CLUSTERS IDENTIFICATION IN THE ELECTRONICS AND ELECTRICAL INDUSTRY IN MANAUS FREE TRADE ZONE.

Almir Kimura Junior, Universidade do Estado do Amazonas, Brazil, akimura@uea.edu.br

Roseani Pereira Parente, Universidade do Estado do Amazonas, Brazil, roseaniparente@gmail.com

Raphael Ribeiro Palheta, Universidade do Estado do Amazonas, Brazil, raphaelpalheta@yahoo.com.br

Naira Neila Batista de Oliveira Norte, Universidade do Estado do Amazonas, Brazil, nairanorte@gmail.com

Roberto Sbragia, Universidade de São Paulo, Brasil , rsbragia@usp.br

Abstract

In this work we analyze if the electronics and electrical companies of the Manaus Free Trade Zone can be classified as an industrial cluster. The location quotient (QL) and the Gini coefficients (GL) were calculated and the results were 5.56 for the QL and 0.613 for the GL respectively. The results were positive, but, as we did not find in the literature any work on the topic using these metrics, for a more conclusive result other factors should be studied such as labor specialization, geographic concentration, vertical and horizontal cooperation and others. Therefore, we can consider the study of the QL and GL metrics as an initial step to define if the electrical industry in Manaus Free Trade Zone suits as an industrial cluster.

Keywords: *Cluster; Gini Cofficients; Location Quotation*

1. INTRODUTION

The Manaus Free Trade Zone is an economic model development by Brazilian government with the objective of integrating the North region with the rest of the country. This model is important for the Amazon, for Brazil and for the world, because conciliate economic and social growth with the preservation of the Amazon forest. Among all different sectors the electronics and electrical (E&E) historically shows higher revenues. Our main research problems are the absence of studies about clusters in Manaus Free Zone in companies of the E&E segment.

In this paper, we will use the location Gini coefficients (GL) and location quotient (QL) to verify if the companies of the E&E segment can be initial classified as an industrial cluster. Section 2 show the Background (Clusters, Cluster identification and a framework to examine technological capability development). Section 3 present a brief information's about Manaus Free Trade Zone. The research methods are outlined in Section 4. Section 5 describes the partial results founded in this paper. Finally, Section 6 discusses the conclusions.

2. BACKGROUND

2.1 Clusters

In the capitalism, mutual cooperation is a good strategic available to companies to gain competitive advantages, clusters are based from the idea of cooperation and competition.

Long before the formal conceptualization of what can be defined as a cluster, the idea and perception in the literature that the concentration of specialized industries in certain localities could help these agglomerated companies to obtain more competitive advantages than if they were acting alone.

At the end of the nineteenth century, in the mid-1890s, Alfred Marshall's [1] classical theory emerged in his “Principles of Economics”, in which he addresses the idea that agglomerated industries can result in competitive advantages generated by division of work and cooperation between these industries located in the same geographical space [2].

Later on, Michael Porter systematized and disseminated the theory and conceptualization of clusters in his work “The Competitive Advantage of Nations”.

In classical theory [3], cluster can be defined as a geographically concentrated grouping of interrelated companies and related institutions in a given area, which are bound by common and complementary elements. Geographic space can vary from a single city or state to an entire country or network of neighboring countries.

According to Porter [4], clusters consist of dense networks of interrelated firms that arise in a region because of strong externalities and spillovers between firms (and various types of institutions). Clusters generate productivity and innovation. Companies that are located within a cluster can transact more efficiently, share technologies and knowledge faster, be more flexibly, start new business more easily, and implement innovations more quickly.

It can also be defined as the geographic concentration of interconnected companies, specialized providers, companies and services and support agents, in which they compete but also cooperate with each other [5].

2.2 Cluster Identification

Methods of identification of industrial clusters, generally involves, the execution of at least two basic steps: First, the choose of the economic region and second, the calculation of the concentration metrics of employment by sector of that region.

The choose of the economic region differs in use of the municipalities or the microregions. The calculation of employment concentrations involves the determination of the Locational Quotient (QL) proposed by [6] that allows the comparison between a basic economic region with a reference one that can be the State or the Country. When the QL is higher than one is indicating a relative specialization in a region. The bigger, the more specialized. Other works use the Locational Gini coefficient (GL) together with the QL. The GL was initially proposed by Krugman [7], and is interpreted as an indicator of the degree of concentration of a given activity on a geographical basis that may be a region, a state or a country. The coefficient varies

from zero to one, more spatially concentrated the activity, the closer the unit will be one [8],[9],[10].

An additional caution in the analysis of the QL and GL results suggests the adoption of some control filters, such as the number of jobs and the number of establishments. The use of these variables can identify, for example, whether a high coefficient of specialization (QL) for a region, is not only due to presence of few large companies.

The authors [8], [10] e [11] differs in the analysis criteria for the results of these indicators, because of that we summarize in tablet 1 the limits established by the authors in which the classes of economic activities should fit to be chosen as potential clusters.

Criteria	Suzigan et al (2003)	Zissimos (2007)	Rezende e Diniz (2013)
QL	>2	>1	≥3
GL	>0.5	>median	Not specified
Firms	>20	>5	≥25
Employees	>1%	>1%	≥500

Table 1 - Summary of the analysis criteria to identify potential clusters

According to [12] with field surveys and case studies would be possible to detect the intangible elements of clusters, such as cooperation between companies or between companies and institutions. This step would allow the validation and refinement of the preliminary selection performed by the table 1.

3. MANAUS FREE TRADE ZONE

The Manaus Free Trade Zone (MFTZ) is the result of a federal geopolitical project, whose objective was to install a model of economic development in the Amazon region through the industrial, commercial and agricultural sectors, with the aim of integrating the northern region with the rest of the country.

The main federal government institution that manages the MFTZ is the Superintendence of the Manaus Free Trade Zone (SUFRAMA). One of its duties is to inspect all the results of the Industrial sector, which can be observed in the annualized performance indicators report.

The ZFM, created on 06/06/1957 through Decree Law 3,173, had its implementation as a Free Trade Zone on 02/28/1967 through Decree Law No. 288. The model according to Article 42 of Decree No. 288, had its initial validity for thirty 30 years, valid for the period from 1967 to 1997 [16]. After this initial phase, it has already obtained four extensions, the last occurred on

08/05/2014, when the National Congress enacted Constitutional Amendment 83/2014, which extended the tax incentives until the year 2073, giving at least more 56 years of this economic model.

The process of modernization of the industrial sector in MFTZ between the third and fourth extensions through automation and focus on quality has led to significant growth in revenues and productivity in the manufacturing industry benefiting the Brazilian industrialization process in general [14].

The electronics and electrical (E&E) segment was chosen for the development of this work, this segment represented 28.31% of total revenues of the year 2016 as shown in figure 1, corresponded a significant amount of 19 billion of reais. [13]

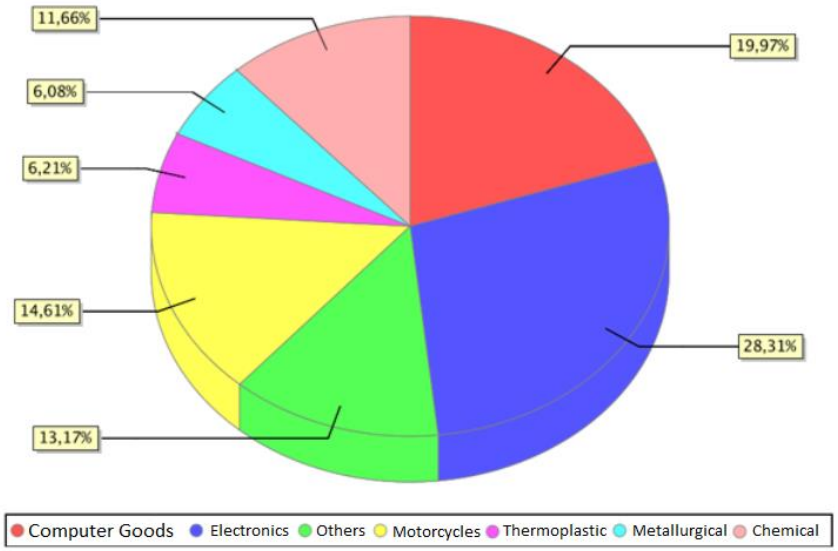

Figure 1 - Sectors revenues of the MFTZ (Suframa, 2017)

4. METHODOLOGY (TOOLS)

4.1 Gini coefficients (GL) and location quotient (QL) equations

For the identification of industrial cluster in the electronics and electrical (E&E) segment, the two basic steps previously explained was used: First, the choose of the economic region and second, the calculation of the concentration metrics of employment by sector of that region.

The database used as a source of information was the Annual Report of Social Information (RAIS- Relação Anual de Informações Sociais) of the Ministry of Labor and Employment (MTE- Ministério do Trabalho e Emprego), used by most of the work focused on the analysis of clusters of companies in Brazil. The advantage of using this database lies in the level of spatial and sectoral detail [15].

The electronics and electrical (E&E) segment will be analyzed, to classify the economic activities of the companies contained in it, the National Classification of Economic Activities (CNAE- Classificação Nacional de Atividades Econômicas) 2.0 was applied to five digits.

The work uses the data of the number of jobs (NJ) informed in RAIS 2015 by the companies of the segment of the E&E classified by Suframa. Seventeen CNAE rankings were identified for which the Locational Quotient (QL) was calculated by the equation:

$$QL=\frac{\frac{\text{NJ in sector i of the county}}{\text{NJ in all sectors of the county}}}{\frac{\text{total NJ in secto i of the country}}{\text{total NJ in all sectors of the country}}} \quad (1)$$

In order to calculate the GL, the sectors were ordered to increase the value of the QL of the considered base variable (number of employees). Next, the Lorenz curve is construct and the area on the line of equality is calculated. The Gini coefficient consists of the value 0.5 minus the value of the calculated area. In summary, we can say that the Local Gini coefficient (GL) shows the spatial concentration of an activity and can be obtained by the expression: [16].

$$GL=1-\frac{1}{n}\sum_{i=1}^{n}(\theta_{i-1}+\theta_i) \quad (2)$$

Where: n is the number of classes (in this case, the CNAE sectors); θ_i is the cumulative percentage share; and, $\theta_{i-1}+\theta_i$ is the cumulative percentage share plus the immediately preceding class. The coefficient varies from zero to one, and the more spatially concentrated the economic activity, the closer to the unit will be the index [10].

5. RESULTS

5.1 QL results

To calculate the QL for the E&E segment of the MFTZ in relation to the same segment in the country (Brazil) was determined with the application of the expression below:

$$QL=\frac{\frac{\text{NJ in the E\&E sector in Manaus}}{\text{NJ in all sectors in Manaus}}}{\frac{\text{total NJ in the E\&E sector in Brazil}}{\text{total NJ in all sectors in Brazil}}} \quad (3)$$

The result found using the equation was 5.56. As defined in the methodology, a QL greater than 1 indicates that there is concentration of an economic activity in the region higher than the concentration of this activity in the country. In this case, the specialization of the E&E segment in Manaus is more than five times higher than the concentration in Brazil.

The results obtained for the QL for each of the CNAE classes associated with the E&E segment are summarized in Table 2.

CNAE Classes	Number of Employees		*Jobs in the Sector*	
	Employees in the Sector in Manaus	Employees in the Sector in Brazil	*QL*	*%Total*
Manufacture of audio, video recording, reception and reproducing apparatus	6.566	13.244	46,01	49,6
Manufacture of electronic components	10.578	32.304	30,39	32,7
Manufacture of optical, photographic and cinematographic equipment and instruments	551	2.455	20,83	22,4
Manufacture of computer and peripheral equipment	4.598	39.586	10,78	11,6
Manufacture of communication equipment	1.975	19.035	9,63	10,4
Manufacture of apparatus and instruments for measuring, testing and control	2.019	23.937	7,83	8,4
Manufacture of batteries, electric accumulators and batteries	551	9.776	5,23	5,6
Manufacture of electricity distribution and control equipment	2.636	59.088	4,14	4,5
Manufacture of electrical equipment and apparatus not elsewhere classified	1.123	28.493	3,66	3,9
Manufacture of generators, transformers and electric motors	1.360	38.376	3,29	3,5
Manufacture of other general-purpose machinery and equipment	3.552	111.556	2,95	3,2
Manufacture of household appliances	1.554	51.057	2,82	3,0
Manufacture of articles of jewelery, imitation jewelery (including electronic games)	375	19.246	1,81	1,9

Manufacture of electromedical and electrotherapeutic equipment and irradiation equipment	81	5.509	1,36	1,5
Manufacture of engines, pumps, compressors and transmission equipment	359	54.933	0,61	0,7
Manufacture of other products	513	52.791	0,53	1,0
Manufacture of machinery and equipment for specific industrial use	369	82.270	0,42	0,4

Table 2 - Locational Quotients of the electronics and electrical segment in Manaus free trade zone

Applying the analysis criteria for industrial cluster identification summarized in Table 1, we observed that of the 17 listed CNAE classes the first 14 (82%) present a QL that meets the requirements defined by the three authors indicating a high degree of industrial specialization.

We highlight the results of the first three classes. As the first two, they had a QL of 46.01 and 30.39. According to data reported in RAIS 2015, the first class gathered 49.6% of employees in the sector in 26 companies that correspond to 22% in relation to the total of companies in Brazil of the same segment. With regard to the second class, there are 32.7% of the employees in the sector in 36 companies operating in the Free Zone of Manaus, representing, 11.3% in relation to the number of companies operating in the same segment in Brazil.

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The third class had a QL of 20.83 and had a total of 22.4% of employees in the sector in 4 companies (30.8%) out of a total of 13 companies operating in the same segment in Brazil.

The companies classified in the first two classes meet all the requirements defined by the three authors summarized in Table 1. The companies of the third class did not meet the criterion of number of companies.

5.2 Gini Locational (GL) results

As seen in the methodology, the first step in calculating the Gini coefficient is to order the QLs in an increasing way, to calculate their accumulated frequency values (the classes were renamed C0 to C17) as seen in Table 3.

Classes	% Classes Accumulated Frequency	QL	*%QL*	% QL Accumulated Frequency	Area under the curve
C0	0,00	0,00	0,00	0,00	0,00000
C1	0,059	0,42	0,003	0,003	0,00008
C2	0,118	0,55	0,004	0,006	0,00027
C3	0,176	0,61	0,004	0,010	0,00049
C4	0,235	1,36	0,009	0,019	0,00087
C5	0,294	1,81	0,012	0,031	0,00149
C6	0,353	2,82	0,019	0,050	0,00238
C7	0,412	2,95	0,019	0,069	0,00350
C8	0,471	3,29	0,022	0,091	0,00470
C9	0,529	3,66	0,024	0,115	0,00604
C10	0,588	4,14	0,027	0,142	0,00755
C11	0,647	5,23	0,034	0,176	0,00936
C12	0,706	7,83	0,051	0,228	0,01188
C13	0,765	9,63	0,063	0,291	0,01525
C14	0,824	10,78	0,071	0,362	0,01919
C15	0,882	20,83	0,137	0,498	0,02530
C16	0,941	30,39	0,200	0,698	0,03519
C17	1,000	46,01	0,302	1,000	0,04994

Table 3 - Locational Quotients of the electronics and electrical segment in Manaus free trade zone

With the data found, the Lorenz curve was developed (Figure 2). We the blue line is the equality and the orange line is the Lorenz curve.

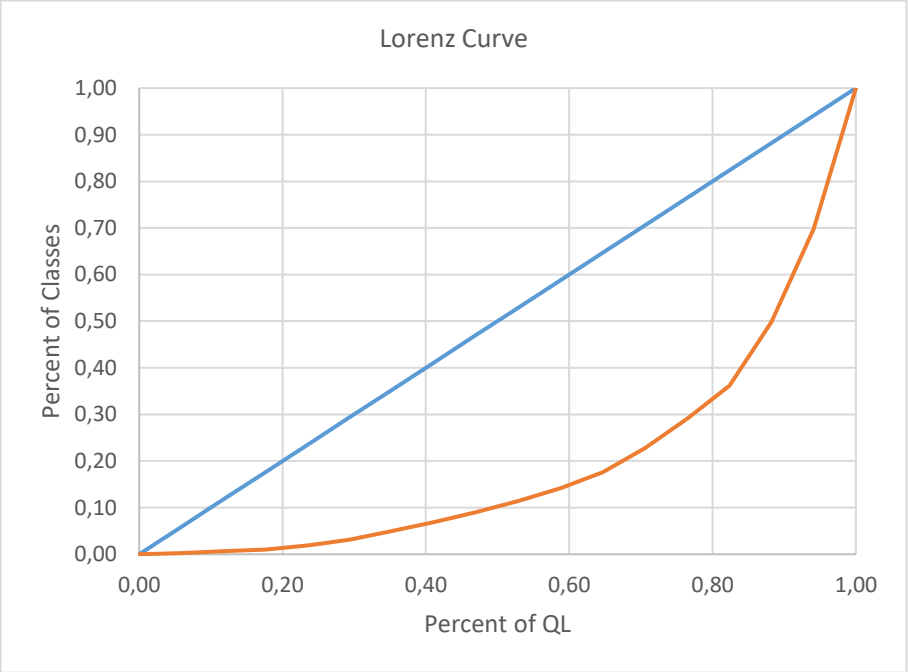

Figure 2 – Lorenz Curve

The value of the area was 0.306 which gives a value of the Locational Gini equal to 0.613. As defined in the methodology, the closer to 1, the more concentrated will be the production activity evaluated. The value obtained meets the criteria established by [8] and [10] summarized in Table 1.

Analyzing the Gini coefficient in Manaus and Brazil, considering employment as the studied variable and not the QL, we obtained respectively the values of 0.566 and 0.399, confirming the concentration of companies in the E&E sector in the Manaus Free Trade Zone.

6. CONCLUSIONS

The purpose of this paper was contribute using indicators and data from the Manaus Free Trade Zone in order to identify an industrial cluster, we do not find in the literature any work on mapping clusters in the Manaus Free Zone using LQ and GL as metrics,. The results were positive, but for a more conclusive result other factors should be studied such as labor specialization, geographic concentration, vertical and horizontal cooperation, empirically it is possible to observe an efficient vertical cooperation system, but we do not have data regarding the existence cooperation between companies. We can consider the study of the QL and GL metrics as an initial step to define if the E&E of the MFTZ suits as an industrial cluster. For a

conclusive view in this regard, further research is needed. The expected final objective of this study is to expand the level of information of scientific works of the E&E sector in the Manaus Free Trade Zone

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