# A study the degree of concentration of the spanish bunkering

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*Abstract*— **This paper shows the Gini Coefficient of the Spanish bunkering, for the Spanish Port System 1960 to the year 2010 with the aim to describe the Spanish bunkering in these periods and propose future strategies. The stage of bunkering must change due to new regulations of marine fuels but to predict the future you must know the past**

**On December 17 came into force on community standard marine fuels. After a complicated negotiation with the industry moves forward a project that is fully compliant with the guidelines of the International Maritime Organization (IMO) and limiting the sulphur and particulate matter of marine fuels used by ships calling or transit through maritime space of the European Union. The impact of a possible extension at European level of the Sulphur Emission Control Areas (SECA) as they are introduced in the Annex VI of the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL) adopted by the International Maritime Organisation (IMO).**

***Key words- Spanish Port System Gini Coefficient, Lorenz Curve, Spanish bunkeringmaritime transport***

## I. INTRODUCTION: BUNKERING VS POLLUTION

Air pollution attracts high political priority as it affects negatively public health and the quality of life. It is a complicated topic both scientifically and politically; conflicting interests of stakeholders are clashing, the scientific basis of their arguments or the rational differs. As a result of the problems of increasing acidification by acid rain in northern Europe caused by air pollution and due to the contribution of emissions from ships, IMO has appointed the following two SECAs within the EU: Baltic Sea (effective May 2006), the North Sea and English Channel (effective November 2007). The standard EU limits described in Directive 1999/32/CE are less stringent than the limits in Annex VI of MARPOL.

Air pollution is a sensitive issue as it affects the quality of life of many people and has a direct impact on their health. Most of the Europeans are living close to the coastline and all main ports are bordering or are part of large urban complexes. The environmental impact of maritime operations, involves the emission of SOx, nitrogen oxides (NOx) and particulate mater (of 2.5 or 10 nm). NOx emissions are related to nutrient overload in water bodies that leads to eutrophication, and the excess of nutrient nitrogen can be detrimental to marine ecosystems and generally to ecosystems with a fragile balance [1].

The issue of air pollution and particularly the abatement of SOx emissions from ships, became a strategic goal of the EU in 2002. The Directive 2005/33/EC of the European Parliament and of the Council regulates the sulphur content of marine fuel, came into force in 2005. This regulatory action is streamlined with Directive 1999/32/EC, which relates to a reduction in the sulphur content of certain liquid fuels; this Directive has set the first sulphur limits for marine distillate oil used in EU territorial waters. Moreover, this directive extended the scope of the previous Directive 93/12/EC on the reduction of SOx emissions to cover certain liquid fuels derived from petroleum and used by seagoing ships. Recently, Directive 2005/33/EC extended the scope of Directive 1999/32/EC to all petroleum derived liquid fuels used by ships operating within Member States' waters. The above European regulatory actions aim to complete international rules and regulations agreed at the IMO and applicable to the world fleet practically. Furthermore, the issue of air pollution has ignited research interest as research and innovative rational approach should be taken into account in order to support actions, opinions and statements in international forums and debates.

Limiting the sulphur content of fuels has been a major concern among European shipping-responsible for 40% of the world fleet, the cost will involve the adequacy of the existing fleet to the new regulations, and therefore, its impact on freight.

The International Maritime Organization (IMO) is a specialized Agency of the United Nations, and its mandate is principally concerned with marine technical and safety issues as well as with marine pollution and prevention of the environment from activity related to maritime transport. In 1973, IMO adopted the International Convention for the Prevention of Pollution from Ships, now known universally as MARPOL, which has been amended by the Protocols of 1978 and 1997 and kept updated with relevant amendments. The MARPOL Convention addresses pollution from ships by oil; by noxious liquid substances carried in bulk; harmful substances carried by sea in packaged form; sewage, garbage; and the prevention of air pollution from ships. MARPOL has greatly contributed to a significant decrease in pollution from international shipping and applies to 99% of the world's merchant tonnage.

The international maritime transport sector is a significant contributor to the Green House Gas (GHG) emissions, where $CO_2$ is the dominant polluter that attracts the interest of policy makers. From the data provided by the International Maritime Organisation (IMO), it is clear that transport activity is responsible for almost 27% of the total burden, and the large proportion of it is attributed to road transportation (≈80%). International shipping contributes only 2.7%, where ships burning marine diesel oil (MDO) and heavy fuel oil (HFO) are reportedly responsible for around 7% of global NOx emissions, around 4% of global sulphur dioxide emissions and 2% of global carbon dioxide emissions (International Maritime Organisation, 2009). The annex of this IMO document provides the full report on the updated 2000 study on greenhouse gas emissions from ships, entitled: Second IMO GHG Study 2009 [1]. The issue of emission reduction from ships is high in the political agenda. Stakeholders have expressed controversial arguments and scientists have identified methodological issues and raised concerns. The very first issue is the premonition of 'targeting' the maritime industry. Indeed, from the data provided by IMO and the study [1] it is clear that transport activity is responsible for almost 27% of the total burden, and the large proportion of it is attributed to road transportation. International shipping contributes only 2.7% of the total and aviation 1.9%, as it can be seen in Figure 1. Despite the relatively limited contribution, the marine industry has been affected disproportionally, if not targeted.

The above wording of 'disproportional impact' is considered in position papers of maritime interest, highlighting the fact that shipping is the most energy friendly mode of transport, when considered in unit terms. Reports, such as of the International Chamber of Shipping [2], highlight the comparison of the $CO_2$ emissions between different modes of transport. [3] reports also that "the World Shipping Council representing more that 60% of the global seaborne trade, takes the stand that the adoption of specific maritime emission caps would be inappropriate in the absence of a broader approach to regulation transportation emissions at the national and global level". In various sources, this stance is taken. The point is that shipping is in absolute terms a significant or substantial emitter, however it is the 'greener', in terms of energy consumption and environmental footprint.

Apparently, shipping is a substantial emitter of non-GHG, such as of NOx and SOx, and regulatory action has been triggered. The new Annex VI of the international convention of MARPOL came into force on 19 May 2005, and a revised Annex VI with significant tighten emissions limits was adopted in October 2008 which entered into force on 1 July 2010.

At European Union level, certain rules on the sulphur content of marine fuel have been incorporated in the EU Directive 2005/33/EC amending Directive 1999/32/EC relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC.

Revisions to the regulations for ozone-depleting substances, volatile organic compounds, shipboard incineration, reception facilities, and fuel oil quality have been made with regulations on fuel oil availability added. The revised measures are expected to have a significant beneficial impact on the atmospheric environment and on human health, particularly for those people living in port cities and coastal communities.

## II. METHODOLOGY: GINI COEFFICIENT (MEASURE THE DEGREE OF CONCENTRATION)

The Gini coefficient was developed to measure the degree of concentration (inequality) of a variable in a distribution of its elements. It compares the Lorenz curve (figure 1) of a ranked empirical distribution with the line of perfect equality. This line assumes that each element has the same contribution to the total summation of the values of a variable. The Gini coefficient ranges between 0, where there is no concentration (perfect equality), and 1 where there is total concentration (perfect inequality).

The Lorenz curve is a graphical representation of the proportionality of a distribution (the cumulative percentage of the values). To build the Lorenz curve, all the elements of a distribution must be ordered from the most important to the least important. Then, each element is plotted according to their cumulative percentage of X and Y, X being the cumulative percentage of elements and Y being their cumulative importance. For instance, out of a distribution of 10 elements (N), the first element would represent 10% of X and whatever percentage of Y it represents (this percentage must be the highest in the distribution). The second element would cumulatively represent 20% of X (its 10% plus the 10% of the first element) and its percentage of Y plus the percentage of Y of the first element.

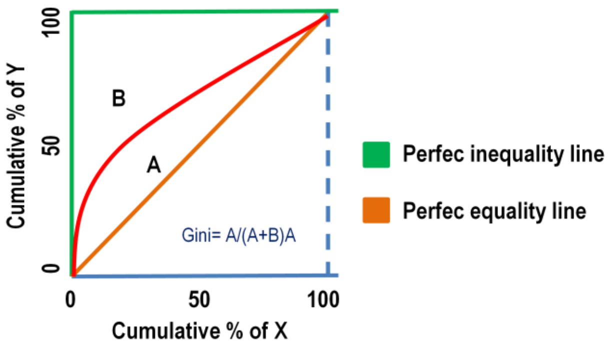


Figure 1. The Lorenz Curve

The Lorenz curve is compared with the perfect equality line, which is a linear relationships that plots a distribution where each element has an equal value in its shares of X and Y.

For instance, in a distribution of 10 elements, if there is perfect equality, the 5th element would have a cumulative percentage of 50% for X and Y. The perfect inequality line represents a distribution where one element has the total cumulative percentage of Y while the others have none.

The Gini coefficient is defined graphically as a ratio of two surfaces involving the summation of all vertical deviations between the Lorenz curve and the perfect equality line (A) divided by the difference between the perfect equality and perfect inequality lines (A+B).

Geographers and many others have used the Gini coefficient in numerous instances, such assessing income distribution among a set of contiguous regions (or countries) or to measure other spatial phenomena such industrial location. Its major purpose as a method in transport geography has been related to measuring the concentration of traffic (figure 1), mainly at terminals, such as assessing changes in port system concentration. Economies of scale in transportation can favor the concentration of traffic at transport terminals, while other considerations such as accessibility to regional markets can be perceived as a countervailing force to concentration. So, the temporal variations of the Gini coefficient reflect changes in the comparative advantages of a location within the transport system.

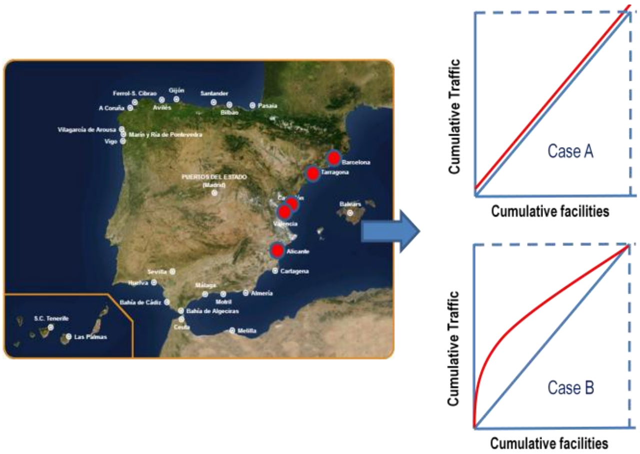


Figure 2. Traffic Concentration and Lorenz Curves

The figure 2 represents a simple system of 5 ports along a coast. In case A, the traffic for each port is the same, so there is no concentration and thus no inequality. The Lorenz curve of this distribution is the same than the perfect equality line; they overlap. In case B, there is some concentration of the traffic in two ports and this concentration is reflected in the Lorenz curve as it is different from the perfect equality line. Case C represents a high level of concentration in *two ports* (for example Barcelona and Valencia) and the Lorenz curve is significantly different from the perfect equality line.

The dissimilarity index is the summation of vertical deviations between the Lorenz curve and the line of perfect equality, also known as the summation of Lorenz differences. The closer the ID is to 1 (or 100 if percentages are used instead of fractions), the more dissimilar the distribution is to the line of perfect equality.

$$ID = 0.5\sum_{i=1}^{N}|X_i - Y_i| \quad (1)$$

Where X and Y are percentages (or fractions) of the total number of elements and their respective values (traffic being the most common). N is the number of elements (observations).

The Gini Coefficient represents the area of concentration between the Lorenz curve and the line of perfect equality as it expresses a proportion of the area enclosed by the triangle defined by the line of perfect equality and the line of perfect inequality. The closer the coefficient is to 1, the more unequal the distribution.

$$G = 1 - \sum_{i=0}^{N}(\sigma Y_{i-1} + \sigma Y_i)(\sigma X_{i-1} - \sigma X_i) \quad (2)$$

Where σX and σY are cumulative percentages of Xs and Ys (in fractions) and N is the number of elements (observations).

## III. CONCLUSIONS

In order to characterize the Spanish bunkering calculates the Gini coefficient, from the years 1960-2010.

The most important bunkering ports in Spain are *Bahía de Algeciras, Las Palmas y Barcelona* (table I). These ports account for 65% of the bunkering market. The bunkering in Spain fell by 4.6% from 2011 to 2012

TABLE I. SPANISH BUNKERING (TONNES) YEARS 2011-2012

| Port Authority | 2011 | 2012 | Variation(%) |
|---|---|---|---|
| A Coruña | 98.090 | 76.155 | -22,36 |
| Alicante | 13.182 | 16.491 | 25,1 |
| Almería | 82.874 | 71.308 | -13,96 |
| Avilés | 38.113 | 38.574 | 1,21 |
| Bahía de Algeciras | 3.464.571 | 3.058.177 | -11,73 |
| Bahía de Cádiz | 103.935 | 119.690 | 15,16 |
| Baleares | 259.719 | 217.024 | -16,44 |
| Barcelona | 1.100.382 | 1.080.219 | -1,83 |
| Bilbao | 130.370 | 121.877 | -6,51 |
| Cartagena | 77.020 | 54.530 | -29,2 |
| Castellón | 36.825 | 33.513 | -8,99 |
| Ceuta | 739.616 | 717.072 | -3,05 |
| Ferrol-S. Cibrao | 15.677 | 15.545 | -0,84 |
| Gijón | 99.865 | 98.978 | -0,89 |
| Huelva | 186.808 | 106.856 | -42,8 |
| Las Palmas | 2.496.798 | 2.444.129 | -2,11 |
| Málaga | 89.448 | 82.784 | -7,45 |

| Port Authority | 2011 | 2012 | Variation(%) |
|---|---|---|---|
| Marín y Ría de Pontevedra | 34.374 | 23.577 | -31,41 |
| Melilla | 30.661 | 28.268 | -7,8 |
| Motril | 23.672 | 29.502 | 24,63 |
| Pasajes | 33.009 | 27.563 | -16,5 |
| Santa Cruz de Tenerife | 936.237 | 948.342 | 1,29 |
| Santander | 48.972 | 52.084 | 6,35 |
| Sevilla | 21.058 | 19.801 | -5,97 |
| Tarragona | 152.285 | 126.994 | -16,61 |
| Valencia | 289.807 | 528.255 | 82,28 |
| Vigo | 275.897 | 245.443 | -11,04 |
| Vilagarcía | 9.088 | 4.313 | -52,54 |
| **TOTAL** | **10.888.353** | **10.387.064** | **-4,6** |

The following figure (figure 3) shows the calculation of the Gini coefficient for the Spanish bunkering is shown from 1960 to 2010.

The Gini coefficient takes values greater than 0.66 indicating a market concentration. Until the 80s the degree of concentration was decreasing, but from 1979 the degree of concentration has been increasing, currently still above 0.8.

This increased level of concentration is due to the policy of specialization are developing Spanish ports from the 80s.

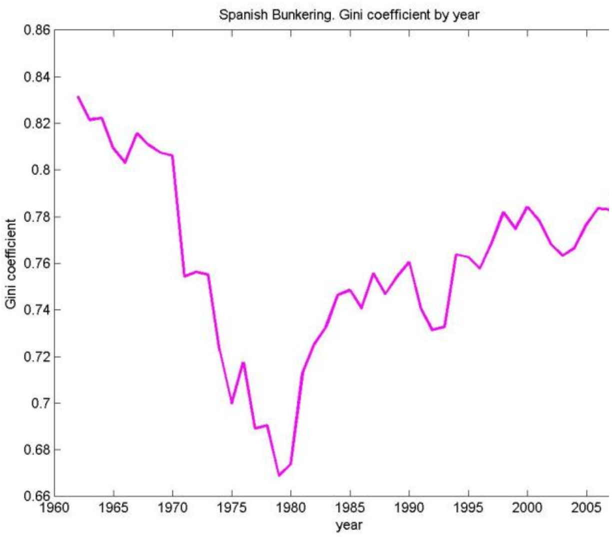


Figure 3. Spanish Bunkering: Gini coefficient by year

Maritime traffic around Europe will definitely increase. This result is critical for many reasons: firstly SOx emissions are concentrated close to city-ports and the coast, where most of the population leaves, thus growing trade volumes and traffic suggest more severe negative impact to the littoral regions. Secondly, because it contributes adversely to wider air pollution issues, such as the ozone levels. Thirdly, because it implies that any decision will directly affect a higher number of ships, and indirectly the trade or the logistic chains they serve.

To facilitate this transition, the European Union has financing transport systems programs as Trans-European Transport Network (TEN-T) and Marco Polo II program. These lines of community grant support initiatives related to improving environmental conditions through the development of new technologies, provide facilities for alternative fuels enter, such as LNG, and encourage the implementation of mechanisms that enable the use of electricity for conducting maneuvers approaching port.

We conclude that for the Spanish port system, the oil crisis tendencies have resulted in concentrating the goods in little more efficient ports

This indicates that as long as the crisis scenario the tendency will be to presentGini Coefficient as pronounced peaks, closer to 1 indicating greater tendency to inequality in the distribution, and is concentrated in a few ports merchandise.

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