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Industrial Agglomeration in Costa Rica: a descriptive analysis

Satoru KUMAGAI[*], Yasushi UEKI[†], David BULLÓN[‡], Natalia SÁNCHEZ[※]

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Abstract

This paper investigates the current situation of industrial agglomeration in Costa Rica, utilizing firm-level panel data for the period 2008-2012. We calculated Location Quotient and Theil Index based on employment by industry and found that 14 cantons have the industrial agglomerations for 9 industries. The analysis is in line with the nature of specific industries, the development of areas of concentration around free zones, and the evolving participation of Costa Rica in GVCs.

Keywords: Costa Rica, Industrial Agglomeration

JEL classification: O54, L60, R12

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[*] Research Fellow Sent Abroad, IDE (kumagai@ide.go.jp)
[†] Economist, Economic Research Institute for ASEAN and East Asia (ERIA)
[‡] Director of Innovation, Ministry of Science, Technology and Telecommunications (MICITT), Costa Rica
[※] Advisor, Directorate of Investment, Ministry of Foreign Trade(COMEX), Costa Rica

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INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

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Satoru KUMAGAI, IDE-JETRO
Yasushi UEKI, ERIA
David BULLÓN, COMEX
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1. Introduction

Industrial agglomeration is one of the oldest topics in the study of economic development. Marshall (1890) first studied the advantages of industrial agglomeration, pointing to three types of positive externalities that emerge from clustering of productive activities: 1) the accumulation of a pool of industry-specific skilled labor, 2) the emergence of suppliers of intermediate inputs, and 3) knowledge spillovers. Since then, industrial agglomeration has been studied in various fields of social sciences, and since the 1990's, spatial economics, or new economic geography, has provided a comprehensive framework on which research is based today. Recently, the World Bank´s World Development Report 2009 discussed the relationship between economic growth and geography comprehensively concluding that industrial agglomeration is

essential to economic development.

Costa Rica is a country that has experienced significant structural transformation since the mid-1980s. Investments in education, trade liberalization and active FDI attraction have been some of the policies that have changed the face of this country`s industrial structure. While there have been many studies to track the development of different sectors in the Costa Rican economy, none of these have had a spatial component that would provide a more nuanced understanding of the role that industrial agglomeration has played.

This paper investigates the current situation of industrial agglomeration in Costa Rica, utilizing firm-level panel data for the period 2008-2012. We analyze the economic geography in Costa Rica, identify the location of industrial agglomeration using the Location Quotient and Theil Index, and demonstrate how it has varied in recent years. While the current dataset does not allow us to draw statistically significant results regarding the presence of agglomeration effects, we lay out a framework for how these effects could be measured in future using methods that rely on firm-level productivity data and methods that rely on the location that new firms chose to establish their operations.

2. Industrial Agglomeration in Costa Rica

2.1 Data

The analysis is based on a firm level database, constructed from the Costa Rica´s business register. The business register is a census of all firm in the country which is maintained by the National Institute of Statistics and Census (INEC) since 2008. The business register contains relevant variables on geographic location by province, canton, and district (see appendix 1), sector identification according to ISIC rev 4 and employment. Employment data is maintained annually using administrative data from the Social Security Agency. Other data, including the location and industry codes are updated through phone surveys that cover 40% of the registry each year. Additional anonymized financial data was added for firms in the special regimes, based on the financial statements that these firms submit to the Trade Promotion Agency

(PROCOMER) as a requirement of participating in the regime. The GPS point of the centroid of each canton was also added to the dataset.

2.2 Basic Statistics

Table 1 shows the distribution of employment by province and industry in Costa Rica, 2012. At national level, the number of employees covered in the dataset is 887,974. By industry, 12.1% are employed in the agriculture and mining sectors, 19.6% in the manufacturing sector and 68.3% in the service sector. By province, 49.6% of employees are in the province of San Jose, followed by Alajuela (15.8%) and Heredia (15.1%)

Table 1: Number of Employees by Province and Industry (2012)

	Agriculture/Mining	Manufacturing	Services	Total	
San José	12,809	51,836	375,725	440,370	(49.6%)
Alajuela	37,081	39,389	63,585	140,055	(15.8%)
Cartago	7,639	20,202	33,127	60,968	(6.9%)
Heredia	6,161	43,699	84,210	134,070	(15.1%)
Guanacaste	5,265	2,947	16,009	24,221	(2.7%)
Puntarenas	6,865	4,383	18,983	30,231	(3.4%)
Limón	31,085	11,758	14,216	57,059	(6.4%)
Total	106,905	174,214	605,855	886,974	(100.0%)
	(12.1%)	(19.6%)	(68.3%)	(100.0%)	

Table 2 shows the distribution of employees in the manufacturing sector by province and by industry at the ISIC 2-digit level. In total, 29.8% of manufacturing employment is in San Jose, closely followed by Heredia (25.1%) and then Alajuela (22.6%). These three provinces host more than three fourths of total manufacturing employment. However, there are many subsectors within manufacturing which are located mainly outside of these three provinces. Cartago hosts a significant share of employees in the wearing apparel industry (ISIC 14), chemical industry (ISIC 20), and motor vehicle industry (ISIC 29), and Puntarenas hosts the basic metal industry (ISIC 24).

Table 2: Employment Share of Each Province by Industry (2012)

	ISIC	San José	Alajuela	Cartago	Heredia	Guanacaste	Puntarenas	Limón	Total
Food products	10	30.30%	27.70%	7.10%	23.00%	3.90%	4.90%	3.10%	100.00%
Beverages	11	53.70%	32.10%	6.70%	6.70%	0.00%	0.00%	0.80%	100.00%
Tobacco products	12	6.70%	0.00%	0.00%	93.30%	0.00%	0.00%	0.00%	100.00%
Textiles	13	69.30%	16.10%	1.80%	11.50%	0.80%	0.10%	0.30%	100.00%
Wearing apparel	14	38.90%	16.10%	35.60%	8.90%	0.10%	0.00%	0.30%	100.00%
Leather and related products	15	13.30%	70.20%	3.30%	12.60%	0.00%	0.40%	0.10%	100.00%
Wood and of products of wood and cork, except furniture	16	14.70%	38.50%	7.50%	23.50%	3.30%	2.00%	10.40%	100.00%
Paper and paper products	17	18.30%	0.80%	8.20%	61.50%	0.00%	0.00%	11.30%	100.00%
Printing and reproduction of recorded media	18	73.10%	11.60%	5.40%	8.30%	0.40%	0.80%	0.50%	100.00%
Coke and refined petroleum products	19	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%
Chemicals and chemical products	20	35.10%	15.20%	38.80%	2.60%	0.20%	7.70%	0.50%	100.00%
Basic pharmaceutical products and pharmaceutical preparations	21	73.30%	2.20%	13.20%	10.30%	1.00%	0.00%	0.00%	100.00%
Rubber and plastics products	22	39.20%	20.40%	2.00%	38.30%	0.00%	0.00%	0.10%	100.00%
Other non-metallic mineral products	23	35.80%	24.50%	24.40%	6.40%	5.90%	1.60%	1.30%	100.00%
Basic metals	24	3.40%	32.00%	4.20%	37.20%	0.00%	23.20%	0.00%	100.00%
Fabricated metal products, except machinery and equipment	25	59.50%	15.90%	10.90%	11.90%	0.30%	0.60%	1.00%	100.00%

Computer, electronic and optical products	26	6.00%	16.50%	2.70%	74.70%	0.00%	0.00%	0.00%	100.00%
Electrical equipment	27	15.40%	49.70%	2.00%	32.90%	0.00%	0.00%	0.00%	100.00%
Machinery and equipment n.e.c.	28	47.40%	14.00%	12.10%	21.80%	0.50%	0.10%	4.00%	100.00%
Motor vehicles, trailers and semi-trailers	29	9.80%	15.00%	73.30%	1.90%	0.00%	0.00%	0.00%	100.00%
Other transport equipment	30	29.60%	58.20%	0.00%	8.20%	0.00%	3.90%	0.00%	100.00%
Furniture	31	43.10%	28.70%	14.50%	9.20%	0.70%	3.20%	0.60%	100.00%
Other manufacturing	32	7.30%	12.00%	16.20%	63.30%	0.10%	1.10%	0.00%	100.00%
Repair and installation of machinery and equipment	33	3.70%	20.50%	1.20%	2.10%	0.00%	0.40%	72.10%	100.00%
All Mfg.		29.80%	22.60%	11.60%	25.10%	1.70%	2.50%	6.70%	

2.3 Agglomeration Indices

The selection of a proper agglomeration index is an important topic in the agglomeration study (Kominers[2008]). There are various new 'theory-backed'indices appeared in tandem with the progress in the field of the new economic geography after 1990's. Here, we conservatively choose two of the agglomeration indices that have been widely used, i.e., Location Quotient and Theil index.

Location Quotient (LQ)

LQ is a standard measure of the industrial agglomeration for a specific industry in a specific location, easy to understand and can be calculated with limited data. The LQ for industry *i* in region *r* is defined as follows:

$$LQ_{ir} = \frac{q_{ir}/q_r}{Q_i/Q} = \frac{q_{ir}/Q_i}{q_r/Q}$$

where q_{ir} is industry *i*'s employment in region *r*, q_r is total employment in region *r*, Q_i is industry *i*'s employment in reference area, and Q is the total employment in reference area. For example, if automotive industry accounts for 3% of total employment in a canton while it accounts for 2% of total manufacturing employment for Costa Rica, then LQ for automotive industry for the region is 3%/2% = 1.5. So, LQ>1 means the canton is more specialized in that industry more than national average.

Theil Index

The Theil Index is used to compare the degree of agglomeration between industries and is calculated as follows:

$$T_i = \sum_r \frac{q_{ir}}{Q_i} \ln(LQ_{ir})$$

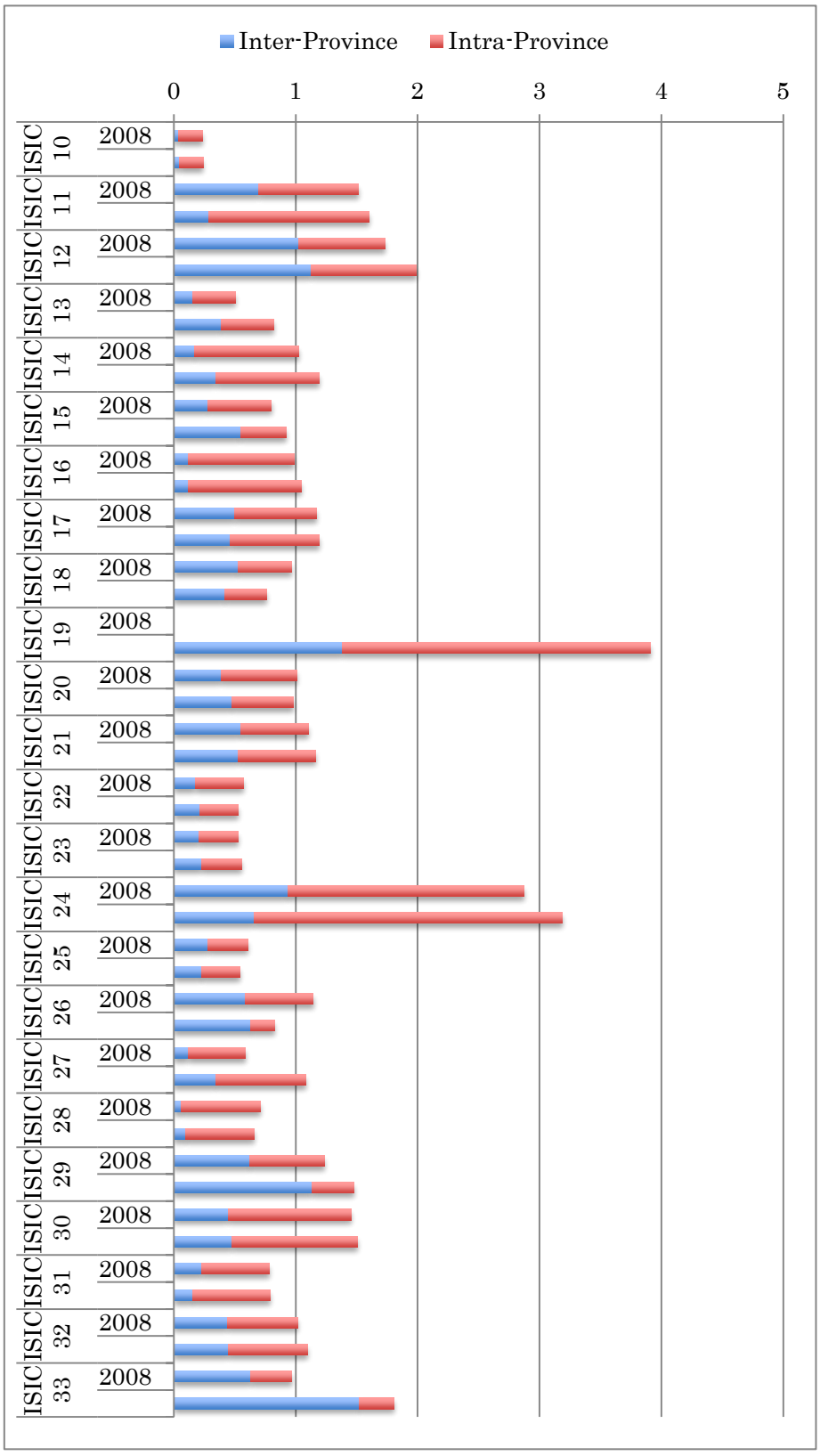
The index takes 0 if the distribution of a specific industry perfectly follows the distribution of a reference value, in this case, total manufacturing employment. A bigger

index value means more concentration compared with the reference value. One of the merits of Theil index is that the index can be decomposed in multiple geographical layers, in this case, inter-province concentration and intra-province concentration. If an industry agglomerates in a specific province but uniformly distributed within the province, the inter-provincial Theil is high while intra-provincial Theil is low, and vice versa.

2.4 Analysis with the Theil Index

Figure 1 shows intra-provincial and inter-provincial Theil index by industry for Costa Rica, 2008 and 2012. A higher index value means higher concentration. There is a wide range of concentration industry by industry. For year 2012, the industry with the lowest concentration is food products (ISIC 10); followed by rubber and plastic (ISIC 22); fabricated metal products (ISIC 25); and other non-metallic mineral products (ISIC 23). The industry with the highest concentration is coke and refined petroleum products (ISIC 19); followed by basic metals (ISIC 24); tobacco products (ISIC12); repair and installation of machinery and equipment (ISIC 33); and beverages (ISIC 11).

Figure 1: Theil Index by Industry (2012)



The industry with the highest inter-province Theil index is repair and installation of

machinery and equipment (ISIC 33); followed by coke and refined petroleum products (ISIC 19); tobacco products (ISIC12); and motor vehicles (ISIC 29). The industry with the lowest inter-province Theil index is food products (ISIC 10); followed by machinery and equipment n.e.s (ISIC 28); and wood and products of wood and cork (ISIC 16). This means that the former industries locate in a handful of provinces, while the latter industries locate in every province alike. The industries that have higher inter-province Theil can be assumed to have a higher scale economy so that many provinces are not able to host these industries.

The industry with the highest intra-province Theil index is basic metals (ISIC 24); followed by coke and refined petroleum products (ISIC 19). The industry with the lowest intra-province Theil index is food products (ISIC 10), followed by computer, electronic and optical products (ISIC 26); and repair and installation of machinery and equipment (ISIC 33). This means that the former industries are concentrated in a limited number of cantons in a province, while the latter industries dispersed widely in a province. The industries that have higher intra-province Theil can be assumed to have a scale economy at province level, and they tend to agglomerate within a province. The industry that has a large-scale plant tends to have a higher intra-province Theil compared with the industries that consist of many small plants.

For the year 2008, there is little difference compared with the year 2012, except that there is no employee under coke and refined petroleum products (ISIC19) for this year. Thus the overall degree of industrial concentration doesn't change noticeably during 2008-2012.[i]

2.5 Identifying industrial agglomerations

The LQ index was calculated for each industry by canton. Appendix 3 contains a graph for each of the industries, showing the extent to which each of the cantons specializes in the each industry.

A Location Quotient above unity for an industry in a region shows that the region has a higher share of employment in the industry compared with the national average. This is

a necessary condition of industrial agglomeration but this alone is not sufficient.

First, a high LQ does not necessarily mean the number of employees for the industry in the region is large. If the total number employee in the region is very small, a high LQ means the industry is important for the region, but not for the nation.

Secondly, a high LQ of employment does not necessarily mean a large number of firms are located in the region. If one company has a large factory in the region, then LQ is likely to be high, but this is not an agglomeration of industry.

To address the above two issues, we define the agglomeration of industry as follows:
1) LQ for the industry in the canton is more than 3,
2) Number of employee in the industry in the canton is at least 100,
3) Number of firms for the industry in the canton is at least 10.

With this definition (we call this as 'conservative' criterion), we identified 14 cantons have the industrial agglomerations for 9 industries (Table 1).

Table 3: Industrial Agglomeration in Costa Rica (Canton-level, 2012)

Canton	Industry	ISIC	LQ	# of firms	# of employee
Province of San José					
San José	Textiles	13	4.29	33	1,604
Desamparados	Fabricated metal products, except machinery and equipment	25	6.56	36	635
	Furniture	31	3.41	18	251
Goicoechea	Printing and reproduction of recorded media	18	3.88	20	335
	Furniture	31	4.11	19	523
Tibas	Printing and reproduction of recorded media	18	8.17	15	374
Montes de Oca	Wearing apparel	14	6.11	17	869

Curridabat	Chemicals and chemical products	20	3.76	12	508
Pérez Zeledón	Wearing apparel	14	5.35	22	370
Province of Alajuela					
San Ramón	Wearing apparel	14	6.27	24	623
	Wood and of products of wood and cork, except furniture	16	5.01	11	143
Palmares	Furniture	31	12.34	17	468
San Carlos	Wood and of products of wood and cork, except furniture	16	8.9	25	636
Valverde Vega	Furniture	31	14.86	19	124
Province of Cartago					
Cartago	Wearing apparel	14	5.53	32	4,152
Province of Heredia					
Heredia	Computer, electronic and optical products	26	3.54	16	2,995
	Other manufacturing	32	5.61	23	8,814

The table shows that there are a series of areas in which agglomeration can be observed, however, the three largest clusters are associated with global value chains in which Costa Rica participates: manufacturing of textiles and wearing apparel, manufacture of computer, electronics and optical products, and repair and installation of machinery and equipment. The first of these is a waning sector that tells a story about comparative advantages that Costa Rica had in recent history, whereas the second and third sectors have emerged as a consequence of comparative advantages that Costa Rica has developed in recent history.

We treat sectors manufacturing of textiles (ISIC13) and manufacturing of wearing apparel (ISIC14) as one sector because of their joint history. For manufacturing of textiles (ISIC 13), San José in San José is the only agglomeration in the county. For manufacturing of wearing apparel (ISIC 14), there are four agglomerations: Montes de

Oca and Pérez Zeledón in San José, San Ramón in Alajuela and Cartago in Cartago, summing to a total of 7618 jobs. Costa Rica's textile industry development during the period of import substituting industrialization between the 1950s and 1970s oriented towards the Central American Market. After the economic crisis of the 1980s, tariffs for the textile industry were significantly reduced in the next decade. In parallel, the industry continued to grow based on an influx of textile operations that took advantage of low-cost labor to export to countries outside of the Central American region the mid-1990s. As wages rose over the next decade, many of these textile companies moved operations to other countries. For this reason the textile cluster is smaller than it once was. The logic of the distribution of areas of agglomeration responds mainly to labor rates and areas where companies are able to glean fiscal incentives.

In contrast, the manufacture of computer, electronic and optical products (ISIC 26), is highly concentrated in Heredia in Heredia, and represents 2995 jobs in electronics and some medical devices firms. Other manufacturing (ISIC32), is also agglomerated in Heredia in Heredia. This sector accounts for the rest of firms in the medical devices sector, summing 8814 jobs. Firms in the electronics and medical devices value chains have established themselves in locations which are close to the main international airport, since a large proportion of their exports use air transport. They began to establish themselves in Costa Rica in the late 1990s and continue to do so today.

Table 4 shows the number of provinces and cantons that host agglomerations by industry. We use two criteria for the agglomeration. One is 'conservative,' mentioned above, and another is 'wide,' defined as below:

1) LQ for the industry in the canton is more than 2 (instead of 3),
2) Number of employee in the industry in the canton is at least 50(instead of 100),
3) Number of firms for the industry in the canton is at least 5(instead of 10).

We can read a few characteristics for each industry from Table 4. First, a number of new agglomerations are detected by 'wide' criterion for Food products, Wearing apparels, Printing and reproduction of recorded media and Furniture industries. This

shows the agglomerations of these industries are relatively small and dispersed. On the other hand, the number of agglomerations doesn't change much for some industries, such as Textile, Chemicals and chemical products, Computer, electronics and optical products, electrical equipment and Motor vehicles, trailers and semi-trailers. For these industries, the agglomerations seem to concentrate in a small number of places, regardless of the agglomeration criteria.

Table 4: The number of Provinces and Cantons that host agglomerations by industry (2012)

Industy	ISIC	Consevative		Wide	
		# of Prov.	# of Cant.	# of Prov.	# of Cant.
Food products	10	0	0	5	7
Beverages	11	0	0	0	0
Tobacco products	12	0	0	0	0
Textiles	13	1	1	1	1
Wearing apparel	14	3	4	4	9
Leather and related products	15	0	0	1	1
Wood and of products of wood and cork, except furniture	16	1	2	3	4
Paper and paper products	17	0	0	0	0
Printing and reproduction of recorded media	18	1	2	1	6
Coke and refined petroleum products	19	0	0	0	0

Chemicals and chemical products	20	1	1	2	2
Basic pharmaceutical products and pharmaceutical preparations	21	0	0	0	0
Rubber and plastics products	22	0	0	2	3
Other non-metallic mineral products	23	0	0	2	2
Basic metals	24	0	0	0	0
Fabricated metal products, except machinery and equipment	25	1	1	1	4
Computer, electronic and optical products	26	1	1	1	1
Electrical equipment	27	0	0	1	1
Machinery and equipment n.e.c.	28	0	0	0	0

Motor vehicles, trailers and semi-trailers	29	0	0	1	1
Other transport equipment	30	0	0	0	0
Furniture	31	2	4	2	7
Other manufacturing	32	1	1	1	1

3. Agglomeration and Productivity

There are various empirical studies on the productivity-enhancement effects of industrial agglomeration that rely on constructing firm-level production functions. Henderson et al (1995) show that in cities, some mature capital goods industries are subject to MAR (Marshall-Arrow-Romer) externalities - the knowledge spillover effect from the agglomeration of firms in the same industry - and that new high-tech industries are subject to both MAR and Jacobs externalities - the innovation-enhancement effect of the agglomeration of varieties of industries in a city.

In another study, Ciccone (2002) estimate the agglomeration effects in Europe at the NUTS 3[1] level and found that the elasticity of labor productivity to employment density in Europe is 4.5 percent, and that it is slightly lower than 5 percent for the United States.

Henderson (2003) also estimates the MAR and Jacobs externalities at a plant level, by estimating the following equation.

[1] NUTS (Nomenclature of Territorial Units for Statistics) is a standard nomenclature used to subdivide all of Europe into geographic subdivisions of countries for statistical purposes. Level 3 is the thirds level of disaggregation.

$$\ln y_k(t) = \alpha \ln X_k(t) + \sum_{s=0}^{2} \beta_s \ln E_j(t-s) + \delta(t) + f_{kj} - \varepsilon_{kj}(t)$$

where $y_k(t)$ is the output of plant *k* at time *t*, and $X_k(t)$ is the vector of inputs, i.e., capital, labour and materials, and $E_j(t-s)$ is the vector of agglomeration measures like total number of plants in the same industry in the same location. $\delta(t)$ and f_{kj} are the time fixed effects and plant location fixed effects dummies. $\varepsilon_{kj}(t)$ is the error term.

He found that MAR externalities are much stronger in high-tech industries than in machinery industries. He uses a Longitudinal Research Data (LRD) from the US Census of Bureau, which contains capital, labor and input material data, for more than 10,000 samples in five selected industries at a county level.

At this time, the Costa Rican data set does not contain enough of the detailed financial data required to estimate production functions at the firm level. The sort of data required includes information on sales and asset values. The dataset used in this paper contains more than 40,000 firms with locational data at the canton level. However, only 150 firms have the financial data necessary to estimate a production function, and of those, only 100 perform manufacturing activities. The sample size is not large enough to obtain statistically significant results, especially considering that the econometric specifications include quite a number of industry and location dummies.

There is another strand of agglomeration research that does not require detailed firm-level financial data. Rosenthal and Strange (2003) assume that if economies of agglomeration are present then newly established firms tend to establish themselves near existing agglomerations. The authors regress the number of new establishments($B_{j,t}$) per square mile and the number of the employee in new establishments($N_{j,t}$) on some agglomeration variables as following equations.

$$B_{j,t} = b_z y_{z,j,t-1} + \gamma_{m,b} + \epsilon_{b,t}$$
$$N_{j,t} = n_z y_{z,j,t-1} + \gamma_{m,n} + \epsilon_{n,t}$$

where y_z are zip-code specific location characteristics and γ_m are all the attribute common to a metropolitan area that affect productivity. ϵ is a error term.

y_z include the number of employment in other and own-industry within a certain concentric distance from the establishment and the Herfindahl index of employment by industry. γ_m are actually metropolitan-area fixed dummies. The data used was the Dun & Bradstreet Marketplace database, which covers more than 12 million establishment in the US. Other factors that affect the cost function and vary regionally are controlled using metropolitan area-specific fixed effects. The authors found that the agglomeration economies in the first mile are up to 10 to 1000 times stronger than that in the two to five mile ranges.

We have applied the Rosenthal and Strange (ibid) regression method on the current Costa Rican dataset, but the results are not stable. The coefficients vary significantly depending on the sample year. It would appear that the number of manufacturing firms in the Costa Rican business register is insufficient to capture statistically significant effects, since in total there are approximately 3000 manufacturing firms, 400 of which were newly established between 2009 and 2011. When these observations are subdivided into 81 cantons and 23 ISIC 2-digit manufacturing industries, 88% of the resulting 1863 canton-industry combinations contains no firms.

One can conclude that both lines of research could be promising in the case of Costa Rica if additional data could be obtained. In order to apply methods that rely on firm-level production functions, detailed financial data would need to be added to the 3000 manufacturing firms in the current database. In order to increase the possibility of observing agglomeration effects using the Rosenthal and Strange regression method, since the data used is already a census, a longer time series would be required.

4. Conclusion

Industrial agglomeration is an important topic in the study of economic development. In this paper, we analyzed the current situation of the distribution of industries in Costa Rica and tried to identify the location of industrial agglomerations, by the firm level

dataset between 2008-2012. We identified 14 cantons have the industrial agglomerations for 9 industries.

We can summarize the ways in which the descriptive analysis is in line with the nature of specific industries, the development of areas of concentration around free zones, and the evolving participation of Costa Rica in GVCs.

An attempt try to detect the productivity-enhancement effects of industrial agglomeration in Costa Rica at firm level using two methods, suggest that there are promising avenues for future research if the dataset could be enhanced with more firm level financial data and a longer time series.

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Appendix 1: Geopolitical categorization

Province	Canton	Number of districts
San José		121
	San José	11
	Escazú	3
	Desamparados	13
	Puriscal	9
	Tarrazú	3
	Aserrí	7
	Mora	6
	Goicoechea	7
	Santa Ana	6
	Alajuelita	5
	Vázquez de Coronad	5
	Acosta	5
	Tibas	5
	Moravia	3
	Montes de Oca	4
	Turrubares	5
	Dota	3
	Curridabat	4
	Pérez Zeledón	11
	León Cortés	6
Alajuela		111
	Alajuela	14
	San Ramón	13
	Grecia	8
	San Mateo	3
	Atenas	8
	Naranjo	8

	Palmares	7
	Poás	5
	Orotina	5
	San Carlos	13
	Alfaro Ruíz	7
	Valverde Vega	5
	Upala	7
	Los Chiles	4
	Guatuso	4
Cartago		51
	Cartago	11
	Paraiso	5
	La Unión	8
	Jiménez	3
	Turrialba	12
	Alvarado	3
	Oreamuno	5
	El Guarco	4
Heredia		47
	Heredia	5
	Barva	6
	Santo Domingo	8
	Santa Bárbara	6
	San Rafael	5
	San Isidro	4
	Belén	3
	Flores	3
	San Pablo	2
	Sarapiqui	5
Guanacaste		59
	Liberia	5

	Nicoya	7
	Santa Cruz	9
	Bagaces	4
	Carrillo	4
	Cañas	5
	Abangares	4
	Tilarán	7
	Nandayure	6
	La Cruz	4
	Hojancha	4
Puntarenas		57
	Puntarenas	16
	Esparza	5
	Buenos Aires	9
	Montes de Oro	3
	Osa	5
	Aguirre	3
	Golfito	4
	Coto Brus	5
	Parrita	1
	Corredores	4
	Garabito	2
Limón		28
	Limón	4
	Pococi	6
	Siquirres	6
	Talamanca	4
	Matina	3
	Guácimo	5
Total		474

Appendix 2: ISIC Rev 4 industry categories

Table A1: ISIC Rev.4 (Manufacturing)

ISIC	Economic Activities
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastics products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair and installation of machinery and equipment

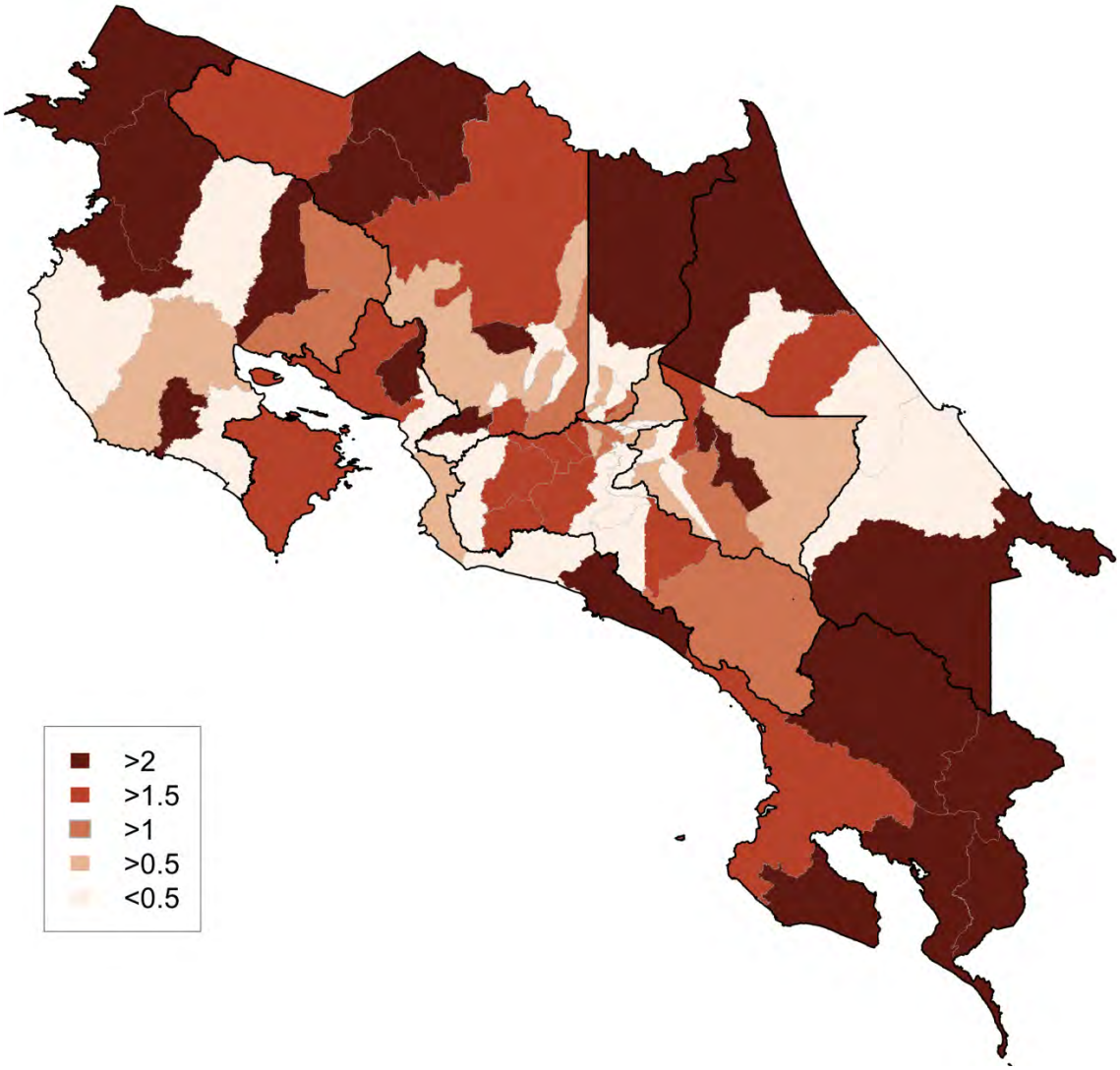
Source: United Nations Statistics Division (https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27).

Appendix 3: Industry level graphs by Location Quotient

Figures 3 to 24 show the LQ by industry and canton. If LQ for a canton is larger than one, then the canton is specialized in that industry more than national average, and colored darker.

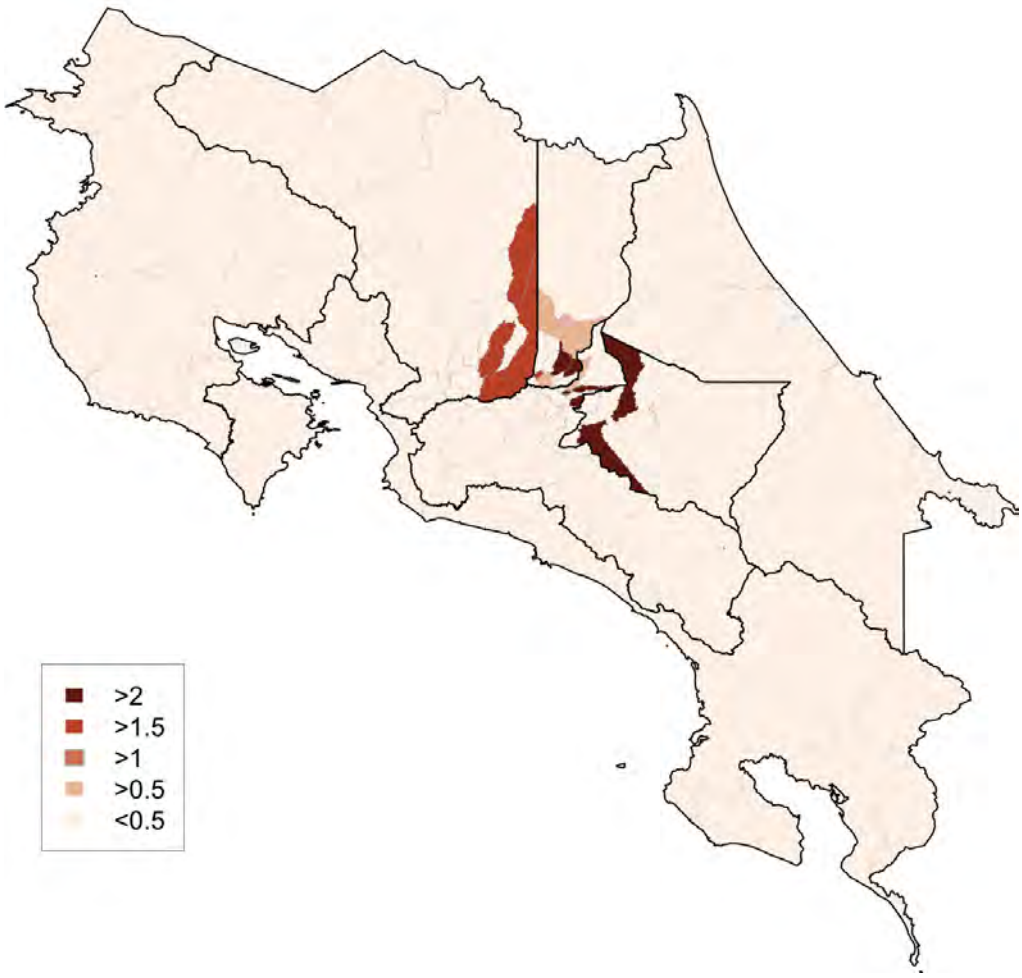
Manufacturing of food products (ISIC10) is dispersed widely all over the country. There is no one outstanding canton specialized in this industry, and the cantons with highest LQ are San Mateo (3.10) in Alajuela, La Cruz (3.10) and Hojancha (3.10) in Guanacaste, and Buenos Aires (3.10) in Puntarenas.

Figure 3: Location Quotient for Manufacturing of Food Products (2012)



Manufacturing of beverages (ISIC11) is concentrated in three provinces: San José, Cartago and Heredia. The canton with highest LQ is Goicoechea (20.01) in San José; El Guarco (2.97) and Oreamuno (2.56) in Cartago; Curridabat (2.52) in San José; and San Isidro (2.43) and San Rafael (2.19) in Heredia.

Figure 4: Location Quotient for Manufacturing of Beverages (2012)

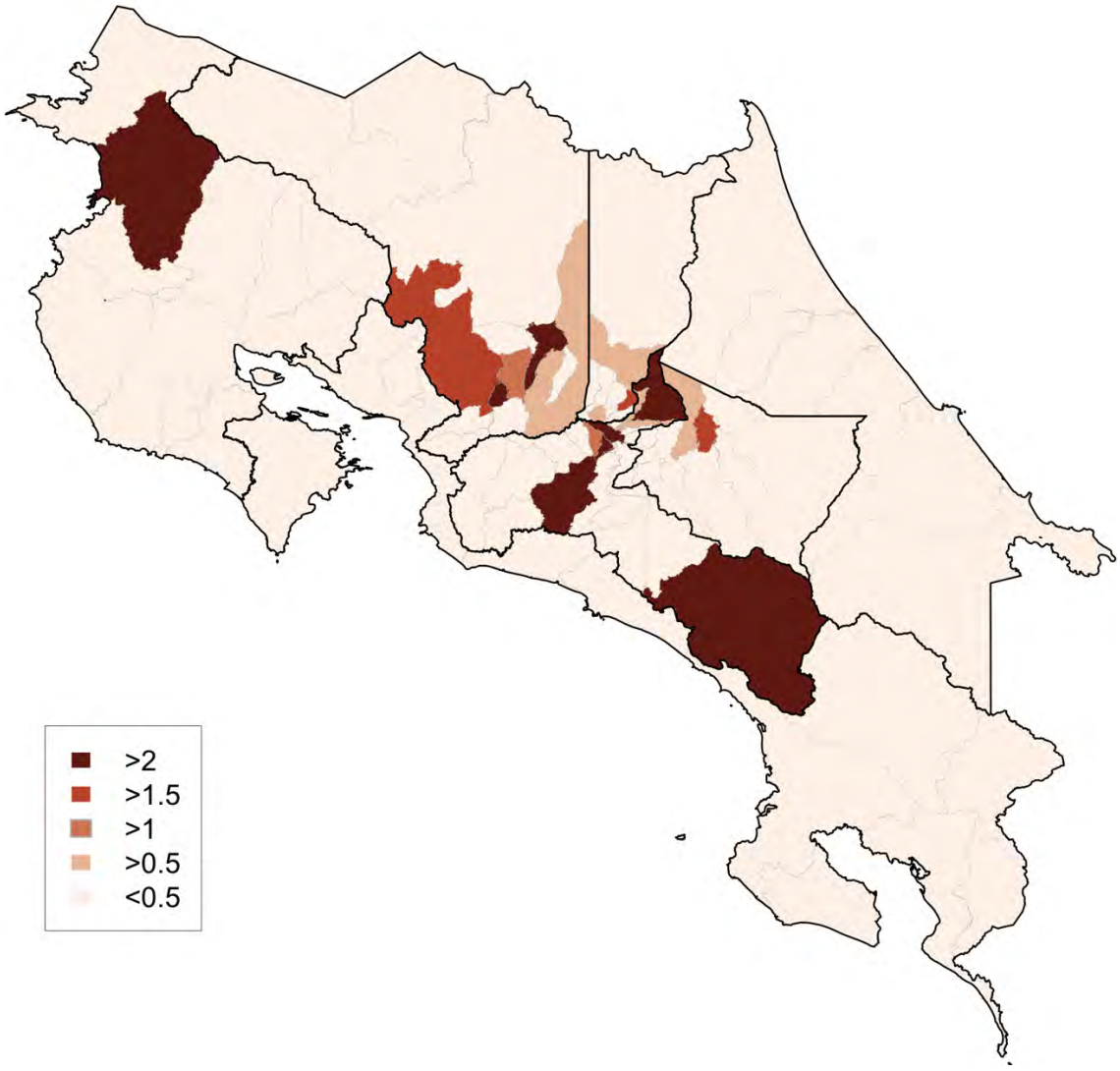


Manufacturing of tobacco products (ISIC12) is highly concentrated and there are only three cantons specialized in tobacco production. One is Belén, Heredia (8.96) and the other is Puriscal (8.75), both in San José Province.

Figure 5: Location Quotient For Manufacturing of Tobacco Products (2012)

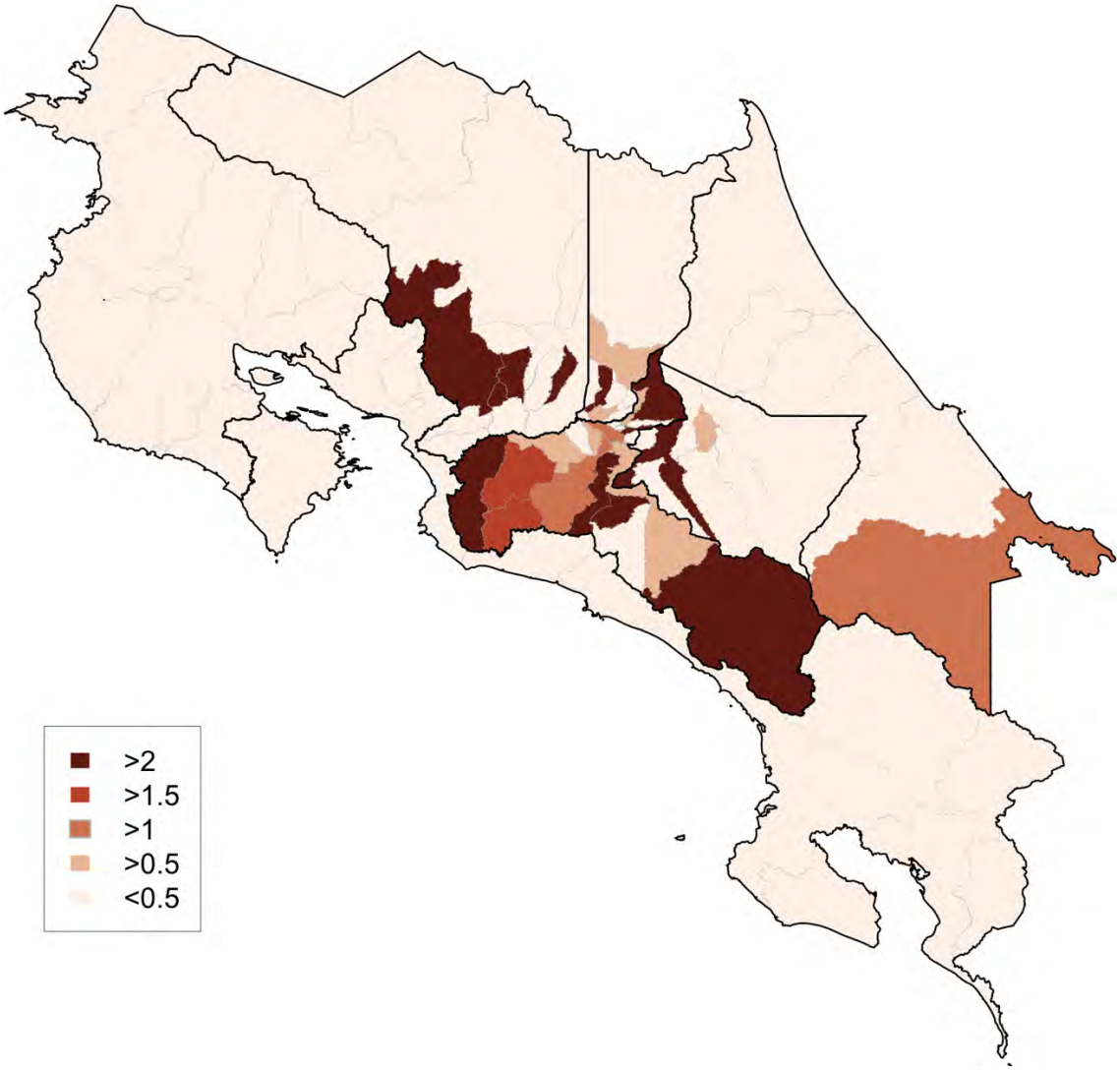
Manufacturing of textiles (ISIC13) is mildly dispersed and the agglomerations are observed in 5 out of 7 provinces. The canton with highest LQ is an Acosta (14.31), and Alajuelita (5.56),Vázquez de Coronado (5.12), and San José (4.29), all in San José Province follow.

Figure 6: Location Quotient for Manufacturing of Textiles (2012)



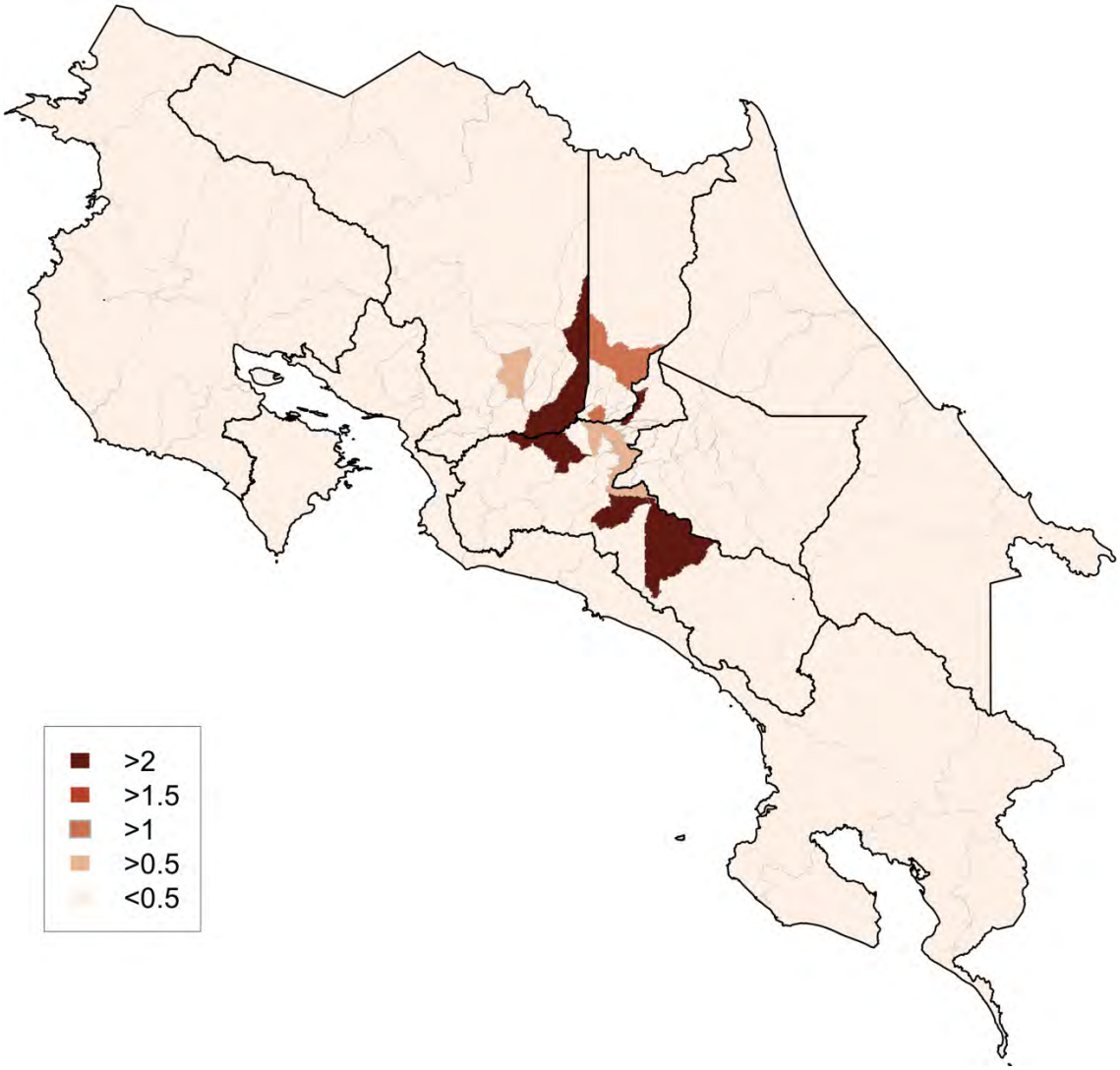
Manufacturing of wearing apparel (ISIC14) is mildly dispersed and the agglomerations are observed in 5 out of 7 provinces. Two cantons with highest LQ are Turrubares (14.87) and Aserrí (13.19) in San José, then Naranjo (8.04) and Poás (7.78) in Alajuela.

Figure 7: Location Quotient for Manufacturing of Wearing Apparel (2012)



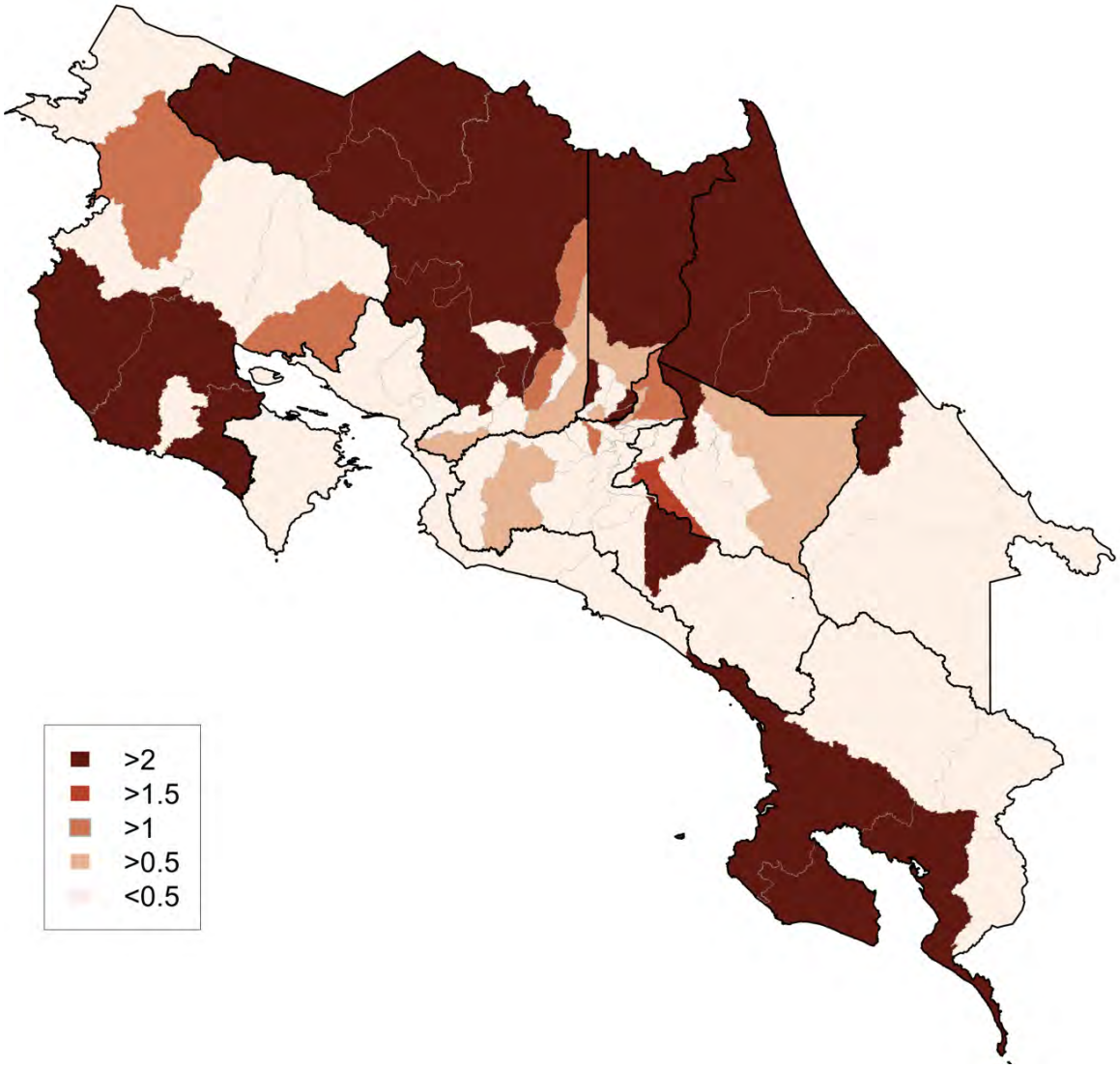
Manufacturing of leather and related products (ISIC15) is concentrated is three provinces: San José, Alajuela and Cartago. The canton with the highest LQ is León Cortés (37.68) in San José, and Mora (7.85) and Dota (6.03) in San José and Alajuela (4.17) in Alajuelaare also specialized in this industry.

Figure 8: Location Quotient for Manufacturing of Leather and Related Products (2012)



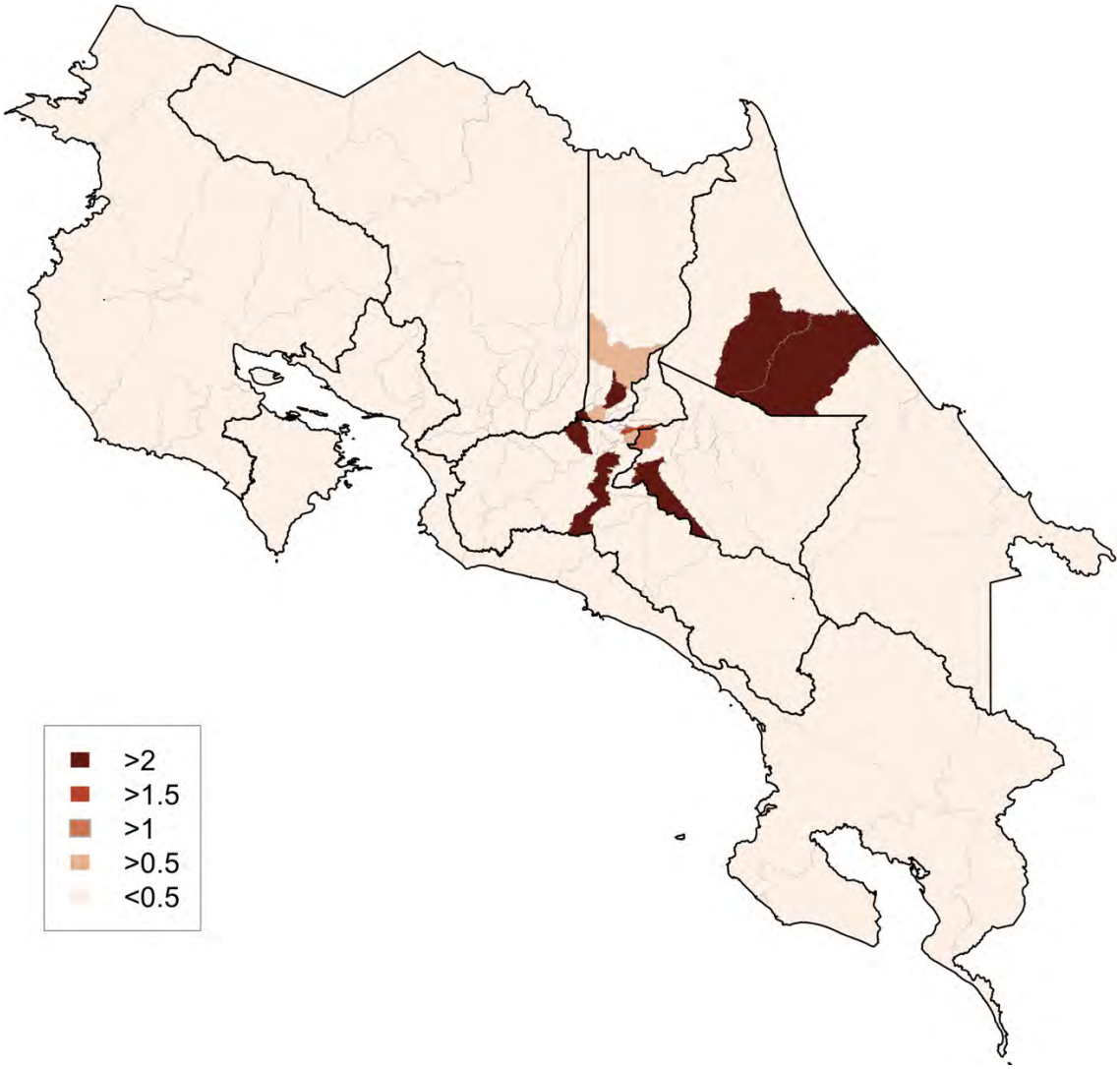
Manufacturing of wood and wood products (ISIC16) is dispersed throughout the country, but some cantons are highly specialized in the industry. Two cantons with the highest LQ are Nandayure (48.89) in Guanacaste and Matina (48.31) in Limón. Santa Bárbara (24.56) in Heredia and Upala (24.16) in Alajuela follow.

Figure 9: Location Quotient for Manufacturing of Wood and Wood Products (2012)



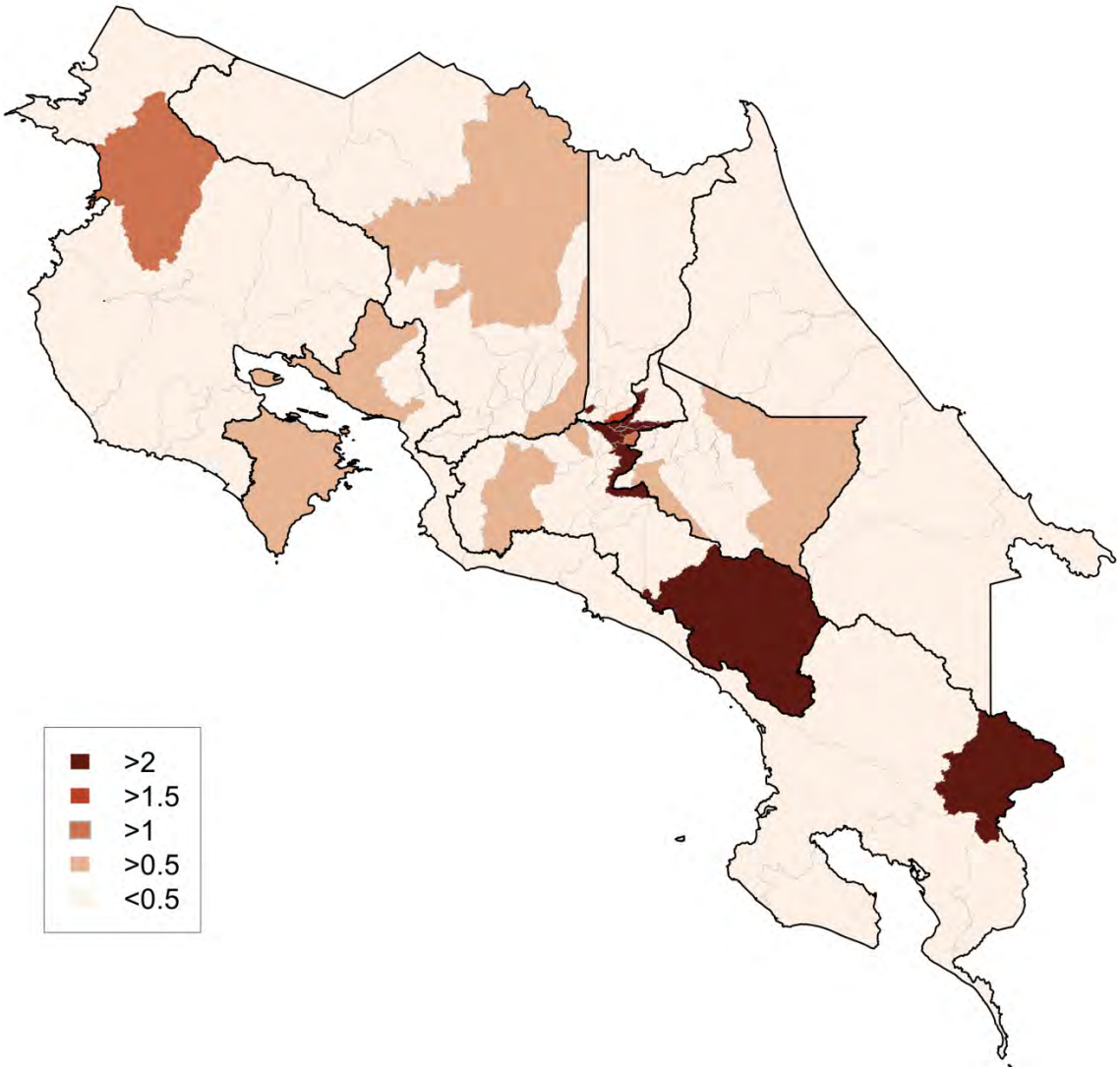
Manufacturing of paper and paper products (ISIC17) is agglomerated in a small number of cantons. The two cantons with the highest LQ are Guácimo (24.26) and Siquirres (11.14), both in Limón, followed bu San Rafael (7.47) and Belén (5.15), both in Heredia.

Figure 10: Location Quotient for Manufacturing of Paper and Paper Products (2012)



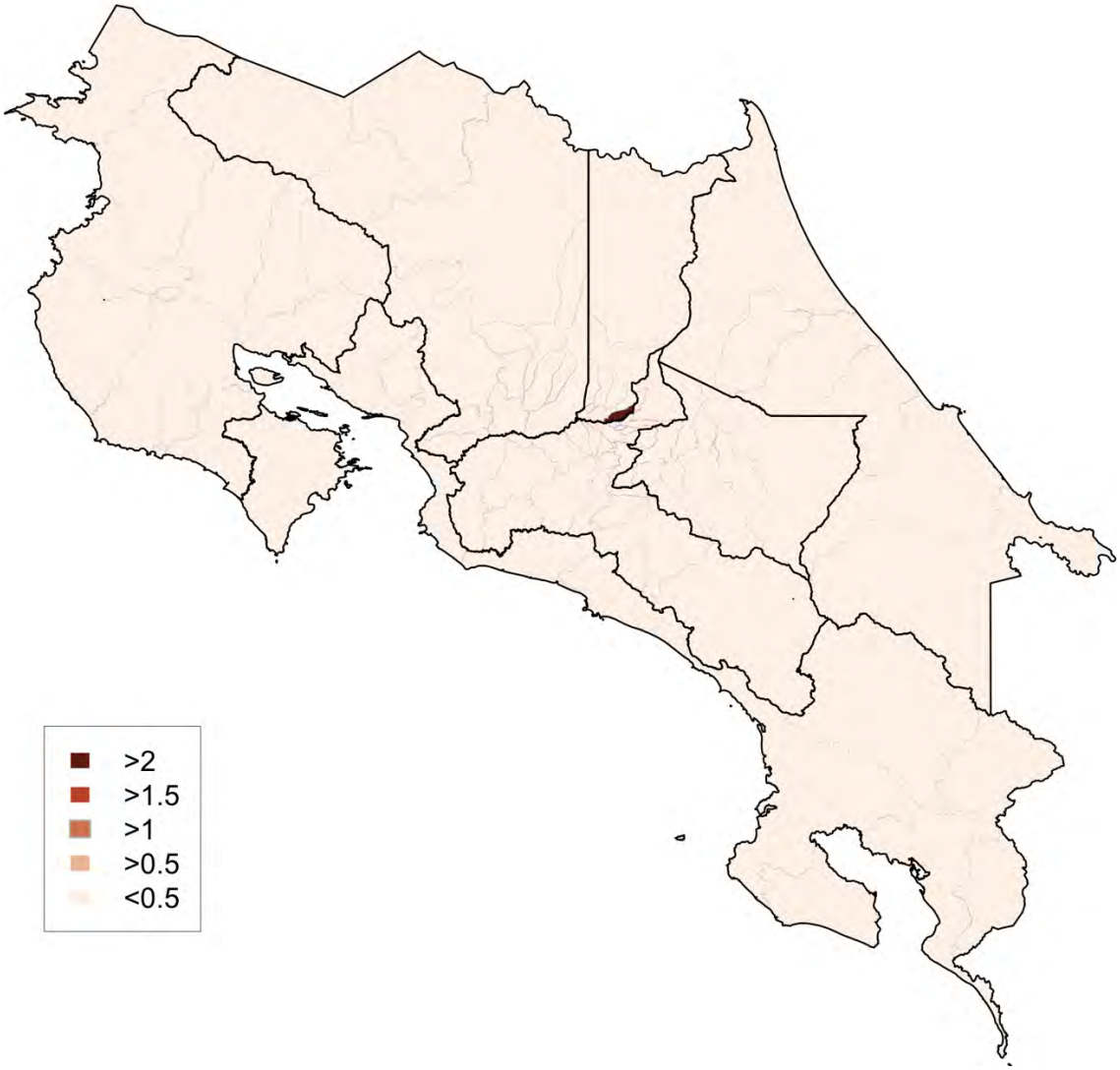
Printing and reproduction of recorded media (ISIC18) is agglomerated in Moravia (8.83) and Tibas (8.17) in San José, and Flores (7.08) in Heredia is also specialized in the industry.

Figure 11: Location Quotient for Printing and Reproduction of Recorded Media (2012)



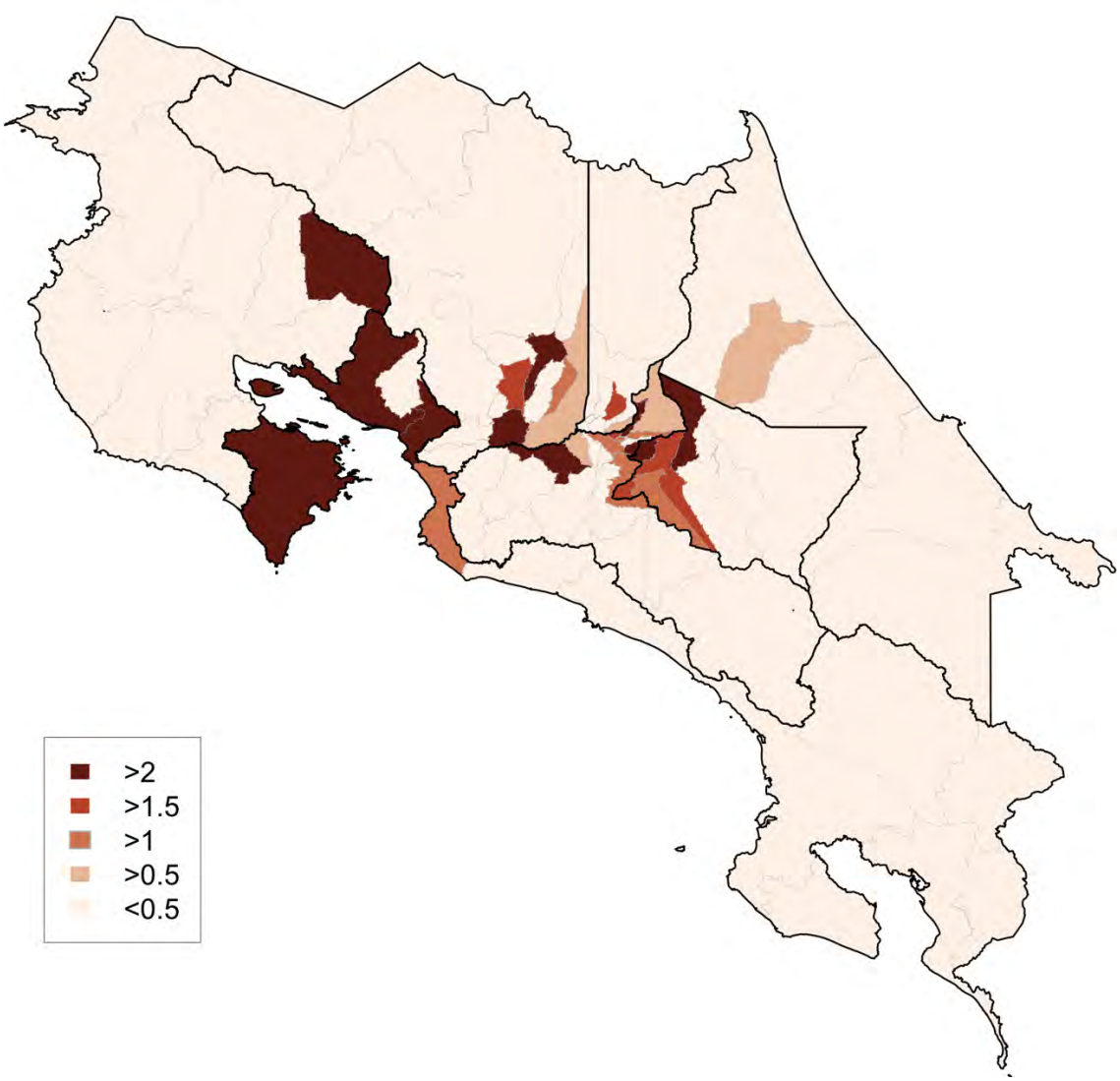
Manufacturing of coke and refined petroleum products (ISIC19) is only located in Santo Domingo, Heredia.

Figure 12: Location Quotient for Manufacturing of Coke and Refined Petroleum Products (2012)



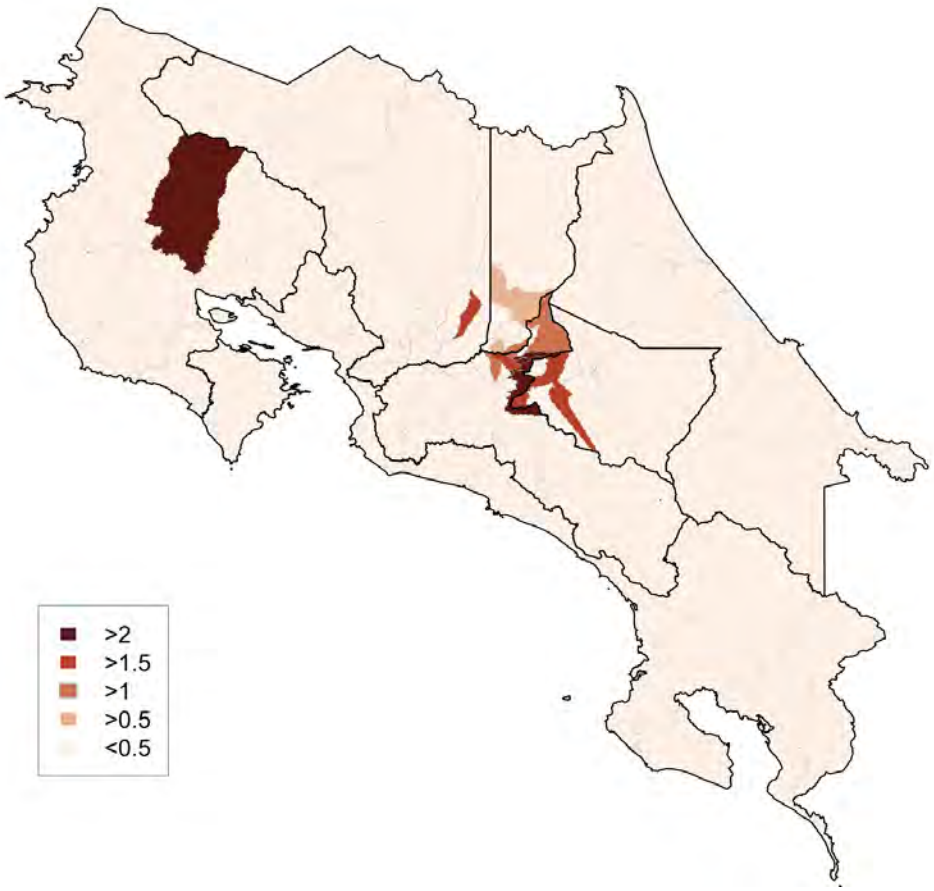
Manufacturing of chemical and chemical products (ISIC20) is concentrated in a small number of cantons. The canton with the highest LQ is La Unión (16.52) in Cartago , followed by Tilarán (11.40) in Guanacaste, Puntarenas (9.43) in Puntarenas, Oreamuno (6.27) in Cartago, and Atenas (5.85) in Alajuela.

Figure 13: Location Quotient for Manufacturing of Chemical and Chemical Products (2012)



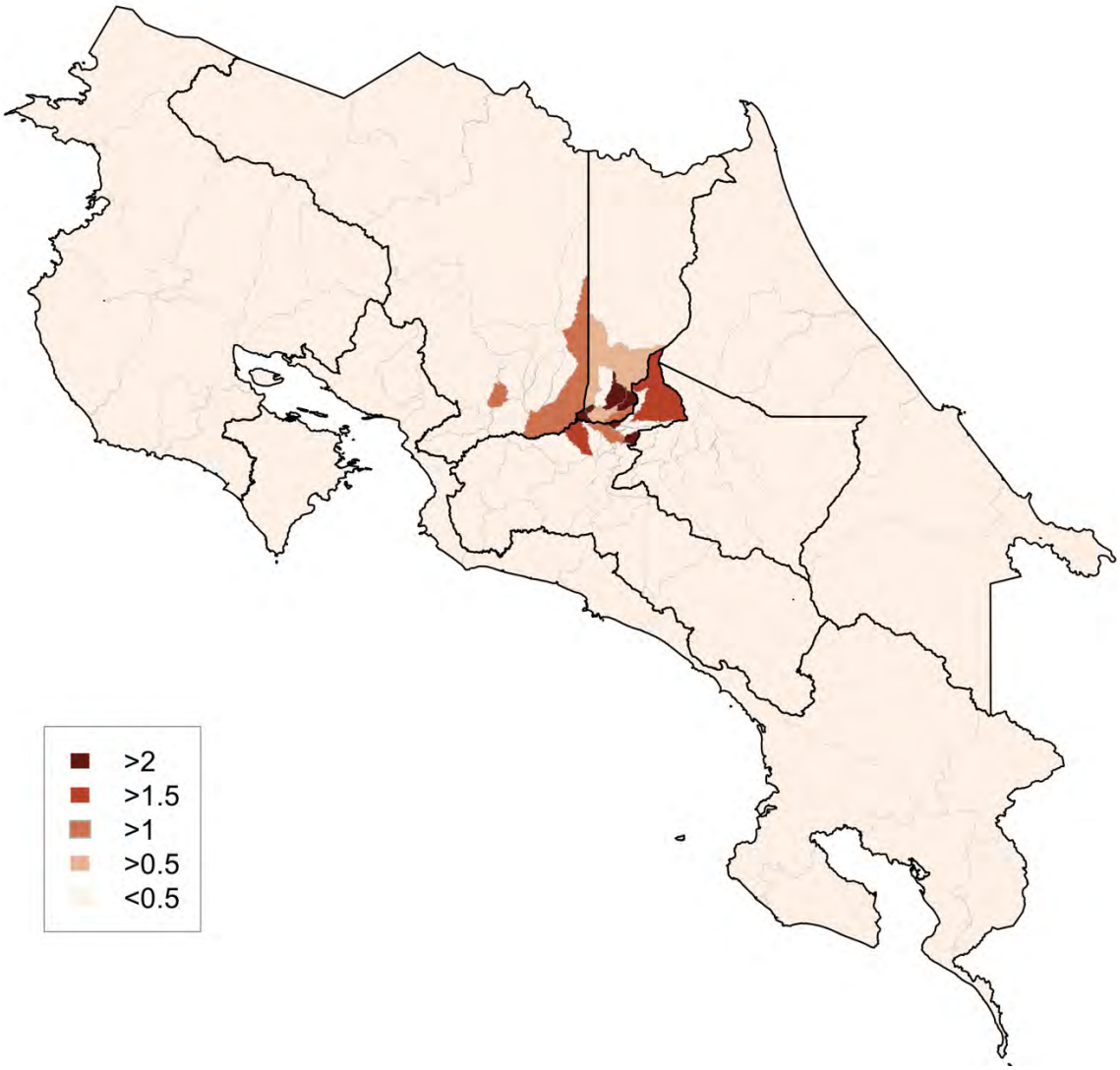
Manufacturing of pharmaceutical products (ISIC21) is concentrated in a small number of cantons. The canton with the highest LQ is Bagaces (32.16) in Guanacaste, followed by Montes de Oca, Goicoechea and Desamparados in San José.

Figure 14: Location Quotient for Manufacturing of Pharmaceutical Products (2012)



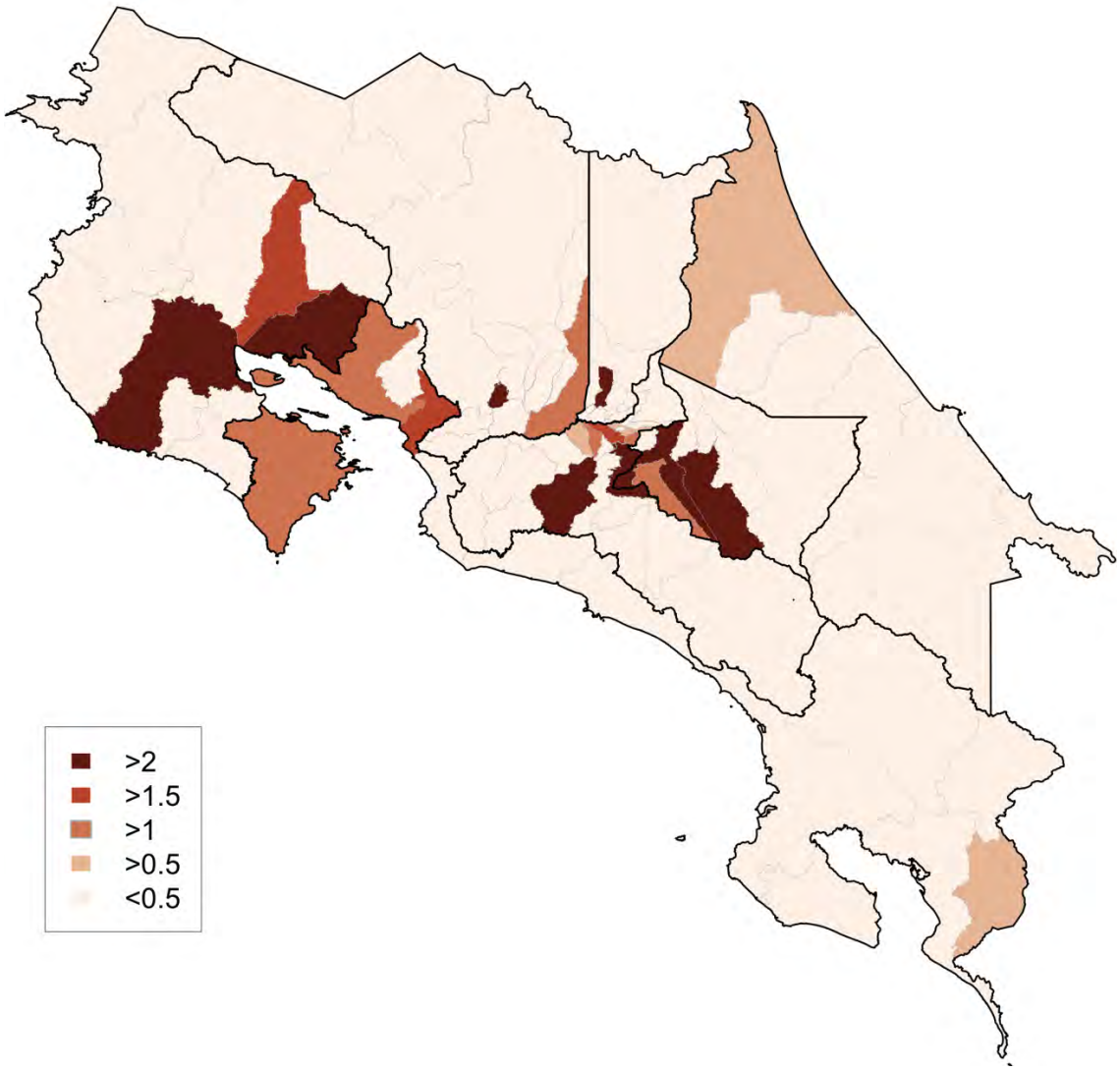
Manufacturing of rubber and plastic products (ISIC22) are highly concentrated in the central area of the country. The canton with the highest LQ is Tibás (6.66) in San José , followed by San Isidro (6.03), Flores (5.98) and San Rafael (4.89) in Heredia.

Figure 15: Location Quotient for Manufacturing of Rubber and Plastic Products (2012)



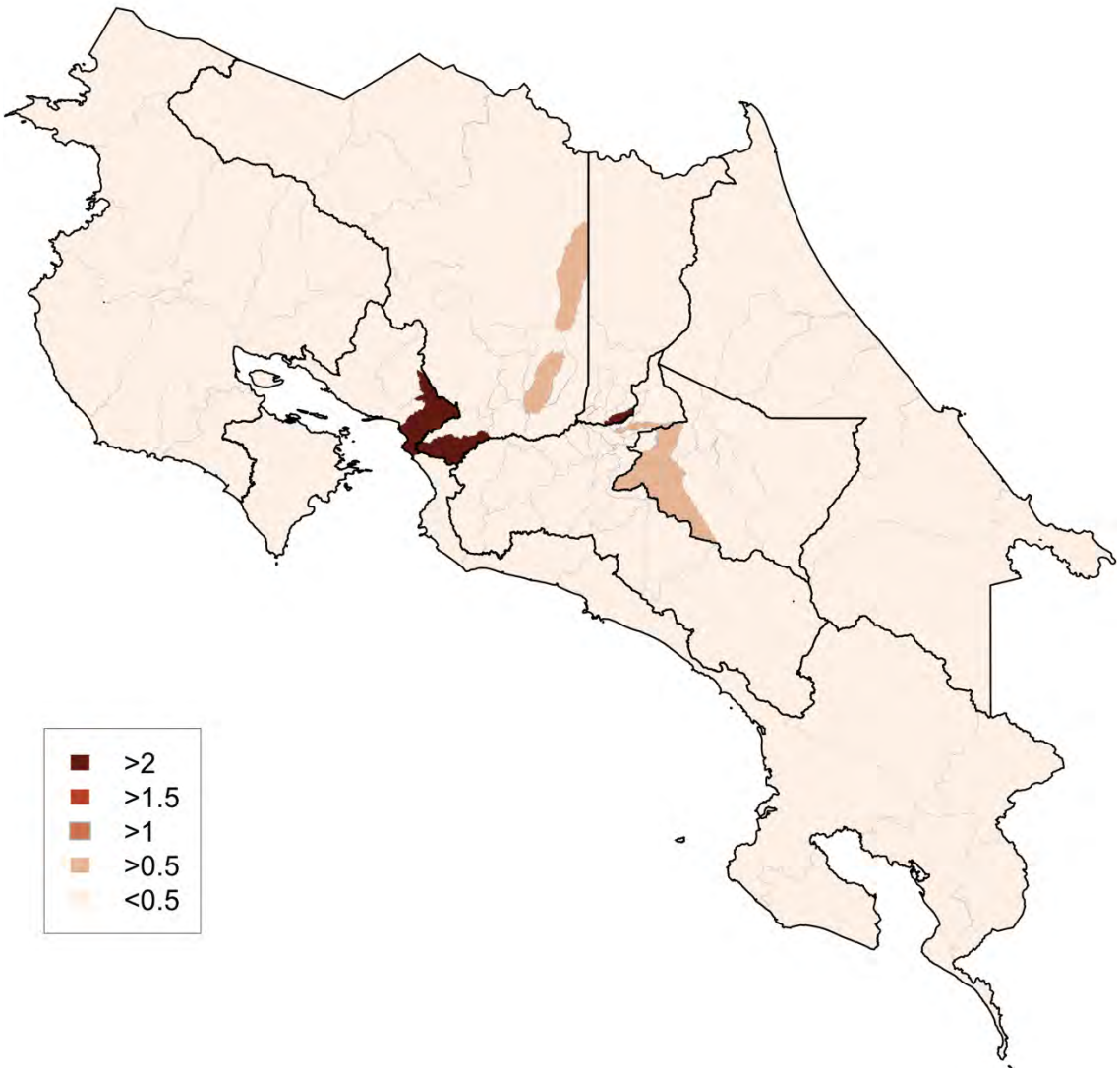
Manufacturing of other non-metallic mineral products (ISIC23) seems to be agglomerated in two areas: the central region of the country and the southern part of Guanacaste. The canton with the highest LQ is Abangares (15.50) in Guanacaste, followed by Nicoya (9.76) in Guanacaste, Paraiso (9.61) in Cartago and Barva (5.16) in Heredia.

Figure 16: Location Quotient for Manufacturing of Other Non-metallic Mineral Products (2012)



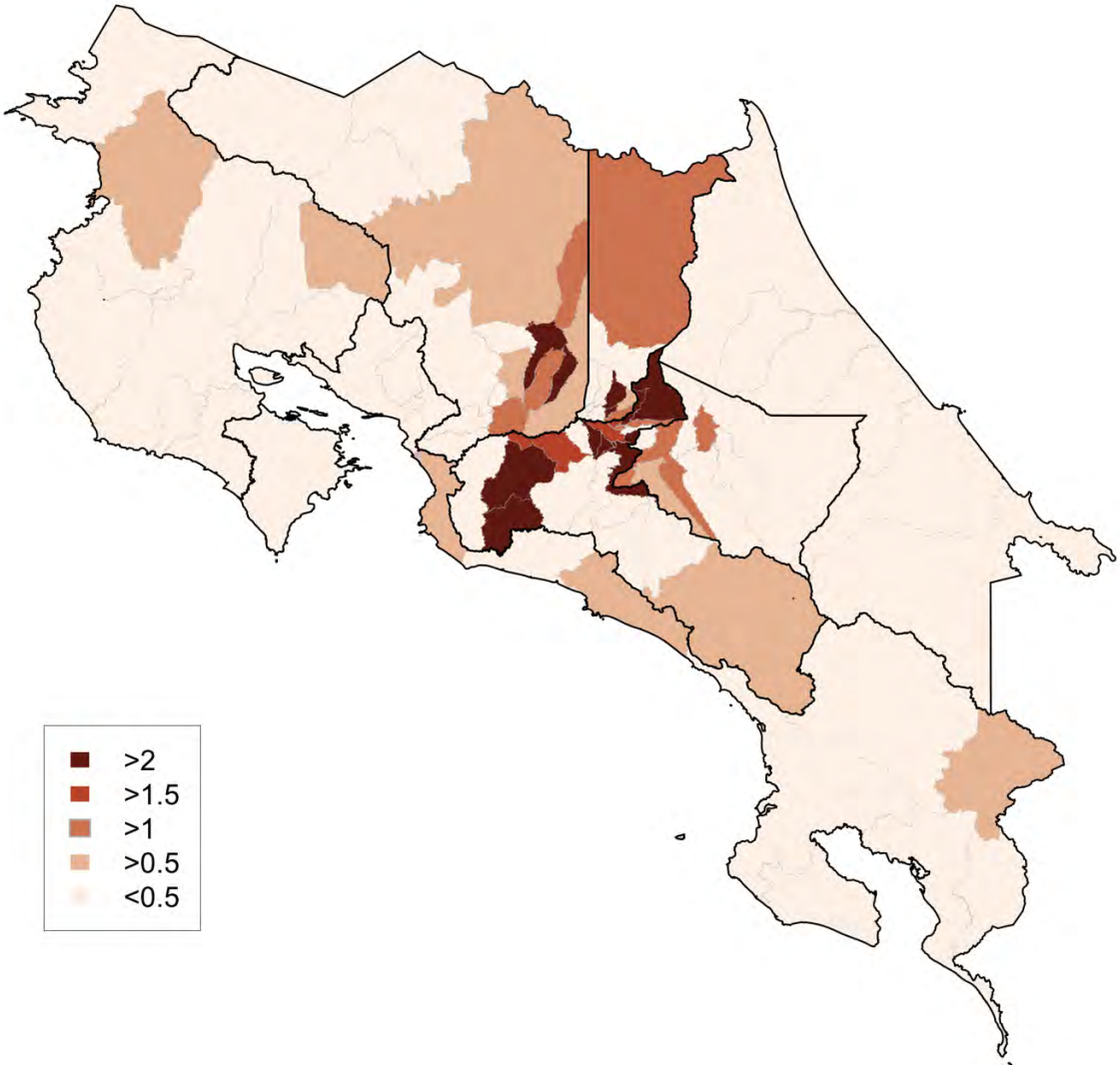
Manufacturing of basic metals (ISIC24) is highly concentrated in a small number of cantons. The cantons with the very high LQ are Orotina (95.28) in Alajuela, Esparza (76.64) in Puntarenas and Santo Domingo (17.22) in Heredia.

Figure 17: Location Quotient for Manufacturing of basic metals (2012)



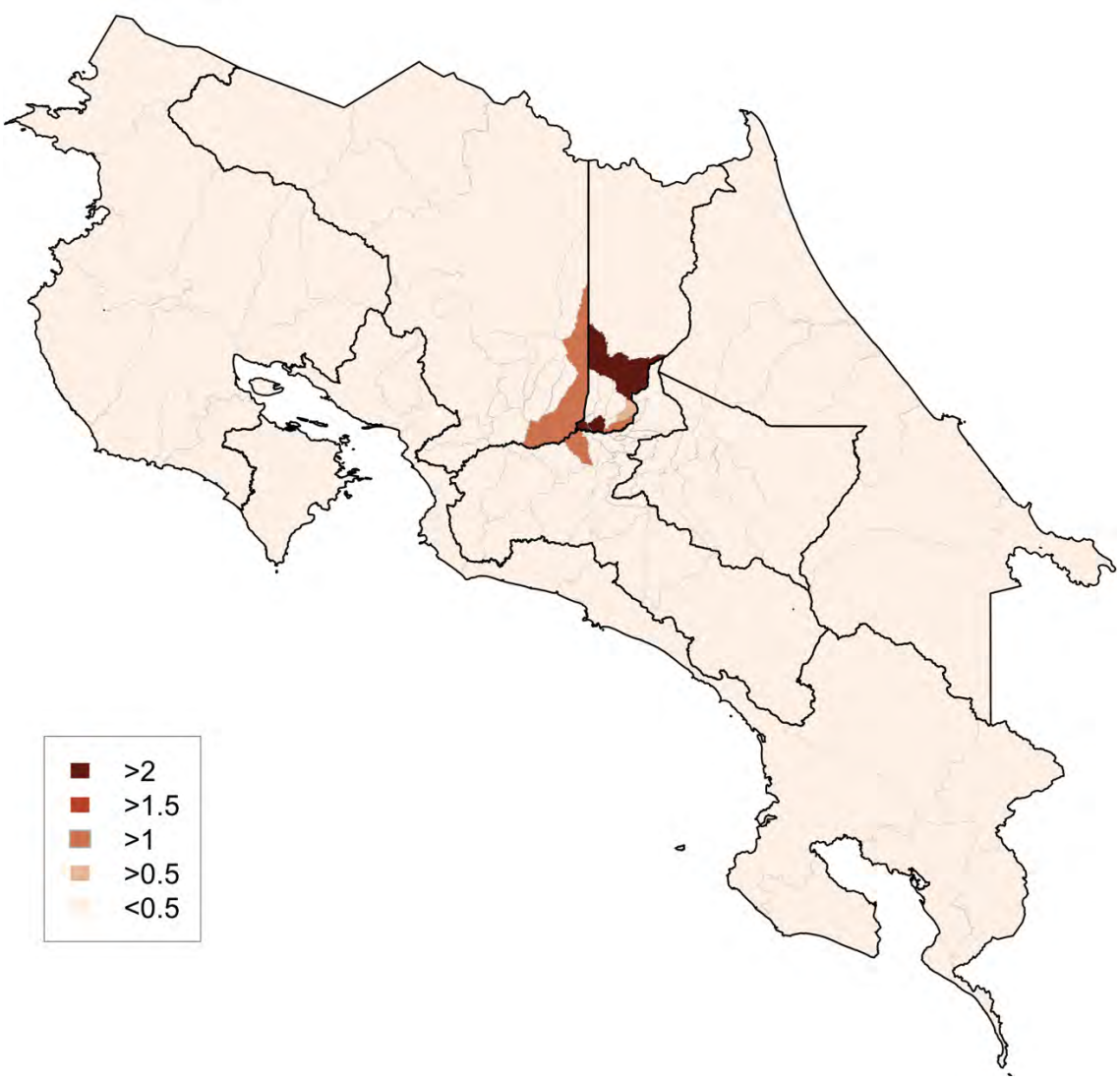
Manufacturing of fabricated metal product (ISIC25) is relatively concentrated in the central region of the country. The canton with the highest LQ is Alajuelita (7.77) in San José, followed by Escazú (7.46) in San José, San Pablo (6.79) in Heredia and Desamparados (6.56) in San José.

Figure 18: Location Quotient for Manufacturing of Fabricated Metal Products (2012)



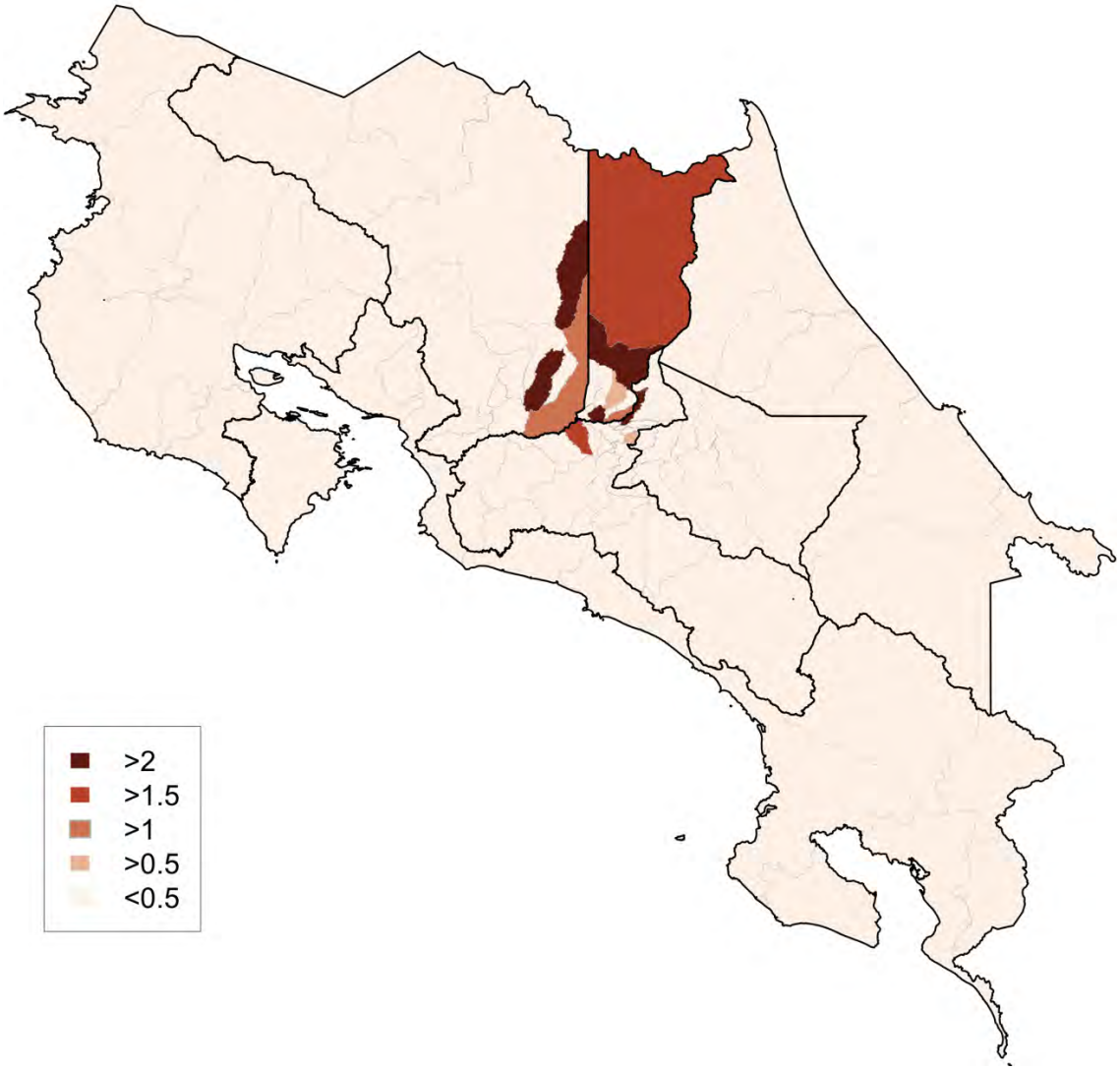
Manufacturing of computer, electronics and optical products (ISIC26) is highly concentrated in Heredia. Two cantons with highest LQ are Heredia (3.54) and Belén (3.15) in Heredia.

Figure 19: Location Quotient for Manufacturing of Computer, Electronics and Optical Products (2012)



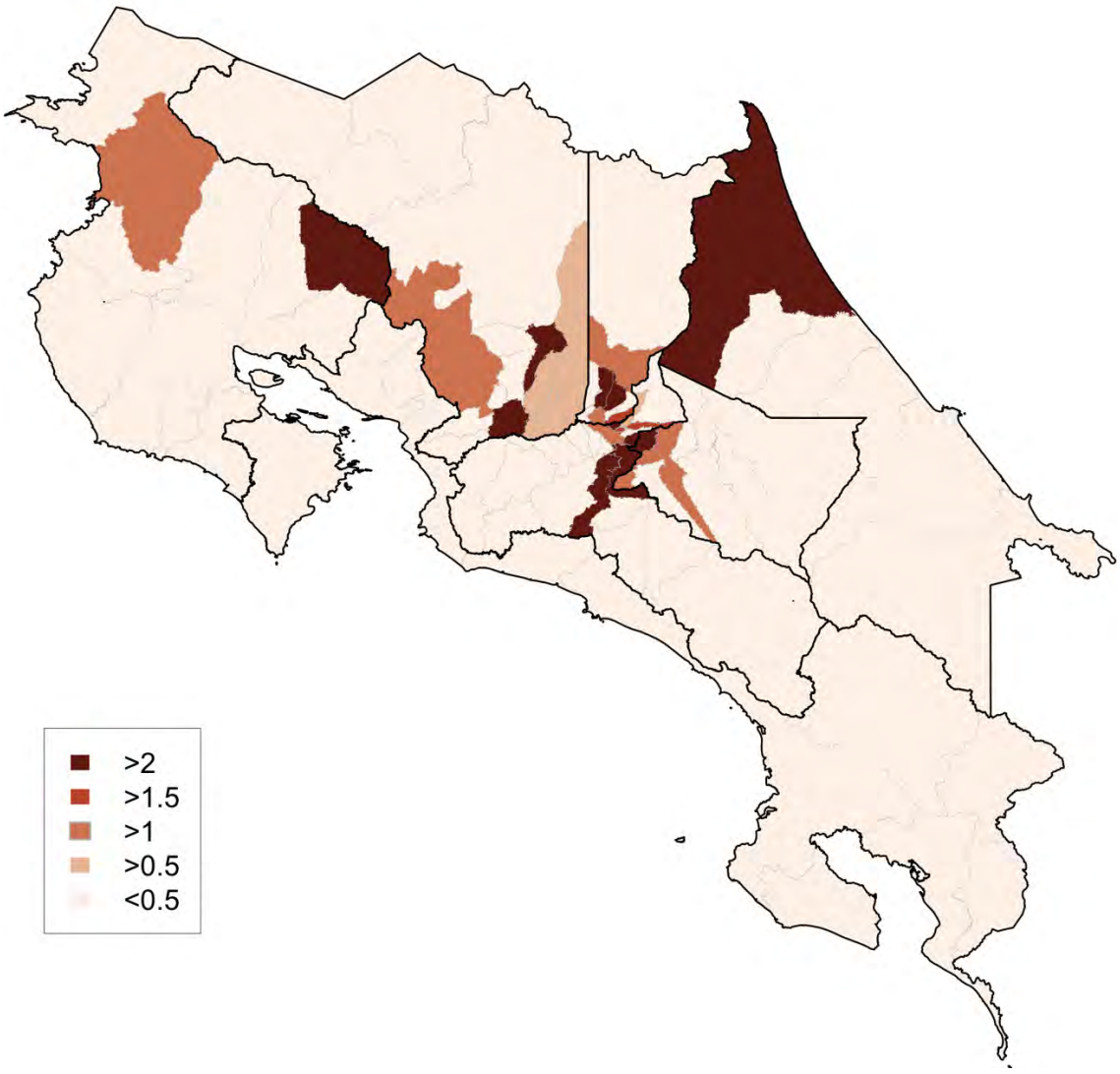
Manufacturing of electrical equipment (ISIC27) is highly concentrated in three provinces. Alajuela, Heredia and San José. The canton with the highest LQ is Grecia (23.88) in Alajuela Province, followed by Moravia (5.80) in San José Province and Heredia (2.32) in Heredia Province.

Figure 20: Location Quotient for Manufacturing of Electrical Equipment (2012)



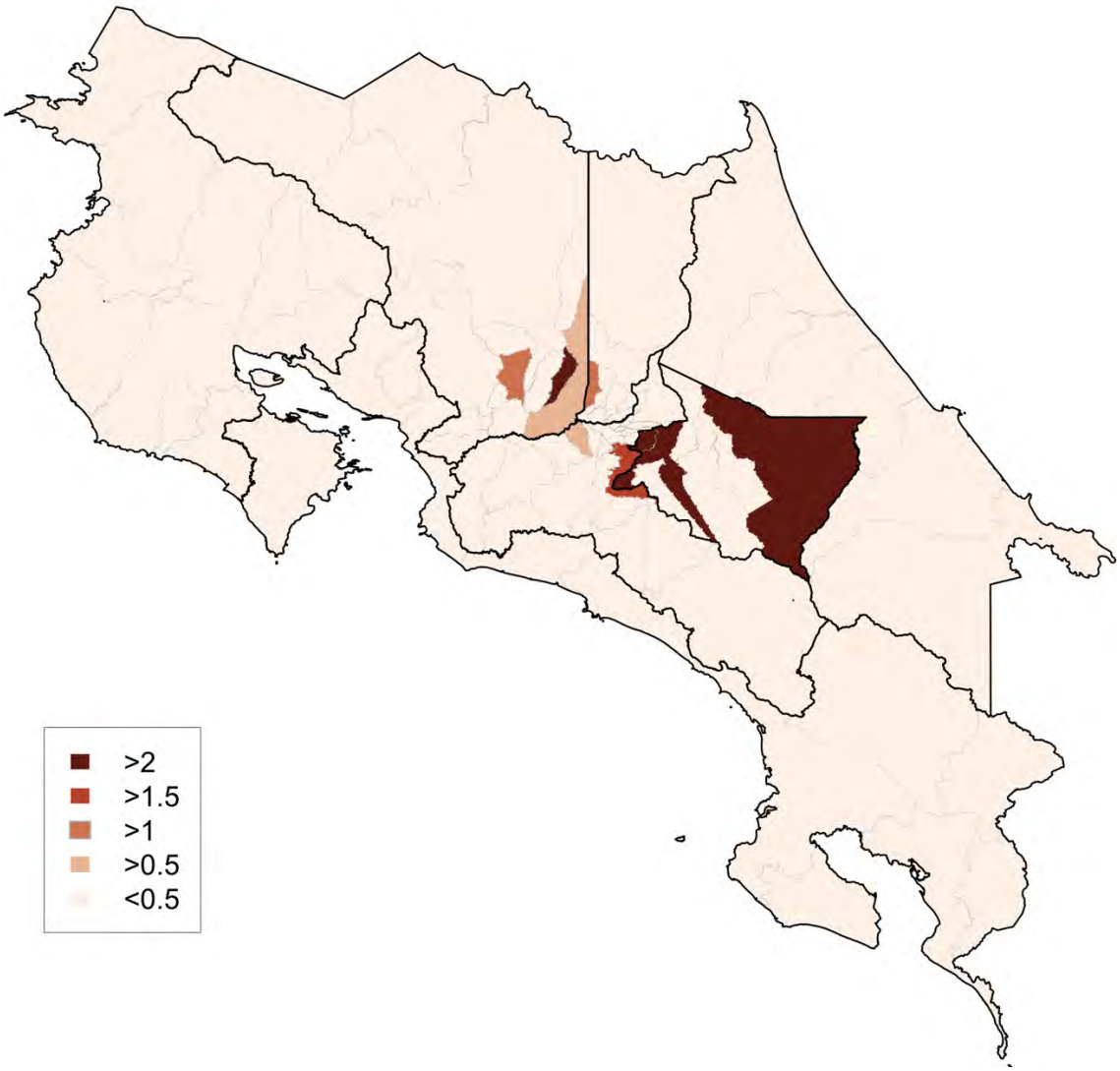
Manufacturing of machinery and equipment, n.e.c.(ISIC28) is relatively dispersed. The canton with the highest LQ is Atenas (15.43) in Alajuela, followed by Tilarán (12.54) in Guanacaste, San Rafael (8.15) in Heredia Province and Desamparados (7.10) in San José.

Figure 21: Location Quotient for Manufacturing of Machinery and Equipment, n.e.c. (2012)



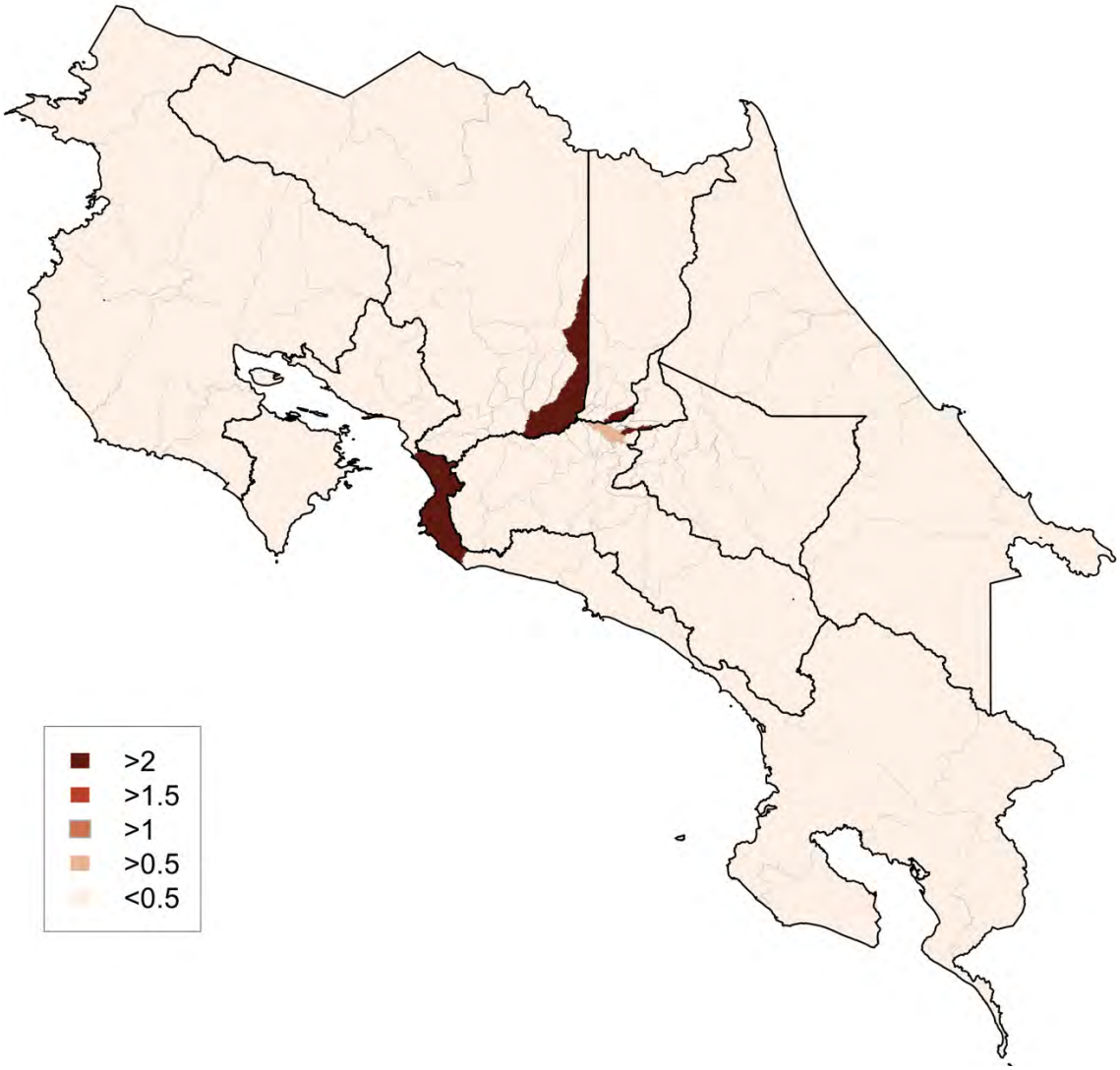
Manufacturing of motor vehicles (ISIC29) is concentrated in a small number of cantons. The canton with the highest LQ is Atenas (15.43) in Alajuela, followed by Tilarán (12.54) in Guanacaste and San Rafael (8.15) in Heredia.

Figure 22: Location Quotient for Manufacturing of Motor Vehicles (2012)



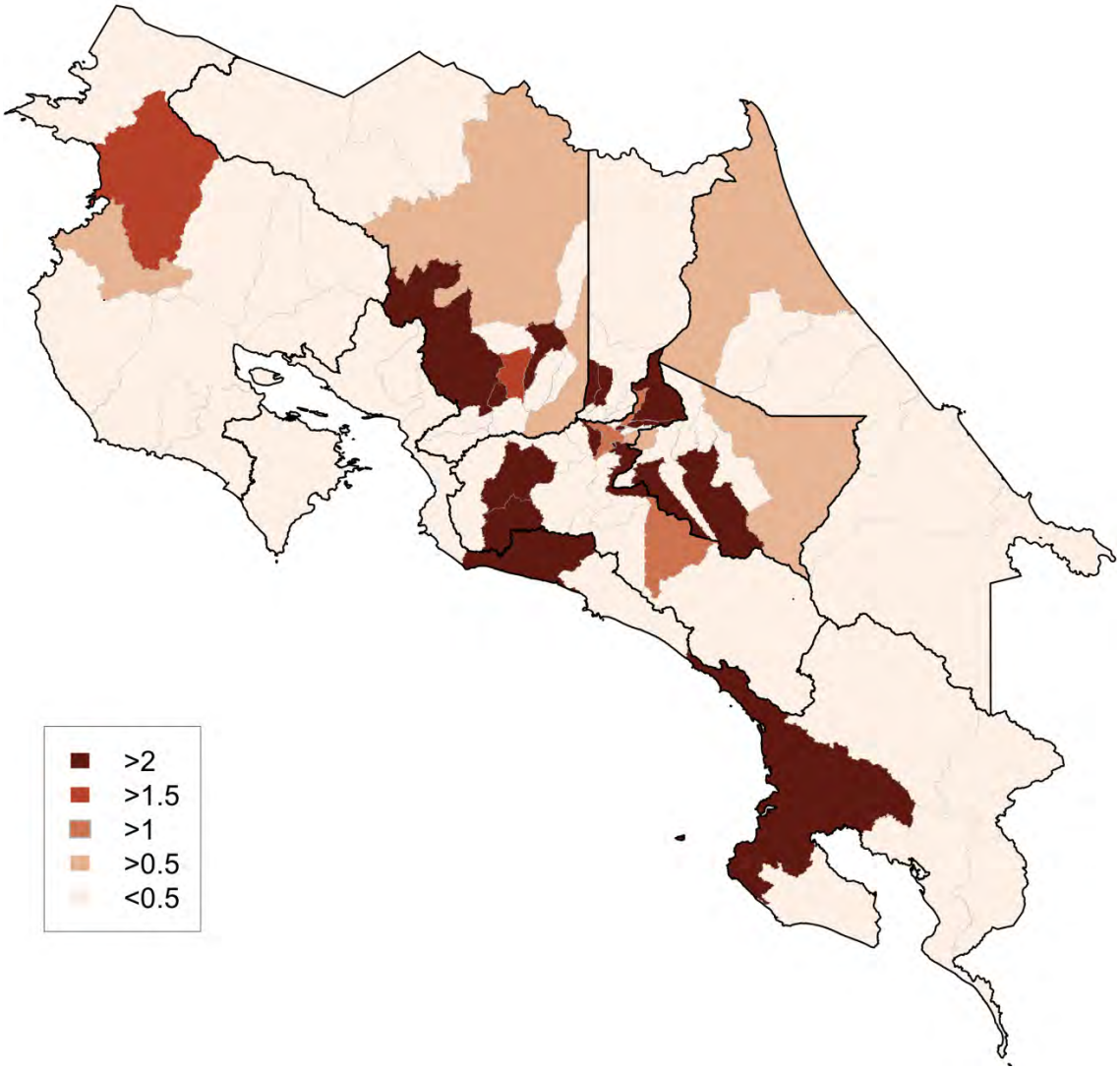
Manufacturing of other transport equipment (ISIC30) is located in few cantons. The canton with the highest LQ is Garabito (179.41) in Puntarenas, followed by Montes de Oca (15.05) in San José.

Figure 23: Location Quotient for Manufacturing of Other Transport Equipment (2012)



Manufacturing of furniture (ISIC31) is dispersed across several provinces. The canton with the highest LQ is Parrita (30.35) in Puntarenas, followed by Valverde Vega (14.86) and Palmares (12.34) in Alajuela, and Barva (9.07) and Santa Bárbara (7.40) in Heredia.

Figure 24: Location Quotient for Manufacturing of Furniture (2012)



Appendix 4: Theil index for whole observations and exporters

Table A2[2]: Theil index for whole observations and exporters

	Whole			Exporter		
	Theil	Within	Between	Theil	Within	Between
2008	1.72	1.62	0.10	0.94	0.90	0.05
		94%	6%		95%	5%
2009	1.71	1.61	0.10	0.89	0.86	0.03
		94%	6%		96%	4%
2010	1.81	1.70	0.11	1.11	1.03	0.08
		94%	6%		93%	7%
2011	1.84	1.75	0.09	1.16	1.11	0.05
		95%	5%		96%	4%
2012	1.95	1.85	0.10	1.25	1.16	0.08
		95%	5%		93%	7%
2012/2008	1.1	1.1	1.0	1.3	1.3	1.8

[2] Table A2 shows Theil index calculated using the whole observations and exporters. The table indicates exporters are not concentrated geographically compared to that for the whole data but tend to be concentrated more recently. The index for both whole data and exporters are explained mostly (around 93-96%) by the intra-provincial Theil index. Table A3 illustrates the change in Theil index between 2008 and 2012 for exporters by industrial category. ISIC 13 (textile), 14 (apparel), 22 (rubber/plastic), 26 (computer, etc.), and 27 (electrical) are becoming more concentrated while their concentration are not high compared to the indicators for the whole manufacturing.

Appendix 5: Their Index for Exporters 2008-2012

Table A3: Theil index for Exporters for 2008 and 2012

	2008			2012			2012/2008
ISIC	Theil	Within	Between	Theil	Within	Between	Theil
10-33	0.94	95%	5%	1.25	93%	7%	1.32
10	0.89	95%	5%	1.03	94%	6%	1.15
11	1.23	80%	20%	1.14	60%	40%	0.93
12				1.12	1%	99%	
13	0.60	96%	4%	1.03	93%	7%	1.73
14	0.55	52%	48%	1.03	50%	50%	1.87
15	0.38	8%	92%	0.44	22%	78%	1.17
16	0.59	69%	31%	0.53	77%	23%	0.91
17	0.83	64%	36%	1.09	69%	31%	1.32
18	0.41	97%	3%	0.32	87%	13%	0.79
19							
20	0.71	86%	14%	0.76	81%	19%	1.07
21	0.46	63%	37%	0.46	66%	34%	1.00
22	0.64	90%	10%	0.95	95%	5%	1.47
23	0.66	54%	46%	0.71	77%	23%	1.07
24	0.67	31%	69%	0.37	44%	56%	0.56
25	0.72	86%	14%	0.72	91%	9%	1.00
26	0.57	66%	34%	0.83	67%	33%	1.46
27	0.59	90%	10%	0.99	78%	22%	1.67
28	0.33	87%	13%	0.43	69%	31%	1.31
29	0.72	70%	30%	0.96	80%	20%	1.33
30	0.01	0%	100%	0			0
31	0.51	98%	2%	0.55	63%	37%	1.09
32	1.07	76%	24%	1.04	79%	21%	0.97
33	0.92	40%	60%	2.07	31%	69%	2.26