates from the burning of fossil fuels (IPCC, 2014). In this way, and due to the sustained trend of increasing energy consumption, countries face a titanic task to control and reduce gas emissions that contribute to climate change [11]. One liter of gasoline emits 2.37 kg of $CO_2$, and one liter of diesel emits 2.65 kg of $CO_2$ [12]. While 1 L LGP emits 1.7 kg of $CO_2$ [13].

The objective of this work is to examine the use of fuels by each of the business sectors, their relationship with productivity, and their impact on GHG generation. For this purpose, the National Standard Industrial Classification ISIC 4 Revision is considered [14]. ISIC: which classifies entities according to the main economic activity they perform. It is based on inputs of goods, services and factors of production. The process and technology of production. The characteristics of the products. The categories of each level of the classification are mutually exclusive [14].

## 2. Materials and Methods

The research is of the documentary type "Documentary research is a process based on the search, recovery, analysis, critique, and interpretation of secondary data; that is, data obtained and recorded by other researchers in documentary sources: printed, audiovisual or electronic" [15], p. 27. In this case, an inquiry is made of INEC statistics, published according to the Structural Business Survey ENESEM of 2019, which is the most recently published.

It has a quantitative approach "This approach is based on the measurement of the characteristics of phenomena, ( . . . ). The obtained data can be interpreted are quantifiable; therefore, it can be measured" [16], p. 75. The study will measure the variables of gasoline, diesel, and LPG consumption and their association with the total production of each business sector according to the CIUU classification, as well as the measurement of $CO_2$ emissions generated by the amount of fuel used.

The study takes into account data provided by INEC of Ecuador in the Business Structural Survey "The ENESEM generates statistical information on the structure and evolution of economic activities categorized according to sections of the International Standard Industrial Classification (ISIC) for large and medium-sized companies in Ecuador" [17]. Table 1 shows the sectors according to this classification, which are 21 sectors in total, noting that the ENESEM considers a total of 17 sectors, excluding those identified in the following: A-Agriculture, livestock, forestry and fishing, O-Public administration and defense, T-Activities of households as employers, non-differentiated activities of households as producers of goods and services for own use, and U-Activities of extraterritorial organizations and bodies.

**Table 1.** CIIU Classification.

| Activity |
|---|
| • Agriculture, livestock, forestry, and fishing. |
| • Mining and quarrying. |
| • Manufacturing industries |
| • Electricity, gas, steam, and air conditioning supply. |
| • Water distribution; sewerage, waste management, and sanitation activities. |
| • Construction |
| • Wholesale and retail trade; repair of motor vehicles and motorcycles. |
| • Motor vehicles and motorcycles. |
| • Transportation and storage. |
| • Accommodation and food service activities. |
| • Information and communication. |
| • Financial and insurance activities. |
| • Real estate activities. |
| • Professional, scientific and technical activities. |
| • Administrative and support service activities. |
| • Public administration and defense; compulsory social security schemes. |
| • Education |
| • Human health care and social work activities. |
| • Arts, entertainment, and recreation |
| • Other service activities |
| • Activities of households as employers; undifferentiated activities of households as producers of goods and services for own use |
| • Activities of extraterritorial organizations and bodies. |

Likewise, the study calculates business productivity, i.e., the relationship between the use of resources in general (in this case, the factors used will be the fuel units) and the product obtained (in this case, the total production of each business sector), which is tabulated. For a better understanding of the behavior of the variables, combined graphs are

presented to visualize the two variables (consumption and productivity) simultaneously. These tables and graphs are processed in Microsoft Excel.

$$\text{Productivity} = \frac{\text{Production obtained}}{\text{Factors used}}$$

The scope of the study is correlational, "the purpose of this type of study is to determine the relationship or degree of association between two or more concepts, categories or variables in a particular context" [18], p. 93.

Pearson's correlation coefficient indicates how closely two variables are associated with each other, with values between −1 and 1. The closer it is to −1, the more closely it refers to a perfect negative correlation. The closer it is to 1, the more it refers to a perfect positive correlation. On the other hand, values close to O (zero) imply that there is no association between the variables studied [19].

This implies that the Pearson correlation coefficient allows us to know if there is any relationship between two variables. It also reveals, in what sense does that correlation occur, and finally, how strong is that correlation; if it is high or if it is low.

The formula for the coefficient is:

$$r = \frac{n\left(\sum xy\right) - \left(\sum x\right)\left(\sum y\right)}{\sqrt{\left[n \sum x^2 - \left(\sum x\right)^2\right]\left[n \sum y^2 - \left(\sum y\right)^2\right]}}$$

where

r = Pearson Coefficient
n = number of the pairs of the stock
$\sum xy$ = sum of products of the paired stocks
$\sum x$ = sum of the x scores
$\sum y$ = sum of the y scores
$\sum x^2$ = sum of the squared x scores
$\sum y^2$ = sum of the squared y scores

In this study, the variables to be correlated would be the consumption of each of the fuels (Super gasoline, Extra gasoline, Eco-País gasoline, diesel, and LPG) with the total production of each business sector.

For this purpose, the hypotheses are tested. Although the contrast is made for the relationship for each type of fuel, in general, the hypotheses are presented below:

- **Hypothesis 0 (H0):** There is no relationship between fuel consumption and total company production.
- **Hypothesis 1 (H1):** There is a relationship between fuel consumption and the companies' total production.

The 95% confidence level is used, so the significance level of 0.05. That is to say that if $p < 0.05$, the null hypothesis Ho is rejected, so the correlation between the variables is significant. Otherwise, if $p > 0.05$, the null hypothesis is accepted, and we can affirm that the correlation is significant. This coefficient is processed with the Statistical Package for Social Sciences (SPSS).

## 3. Results

Initially, the information obtained from the ENESEM is presented, considering each of the business sectors, the amount of fuel consumed, and total production (see Table 2).

As shown in Figure 1, the bulk of Ecuador's companies belong to the wholesale and retail trade sector, which account for 50% of the total, followed by the manufacturing sector, which accounts for just over 13% of the total number of companies.

Productivity is found by dividing total production by the consumption of each of the fuels. Therefore, it is expressed in dollars per gallon of fuel consumed (See Table 3).
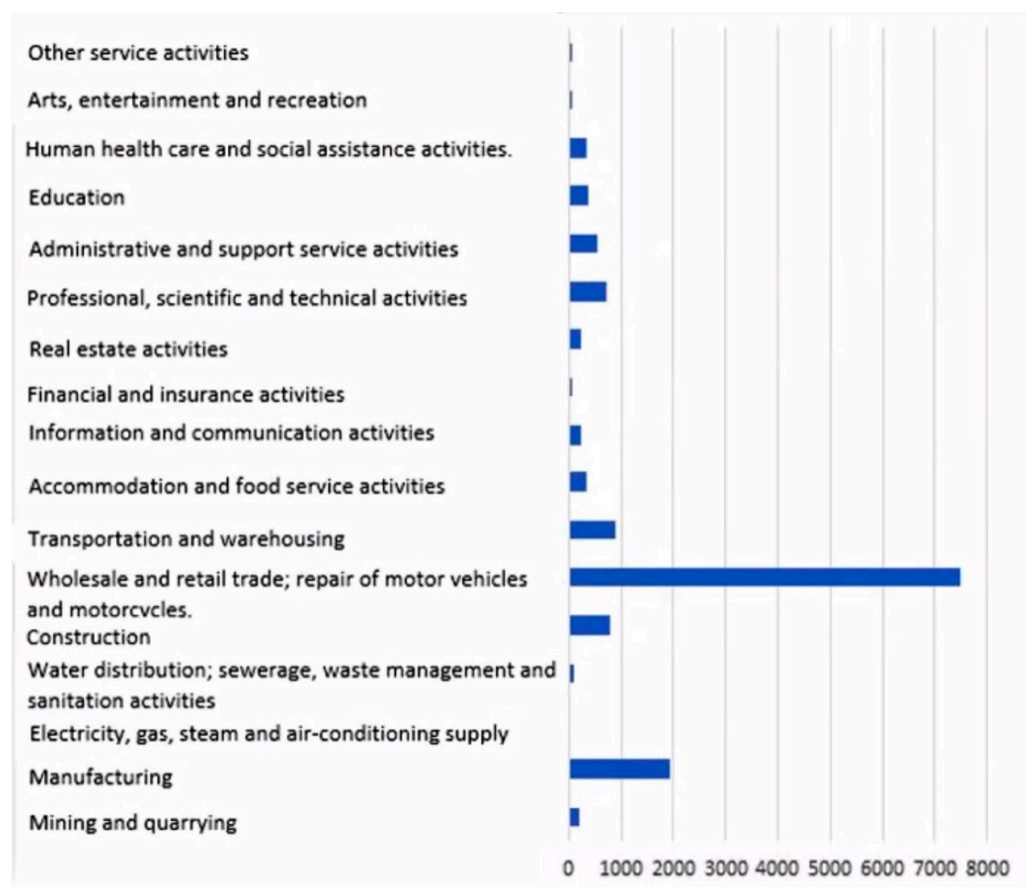
**Table 2.** Quantity of fuels and total production of companies in Ecuador.

| Description | No. of Companies | Super Gasoline (Gallons) | Extra Gasoline (Gallons) | Gasoline Ecopais (Gallons) | Diesel (Gallons) | Liquefied Petroleum Gas (LPG) (Kilograms) | Total Production ($) |
|---|---|---|---|---|---|---|---|
| **National Total** | **14,430** | **20,562,813** | **159,443,506** | **36,846,092** | **445,081,098** | **149,501,808** | **91,206,649,683** |
| Mining and quarrying | 193 | 366,016 | 1,207,673 | 20,529 | 117,501,306 | 11,398,016 | 11,258,436,486.40 |
| Manufacturing industries | 1927 | 3,238,974 | 26,216,352 | 1,074,321 | 112,871,957 | 113,386,737 | 32,403,954,633.64 |
| Electricity, gas, steam, and air conditioning supply | 39 | 164,306 | 1,738,937 | 15,167 | 29,753,262 | - | 3,940,282,129.00 |
| Water distribution; sewerage, waste management, and sanitation activities | 89 | 549,597 | 108,527,128 | 82,966 | 32,034,836 | 519,673 | 1,232,272,581.08 |
| Construction | 789 | 1,419,771 | 3,196,835 | 301,007 | 41,608,949 | 17,999 | 3,793,344,190.57 |
| Wholesale and retail trade; repair of automotive vehicles and motorcycles | 7486 | 10,558,487 | 11,207,790 | 1,287,107 | 31,855,493 | 5,972,016 | 14,663,108,137.12 |
| Transportation and storage | 906 | 911,879 | 1,283,093 | 33,031,042 | 54,463,114 | 275,555 | 5,268,300,219.10 |
| Accommodation and food service activities | 344 | 473,422 | 129,514 | 206,097 | 1,770,984 | 14,660,407 | 1,742,412,612.25 |
| Information and communication | 249 | 429,892 | 460,755 | 82,975 | 913,158 | 4053 | 4,780,503,064.52 |
| Financial and insurance activities | 56 | 109,663 | 53,472 | 34,118 | 10,359 | - | 2,389,789,840.48 |
| Real estate activities | 240 | 55,844 | 295,994 | 183,616 | 813,865 | 811,226 | 883,609,652.24 |
| Professional, scientific and technical activities | 723 | 367,398 | 888,491 | 103,306 | 2,193,843 | 224,057 | 2,079,969,501.72 |
| Administrative and support service activities | 551 | 1,021,479 | 1,852,865 | 366,263 | 15,311,566 | 451,912 | 2,154,560,505.98 |
| Teaching | 362 | 541,563 | 1,910,185 | 28,252 | 410,818 | 35,998 | 1,886,461,589.61 |
| Human health care and social welfare activities | 354 | 113,916 | 256,237 | 28,941 | 1,716,796 | 1,427,940 | 2,210,131,806.67 |
| Arts, entertainment, and recreation | 61 | 135,953 | 64,818 | 388 | 1,197,098 | 136,402 | 303,808,561.80 |
| Other service activities | 61 | 104,652 | 153,368 | - | 653,694 | 179,815 | 215,704,170.97 |

Figure 2 shows that the sector with the highest consumption of super gasoline is the Wholesale and retail trade; repair of motor vehicles and motorcycles, with a little more than 10 million gallons per year, with a productivity of less than 1500 dollars per gallon, The next largest sector in terms of super gasoline consumption is the manufacturing industry, with more than 3 million per year, however, its productivity is approximately US$10,000 per gallon. There are also four sectors with low consumption and high productivity such as mining and quarrying, electricity, gas, steam and air conditioning supply, financial and insurance activities, and human health care and social work activities.

**Table 3.** Quantity of productivity of companies in relation to fuel consumption.

| Description | Super Gasoline (Gallons) | Extra Gasoline (Gallons) | Gasoline Ecopais (Gallons) | Diesel (Gallons) | Gas (LPG) (Kilograms) |
|---|---|---|---|---|---|
| Mining and quarrying | 30,759 | 9322 | 548,416 | 96 | 988 |
| Manufacturing industries | 10,004 | 1236 | 30,162 | 287 | 286 |
| Electricity, gas, steam, and air conditioning supply | 23,981 | 2266 | 259,793 | 132 | 3,940,282,129 |
| Water distribution; sewerage, waste management, and sanitation activities | 2242 | 11 | 14,853 | 38 | 2371 |
| Construction | 2672 | 1187 | 12,602 | 91 | 210,753 |
| Wholesale and retail trade; repair of automotive vehicles and motorcycles | 1389 | 1308 | 11,392 | 460 | 2455 |
| Transportation and storage | 5777 | 4106 | 159 | 97 | 19,119 |
| Accommodation and food service activities | 3680 | 13,453 | 8454 | 984 | 119 |
| Information and communication | 11,120 | 10,375 | 57,614 | 5235 | 1,179,497 |
| Financial and insurance activities | 21,792 | 44,692 | 70,045 | 230,697 | 2,389,789,840 |
| Real estate activities | 15,823 | 2985 | 4812 | 1086 | 1089 |
| Professional, scientific and technical activities | 5661 | 2341 | 20,134 | 948 | 9283 |
| Administrative and support service activities | 2109 | 1163 | 5883 | 141 | 4768 |
| Education | 3483 | 988 | 66,773 | 4592 | 52,405 |
| Human health care and social welfare activities | 19,401 | 8625 | 76,367 | 1287 | 1548 |
| Arts, entertainment, and recreation | 2235 | 4687 | 783,012 | 254 | 2227 |
| Other service activities | 2061 | 1406 | 215,704,171 | 330 | 1200 |



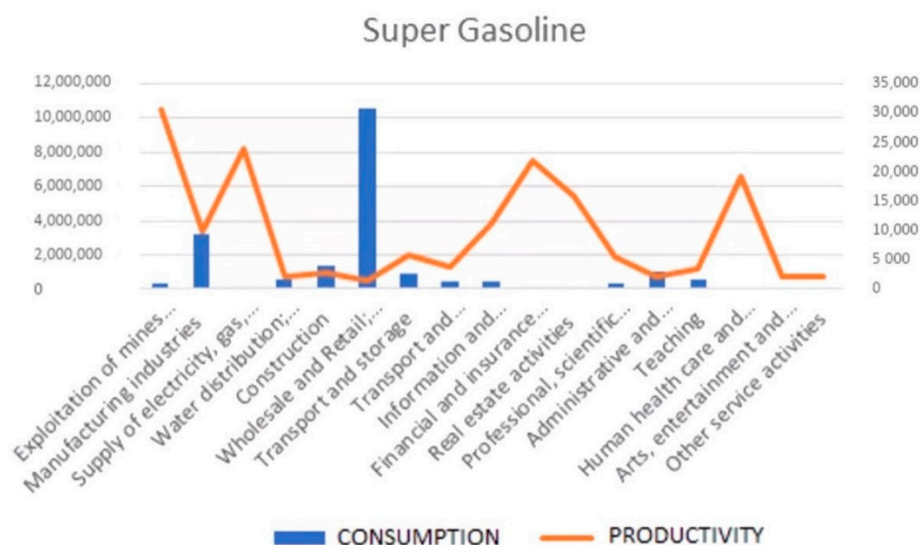**Figure 1.** List of companies by sector according to ISIC.

**Figure 2.** Consumption and productivity of Super Gasoline.

It can be seen in Figure 3 that the sector with the highest consumption of extra gasoline is water distribution and sewerage waste management and sanitation activities, with more than 100 million gallons per year, but with an almost zero productivity of 11 dollars per gallon, in second place is the manufacturing industry sector, with a consumption of more than 20 million gallons, also with very low productivity of just over $1000 per gallon, there are also sectors with high productivity such as Financial and insurance activities and Accommodation and food service activities.
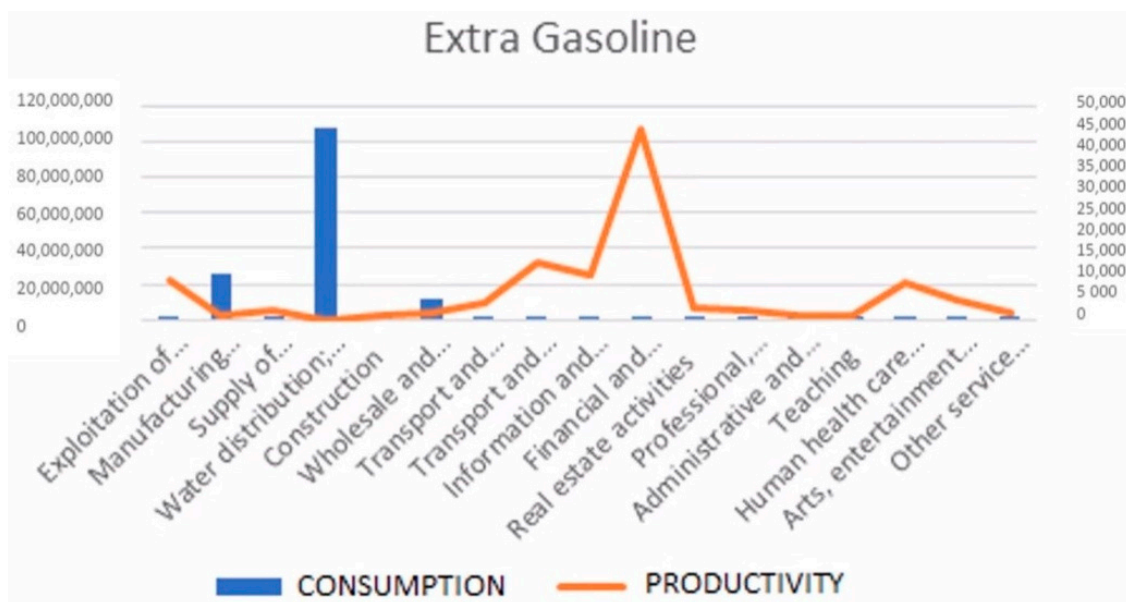


**Figure 3.** Extra Gasoline Consumption and Productivity.

As shown in Figure 4, the largest consumer of gasoline Ecopais, is the Transportation and warehousing sector, with a little over 30 million gallons, and with very low productivity of less than $150 per gallon, followed by the Wholesale and retail trade sector; repair of motor vehicles and motorcycles. However, the consumption of Ecopais gasoline is negligible with almost 1.3 million gallons, while the most productive sectors are the arts, entertainment and recreation, mining and supply of electricity, gas, steam, and air conditioning. The other service activities sector does not use this type of fuel.
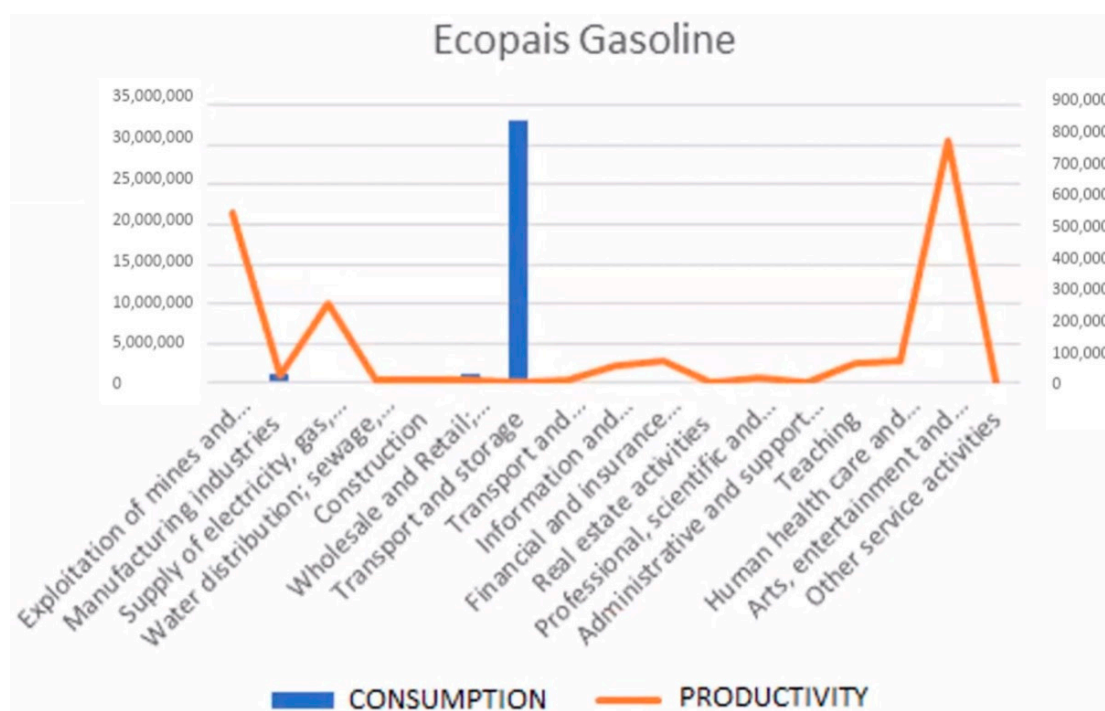
**Figure 4.** Ecopais gasoline consumption and productivity.

Figure 5 shows that the main consumers of diesel are the Mining and quarrying sector and the Manufacturing sector, with more than 100 million gallons each, but with very low productivity that does not reach 300 dollars per gallon. While financial and insurance activities have high productivity since their consumption is negligible.
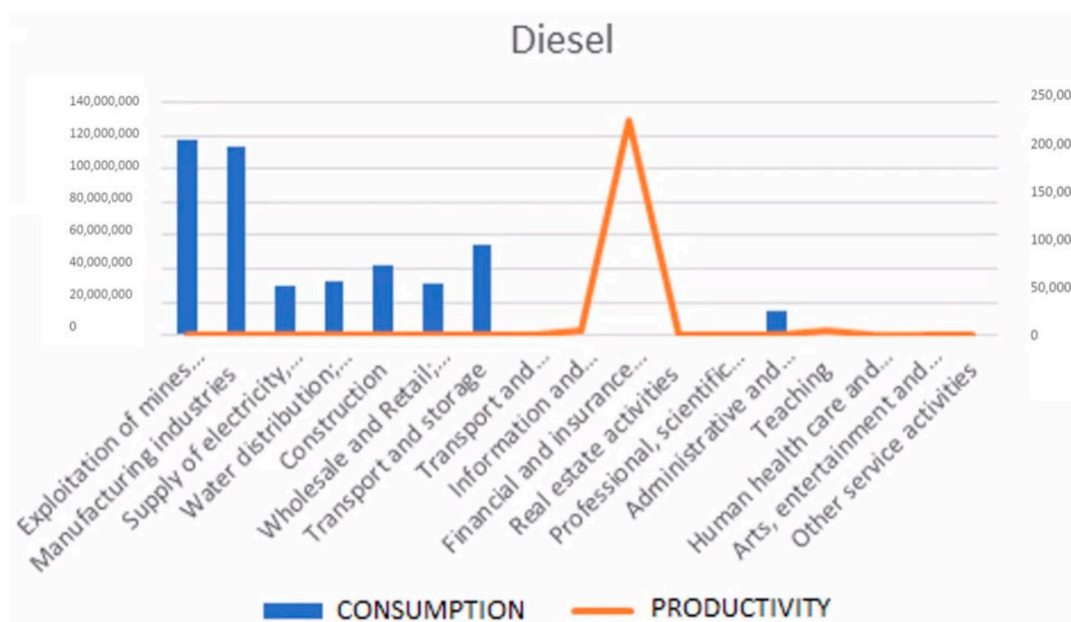


**Figure 5.** Diesel consumption and productivity.

Figure 6 shows that the sector with the highest LPG consumption is the manufacturing industry; however, its productivity does not reach $300 per gallon. While the sector with the highest productivity is Information and communication with approximately 1,200,200 dollars per gallon. The sectors of electricity, gas, steam and air conditioning supply and financial and insurance activities do not register any consumption of this fuel.
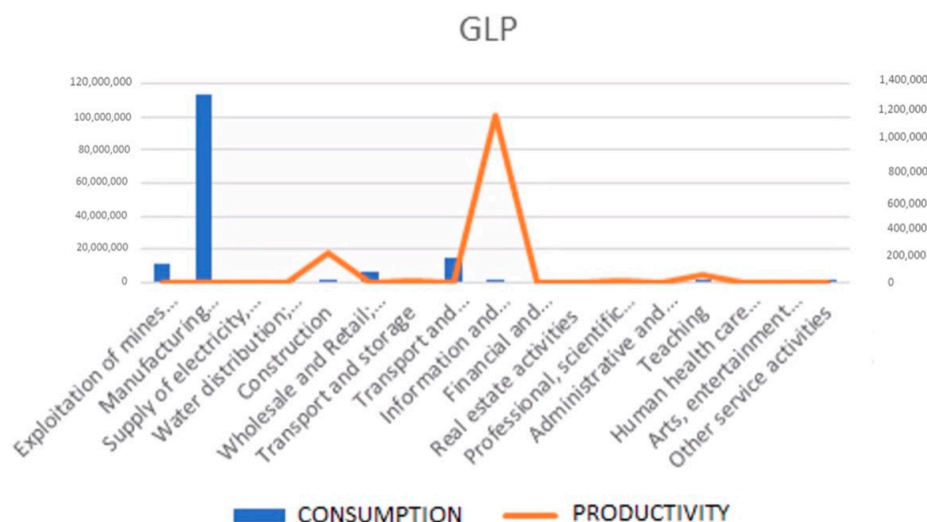
**Figure 6.** LPG Gasoline consumption and productivity.

After this univariate analysis, a correlational analysis of the consumption of each type of fuel and the total production of each sector is performed.

**First Contrast of hypotheses**

**Hypothesis 0 (H0):** There is no relationship between super gasoline consumption and firms' total production.

**Hypothesis 1 (H1):** There is a relationship between the consumption of super gasoline and the total production of the companies.

Table 4 shows that $p < 0.05$ with a value of 0.026, which implies the rejection of the null hypothesis, revealing that there is a significant association between the consumption of super gasoline and total production.

**Table 4.** Correlation coefficient between super gasoline consumption and total production.

| Correlations | | SUPER | PRODUCTION |
|---|---|---|---|
| | Pearson correlation | 1 | 0.536 |
| SUPER | Sig. (bilateral) | | 0.026 |
| | N | 17 | 17 |
| | Pearson correlation | 0.536 * | 1 |
| PRODUCTION | Sig. (bilateral) | 0.026 | |
| | N | 17 | 17 |

* Correlation is significant at the 0.05 level (bilateral).

**Second Contrast of hypotheses**

**Hypothesis 0 (H0):** There is no relationship between the consumption of extra gasoline and the total production of the firms.

**Hypothesis 1 (H1):** There is a relationship between the consumption of extra gasoline and the total production of the companies.

Table 5 shows that $p > 0.05$ with a value of 0.695, which implies accepting the null hypothesis, revealing that there is no significant association between the consumption of extra gasoline and total production.

**Table 5.** Correlation coefficient between extra gasoline consumption and total production.

| Correlations | | | |
|---|---|---|---|
| | | **EXTRA** | **PRODUCTION** |
| EXTRA | Pearson correlation | 1 | 0.103 |
| | Sig. (bilateral) | | 0.695 |
| | N | 17 | 17 |
| PRODUCTION | Pearson correlation | 0.103 | 1 |
| | Sig. (bilateral) | 0.695 | |
| | N | 17 | 17 |

### Third Contrast of hypotheses

**Hypothesis 0 (H0):** There is no relationship between the consumption of Ecopais gasoline and the total production of the companies.

**Hypothesis 1 (H1):** There is a relationship between the consumption of Ecopais gasoline and the total production of the companies.

Table 6 shows that $p > 0.05$ with a value of 0.899, which implies acceptance of the null hypothesis, revealing that there is no significant association between Ecopais gasoline consumption and total production.

**Table 6.** Correlation coefficient between Ecopais gasoline consumption and total production.

| Correlations | | | |
|---|---|---|---|
| | | **ECOPAIS** | **PRODUCTION** |
| ECOPAIS | Pearson correlation | 1 | 0.033 |
| | Sig. (bilateral) | | 0.899 |
| | N | 17 | 17 |
| PRODUCTION | Pearson correlation | 0.033 | 1 |
| | Sig. (bilateral) | 0.899 | |
| | N | 17 | 17 |

### Fourth Contrast of hypotheses

**Hypothesis 0 (H0):** There is no relationship between diesel consumption and the total production of companies.

**Hypothesis 1 (H1):** There is a relationship between diesel consumption and the total production of the companies.

As shown in Table 7, $p < 0.05$ with a value of 0.000, which implies rejecting the null hypothesis, revealing that there is a significant association between diesel consumption and total production.

**Table 7.** Correlation coefficient between diesel consumption and total production.

| Correlations | | | |
|---|---|---|---|
| | | **DIESEL** | **PRODUCTION** |
| DIESEL | Pearson correlation | 1 | 0.773 |
| | Sig. (bilateral) | | 0.000 |
| | N | 17 | 17 |
| PRODUCTION | Pearson correlation | 0.773 * | 1 |
| | Sig. (bilateral) | 0.000 | |
| | N | 17 | 17 |

* The correlation is significant at the 0.05 level (bilateral).

**Fifth Contrast of hypotheses**

**Hypothesis 0 (H0):** There is no relationship between LPG consumption and the total production of the companies.

**Hypothesis 1 (H1):** There is a relationship between LPG consumption and companies' total production.

Table 8 shows that $p < 0.05$ with a value of 0.000, which implies the rejection of the null hypothesis, revealing that there is a significant association between LPG consumption and total production.

**Table 8.** Correlation coefficient between LPG consumption and total production.

| Correlaciones | | GLP | PRODUCTION |
|---|---|---|---|
| GLP | Pearson correlation | 1 | 0.899 |
| | Sig. (bilateral) | | 0.000 |
| | N | 17 | 17 |
| PRODUCTION | Pearson correlation | 0.899 | 1 |
| | Sig. (bilateral) | 0.000 | |
| | N | 17 | 17 |

Correlation is significant at the 0.01 level (bilateral).

## 4. Discussion

Of the fossil fuels analyzed, LPG is the one that pollutes the least due to its composition, which responds to a lower octane rating.

In 2019 in Ecuador there was a total of 40 Megatons of $CO_2$ generated [20], see Table 9.

**Table 9.** Calculation of Megatons of $CO_2$ generated.

| Fuel | Conversion | | Total Units Consumed in Original Unit of Measure | Total Units Consumed in Liters | Kg of $CO_2$ Per Liter | Kg of $CO_2$ Generated | Megatons of $CO_2$ Generated |
|---|---|---|---|---|---|---|---|
| | Original Unit of Measurement | Liters | | | | | |
| Gasoline (Gallons) | 1 | 3785 | 216,852,411 | 820,873,117 | 2.37 | 1,945,469,286 | 1.95 |
| Diesel (Gallons) | 1 | 3785 | 445,081,098 | 1,684,809,988 | 2.65 | 4,464,746,469 | 4.46 |
| GLP (kilograms) | 1 | 1850 | 149,501,808 | 276,578,345 | 0.70 | 470,183,186 | 0.47 |
| | | | Total | | | | 6.88 |

Precisely in 2019, in accordance with the Paris Agreement, the Nationally Determined Contribution (NDC) is formulated, in which each country establishes the lines of action to contribute to the mitigation of climate change in different sectors. The Nationally Determined Contribution (NDC) is formulated for the Energy, Agriculture, Industrial Processes, and Waste sectors, based on an estimated GHG emission reduction potential of 20.9% in relation to the baseline scenario for 2025, subject to the support of international cooperation to implement the lines of action established in this conditional scenario [21].

Consequently, Corporate Social Responsibility is of vital importance, which "focuses on three aspects: care for the environment, the working conditions of its workers, and support for humanitarian causes". [22]. In this sense, the International Organization for Standardization ISO 26000, "provides guidance to those who recognize that respect for society and the environment is a critical success factor" For companies and organizations. And the urgent intervention is in the care of the environment, with emphasis on the fight against climate change.

## 5. Conclusions

Consideration of Greenhouse Gases is important, since a large part of their generation is a consequence of human activity, especially the use of fossil fuels that produce Carbon Dioxide ($CO_2$), and that are gradually affecting the climate of the planet, increasing the temperature to levels that can become irreversible.

The results obtained with respect to the analysis of the variables of gas, diesel, and LPG consumption and total production of the 17 business sectors registered in the Structural Business Survey (ENESEM) correspond to the year 2019 and consider the companies classified as medium and large.

With respect to fuel consumption by each of the business sectors, it can be concluded that: In super gasoline, the sectors with the highest consumption are wholesale and retail trade, repair of motor vehicles and motorcycles, and the manufacturing industry. In extra gasoline, the sectors with the highest consumption are water distribution, sewage, waste management, and sanitation activities, as well as the manufacturing industry. In Ecopais gasoline, the sector with the highest consumption is transportation. Ecopais gasoline consumption and productivity and storage sector. In diesel, the sector with the highest consumption is the Mining and quarrying sector and the manufacturing industry sector. In LPG, the sector with the highest consumption is the manufacturing industry. It is noticeable that, in general, the manufacturing industries sector has shown higher productivity, when compared to sectors that also have a high consumption of fossil fuels.

Regarding the association between fuel consumption and total production, it can be noted that: with respect to gasoline, the correlation coefficients are positive, being significant for that of super gasoline, while those of extra gasoline and Ecopais are not significant, which implies that high consumption of the latter two types of gasoline is not associated with high production in the business sectors. The correlation index for diesel consumption is also positive and significant, which implies that if there is an association, the higher the diesel consumption, the higher the total production. In the case of LPG, the index is also positive and significant, revealing that there is an association, i.e., the higher the LPG consumption, the higher the production.

Regarding $CO_2$ emissions, it is observed that in 2019, the largest generator is diesel, with a little more than 4 megatons per year, followed by gasoline with a little less than 2 megatons per year, and finally LPG with less than 0.5 megatons per year. Consequently, LPG fuel, whose association with production is most significant, is the least polluting. The total $CO_2$ emissions of the analyzed sectors generate approximately 7 megatons of the total 40 megatons generated in the country in 2019.

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