UNIVERSIDAD DEL NORTE

Vigilada Mineducación

A characterization of Colombian industries under Schumpeter's patterns of innovation

J. Taborda-Nuñez[1]

[1]Student. Department of Economics, Universidad del Norte.
jtabordaj@uninorte.edu.co

Bachelor Thesis. December 1, 2022

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Introduction

- The question I will answer today is **Who drives innovation within an industry?**.
- I will use Schumpeterian patterns of innovation: Mark I and Mark II.
- Characterization exercises "*have been standing the test of time quite well*" (Fontana et al., 2012). **But they are missing in some countries**.
- I will do it for Colombia, using a cluster algorithm with three indicators commonly used in the literature.
- **Data sources:** EDIT and EAM surveys (2018). Both **spatial** and **numeric** variables are of interest.

Objectives

Main objective: **characterize** Colombian industries within the manufacturing sectors as Mark I or Mark II industries.

- **Combine information** from EAM and EDIT
- **Construct quantitative analysis** at the firm level
- **Group industries** through a cluster algorithm
- **Inquire** on potential policy implications, based on both spatial and numeric results

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Innovation

The concept of innovation:

- ***"New or improved product or process (or a combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)"*** OECD (2018, p.20)
- Innovative activities: Activities to reach innovation

Market Structure and Innovation

Mark I

- Small firms are the drivers of innovation (Schumpeter, 1911).
- Perfect competition, **radical** innovations... something new (Schumpeter, 1942)

Mark II

- Large firms are the drivers of innovation (Schumpeter, 1942).
- Monopoly/Oligopoly, **incremental** innovations... enhancements of existing elements (Kirzner, 1973)

(Later on, we will see how to measure this)

Market Structure and Innovation

Backend of these marks:

- Fontana et al. (2012): Turbulence vs Stability
- Arrow replacement effect (1962)
- Baumol proposition (2004)
- Gilbert (2006) incentives to innovate based on potential profits
- Shapiro's revisit (2012): Unifying principle... **competition**

Innovation systems

- A set of interactions that foster, create, transform and diffuse knowledge on a specific territory (Nelson, 1993)
- **National** Innovation Systems (Nelson, 1993) *NSI*
- **Sectoral** Innovation Systems (Malerba, 2002;2003;2005) *SSI*
- **Regional** Innovation Systems (Asheim and Gertler, 2006) *RSI*
- Concepts of interest: Institutionalism, spatial economics, agglomeration
- The literature focus is NSI, this article will be at an RSI level

Literature

- **Market structure as a determinant of innovation** (Loury, 1979; Mansfield, 1963; Raider, 1998)
- **Previous characterizations:** Malerba and Orsenigo (1996), Breschi et al. (2000), Landström & Schön (2010), Castellaci and Zheng (2010), Corrocher et al. (2007).
- **Pavitt's alternative** based on **Kondratiev waves** (Archibugi, 2001). **Is it useful?**

Colombia's case

A periphery economy: Pavitt's approach is not suitable

- Dependence Theory (Ahiakpor, 1985)
- Empirical evidence sustaining Prebisch-Singer hypothesis (Arezki et al., 2013)
- Flows of low/high added value goods
- A lot of weight on commodities and first gen manufactures
- Innovation in Colombia: firm, industry, domestic market levels

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Data sources

- Cross-section, inner join of 2018 **EAM** and manufacture **EDIT**.
- EAM is a census of firms with $>$ 10 employees or 517 million pesos in sales. EDIT samples EAM sectors and follows OECD guidelines.
- Small firms and the informal economy are excluded.
- Each firm has a "Numero de Orden" (NORDEMP) for identification, and an "ID Departamental" (DIVIPOLA) for spatial analysis.

Initial **n = 6405**

Dimensions

Concentration (*CON*):

- Malerba and Orsenigo (1996)
- H-H Concentration Index of Market Share of output, innovative activities, labour demand and supply
- Geometrical mean to smooth values

$$CON = (HH_{ms} * HH_{msa} * HH_{lsd} * HH_{ss})^{1/4} \quad (1)$$

Dimensions

Technological Opportunities (*TO*)

- Maleki et al. (2018)
- Relative change of protection mechanisms
- Conventional and non-conventional, so we see the larger picture

$$TO = \frac{PM_{1718} + NCPM_{1718}}{PM} \tag{2}$$

Dimensions

Stability (*STA*)

- The dynamic problem. **EDIT is non comparable**
- Thus, we need another approach. A static approach
- Based on Baumol (2004) proposition

$$STA = Sr - Si \tag{3}$$

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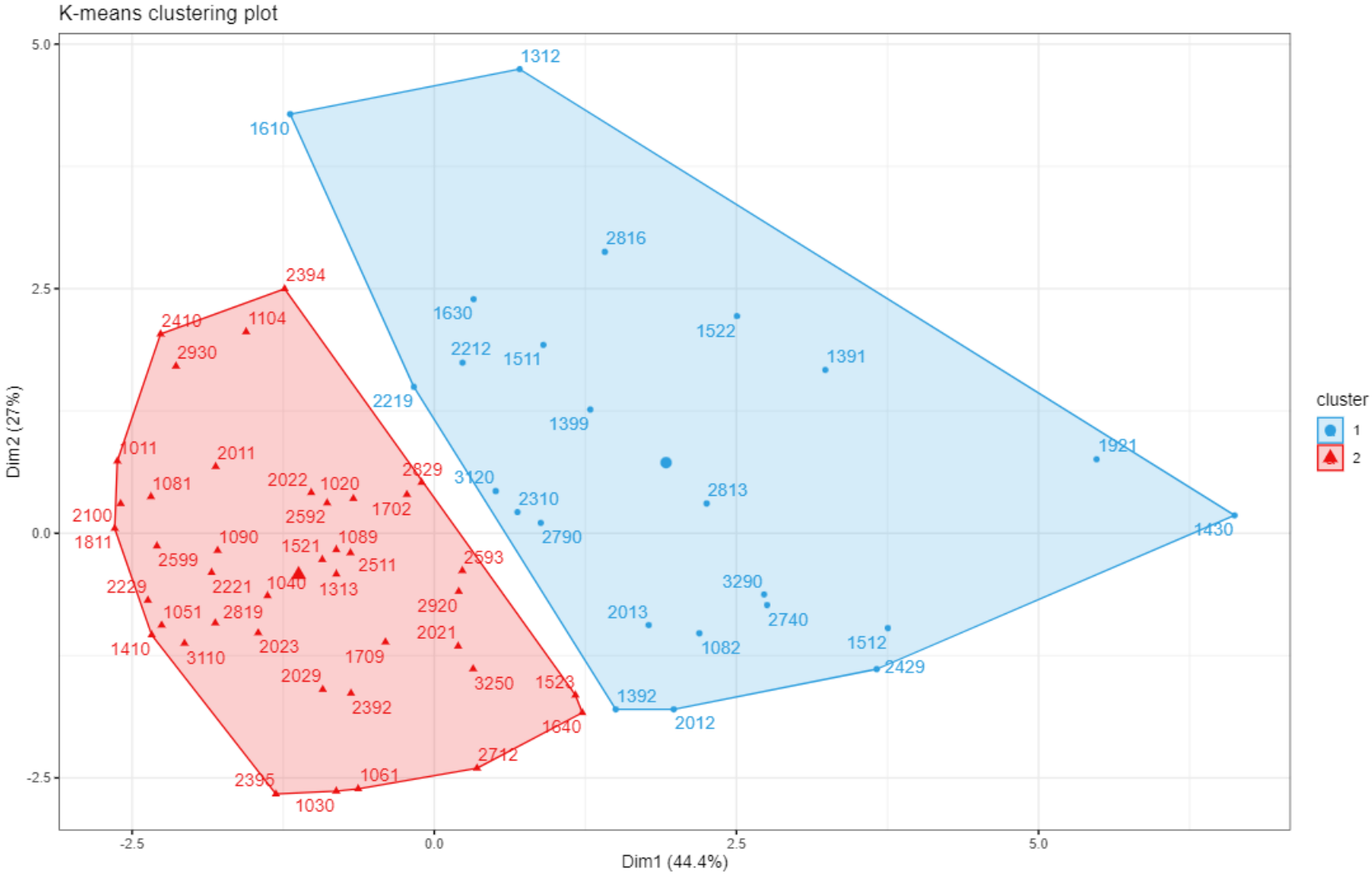
Warming up

- Some data limitations –> Data availability
- Some industries report zero innovation spending, or have a small amount of firms
- Filter for industries with less than 20 firms. Resulting **n = 5986**

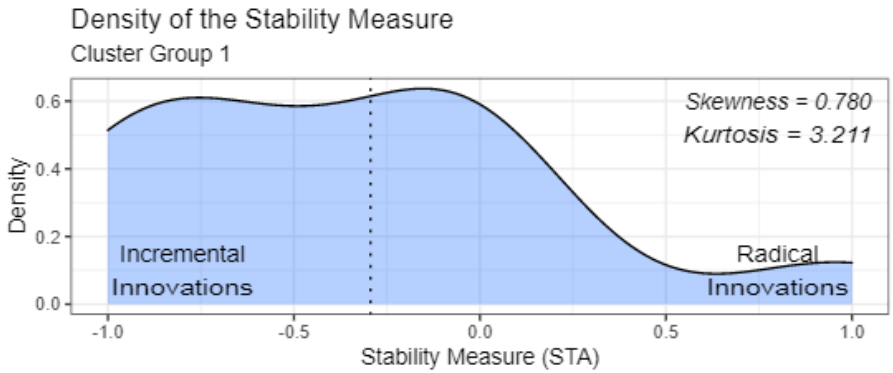
k-means cluster: Lloyd algorithm, 10 repetitions, standardized euclid distance with low ρ between measures ($< |0.1|$)

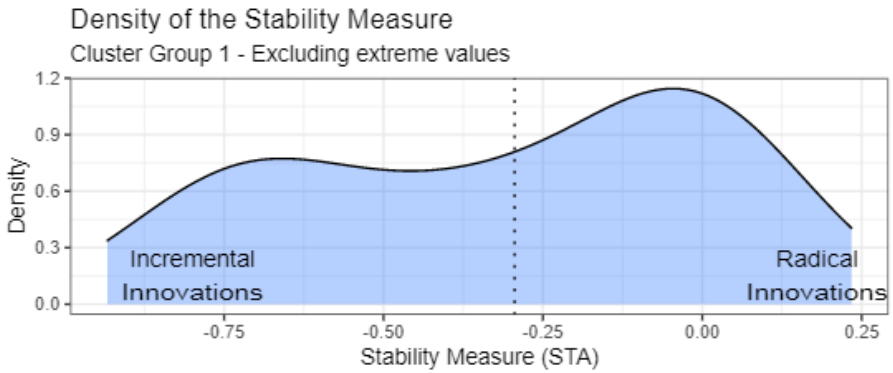
Figure: Preliminary characterization of Colombian Manufacture using a two groups k-means clustering method

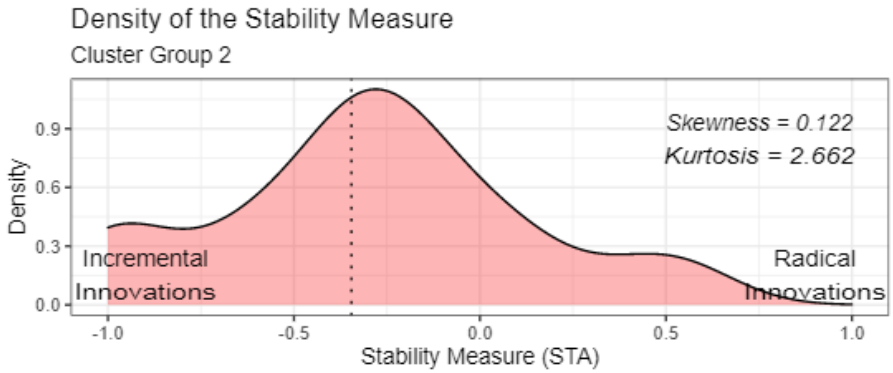


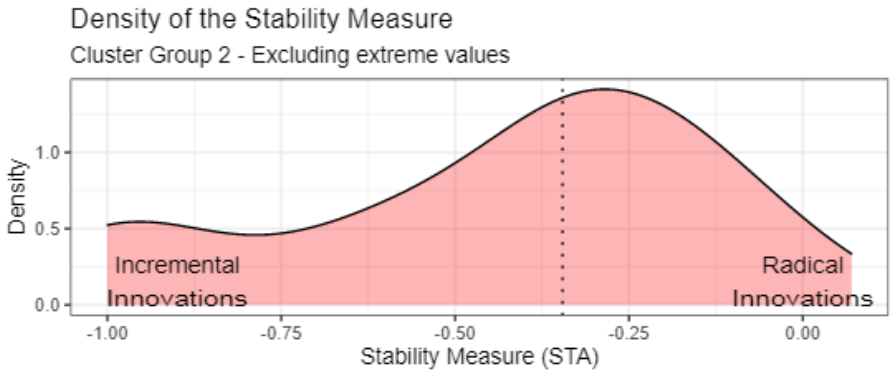
Results

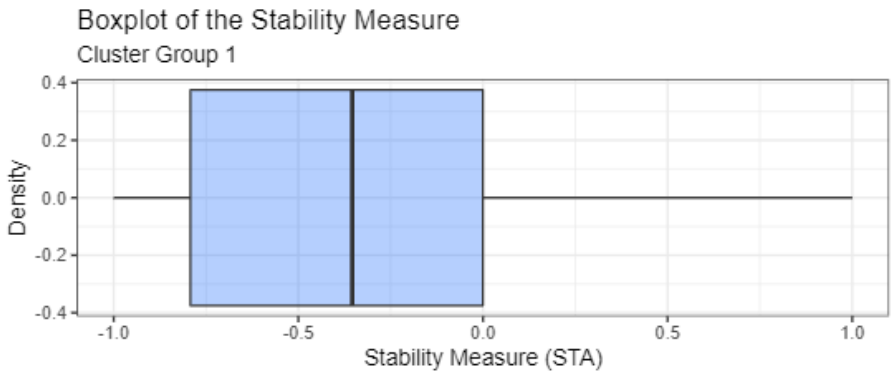
- Dim1 and Dim2
- Two groups: Cluster Group 1 (CG1) and Cluster Group 2 (CG2)
  - CG1 –> n = 794
  - CG2 –> n = 5192

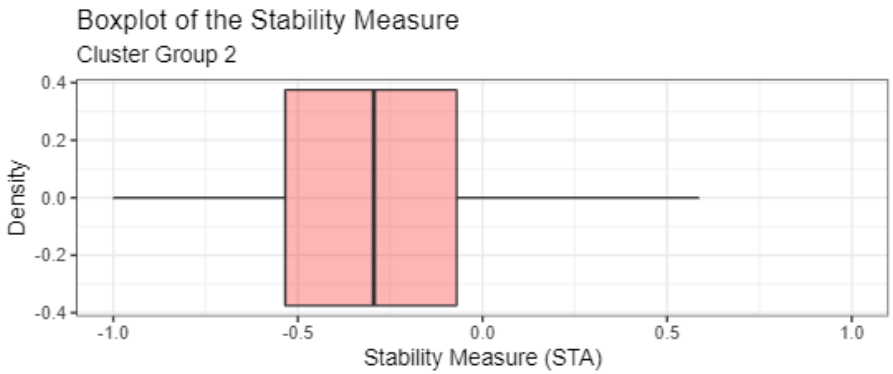

Density of the Stability Measure
Cluster Group 1
Skewness = 0.780
Kurtosis = 3.211
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

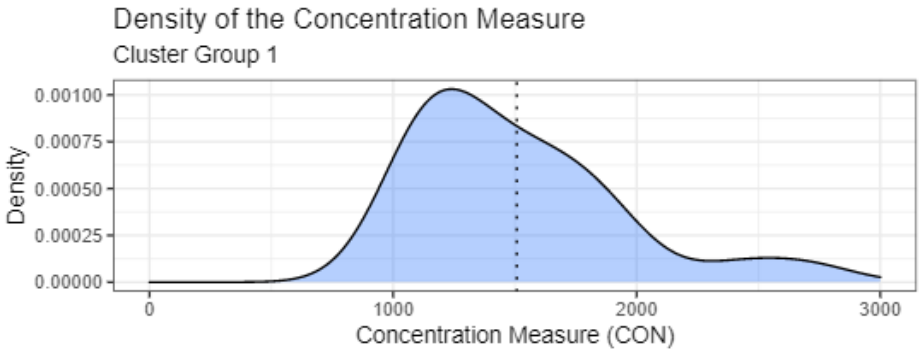

Density of the Stability Measure
Cluster Group 1 - Excluding extreme values
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

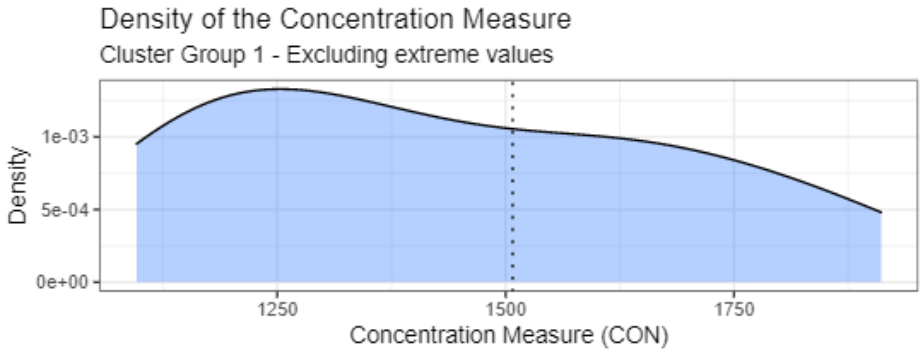

Density of the Stability Measure
Cluster Group 2
Skewness = 0.122
Kurtosis = 2.662
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

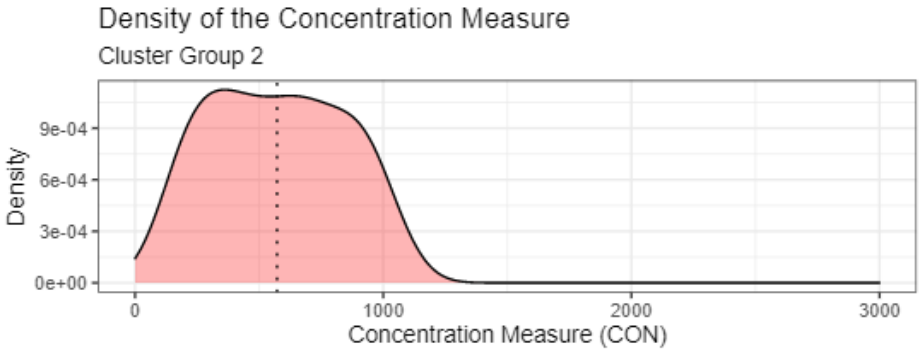

Density of the Stability Measure
Cluster Group 2 - Excluding extreme values
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

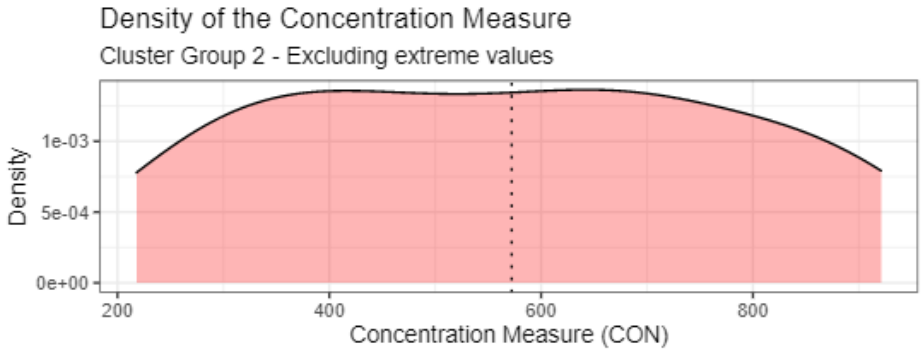

Boxplot of the Stability Measure
Cluster Group 1
Density
Stability Measure (STA)

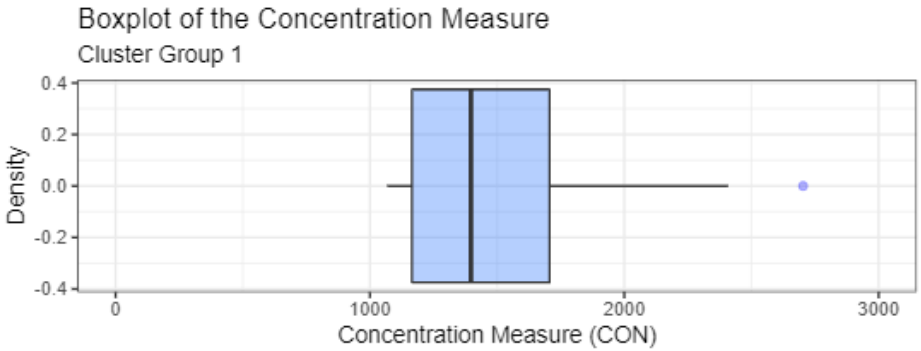

Boxplot of the Stability Measure
Cluster Group 2
Density
Stability Measure (STA)

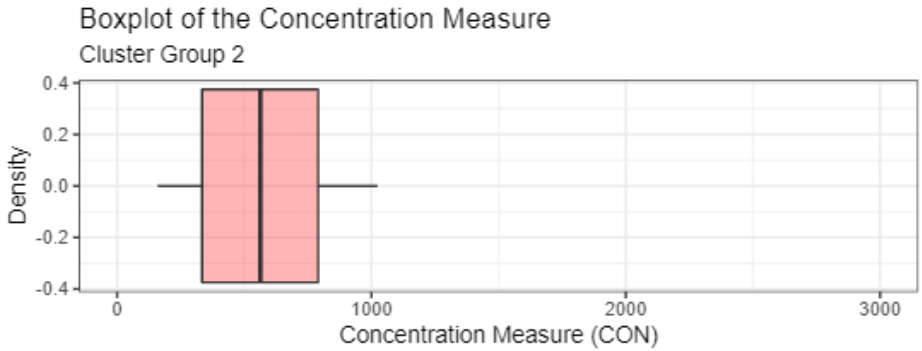

Density of the Concentration Measure
Cluster Group 1
Density
0.00100
0.00075
0.00050
0.00025
0.00000
0
1000
2000
3000
Concentration Measure (CON)

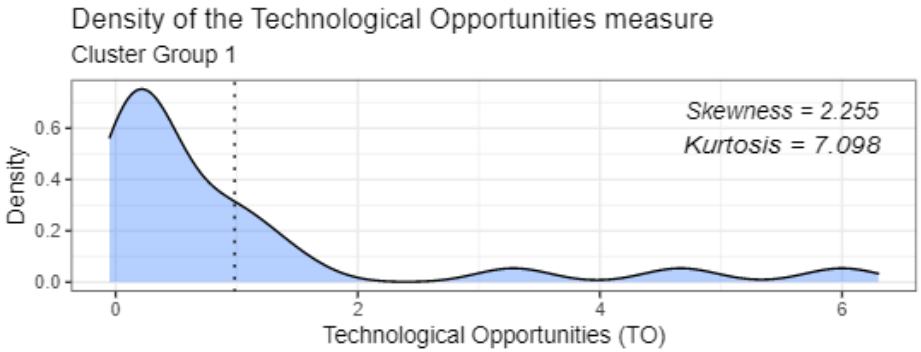

Density of the Concentration Measure
Cluster Group 1 - Excluding extreme values
Density
1e-03
5e-04
0e+00
1250
1500
1750
Concentration Measure (CON)

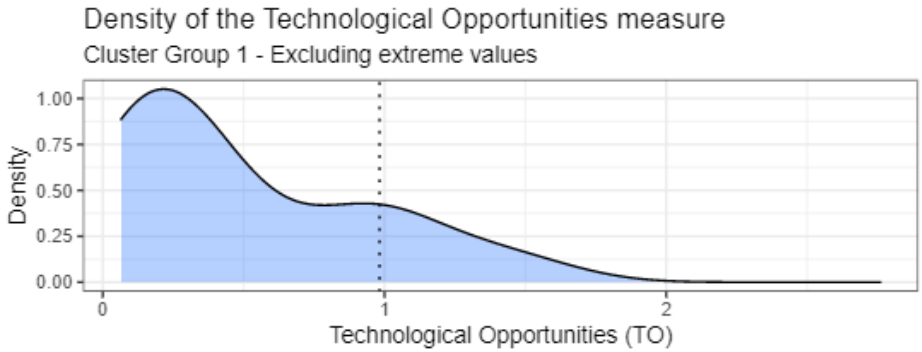

Density of the Concentration Measure
Cluster Group 2
Density
9e-04
6e-04
3e-04
0e+00
0
1000
2000
3000
Concentration Measure (CON)

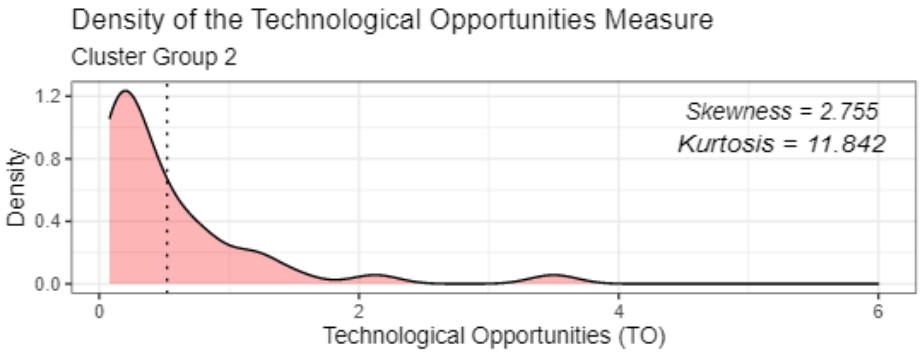

Density of the Concentration Measure
Cluster Group 2 - Excluding extreme values
Density
1e-03
5e-04
0e+00
200
400
600
800
Concentration Measure (CON)

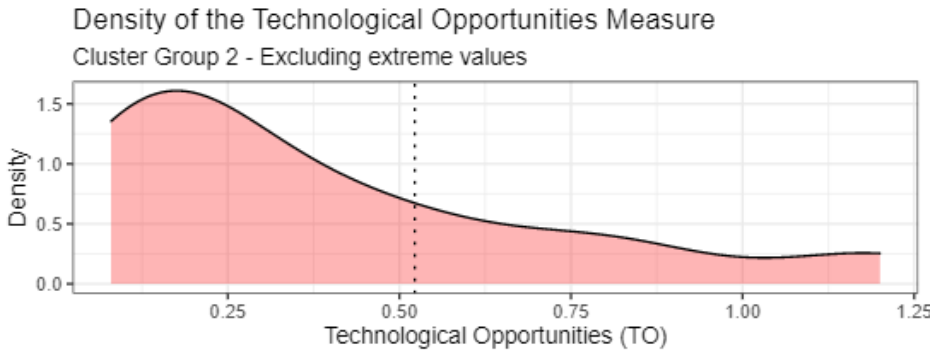

Boxplot of the Concentration Measure
Cluster Group 1
Density
0.4
0.2
0.0
-0.2
-0.4
0
1000
2000
3000
Concentration Measure (CON)


Boxplot of the Concentration Measure
Cluster Group 2
Density
0.4
0.2
0.0
-0.2
-0.4
0
1000
2000
3000
Concentration Measure (CON)


Density of the Technological Opportunities measure
Cluster Group 1
Skewness = 2.255
Kurtosis = 7.098
Density
Technological Opportunities (TO)


Density of the Technological Opportunities measure
Cluster Group 1 - Excluding extreme values
Density
Technological Opportunities (TO)


Density of the Technological Opportunities Measure
Cluster Group 2
Skewness = 2.755
Kurtosis = 11.842
Density
Technological Opportunities (TO)


Density of the Technological Opportunities Measure
Cluster Group 2 - Excluding extreme values
Density
Technological Opportunities (TO)

Boxplot of the Technological Opportunities Measure
Cluster Group 1
Density
Technological Opportunities (TO)

Boxplot of the Technological Opportunities Measure
Cluster Group 2
Density
Technological Opportunities (TO)

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General Implications

The most important implication:

- **Red cluster** (CG2): Mark I industries, small firms drive innovation
- **Blue cluster** (CG1): Mark II industries, large firms drive innovation

Sectoral trends

Several implications for certain segments:

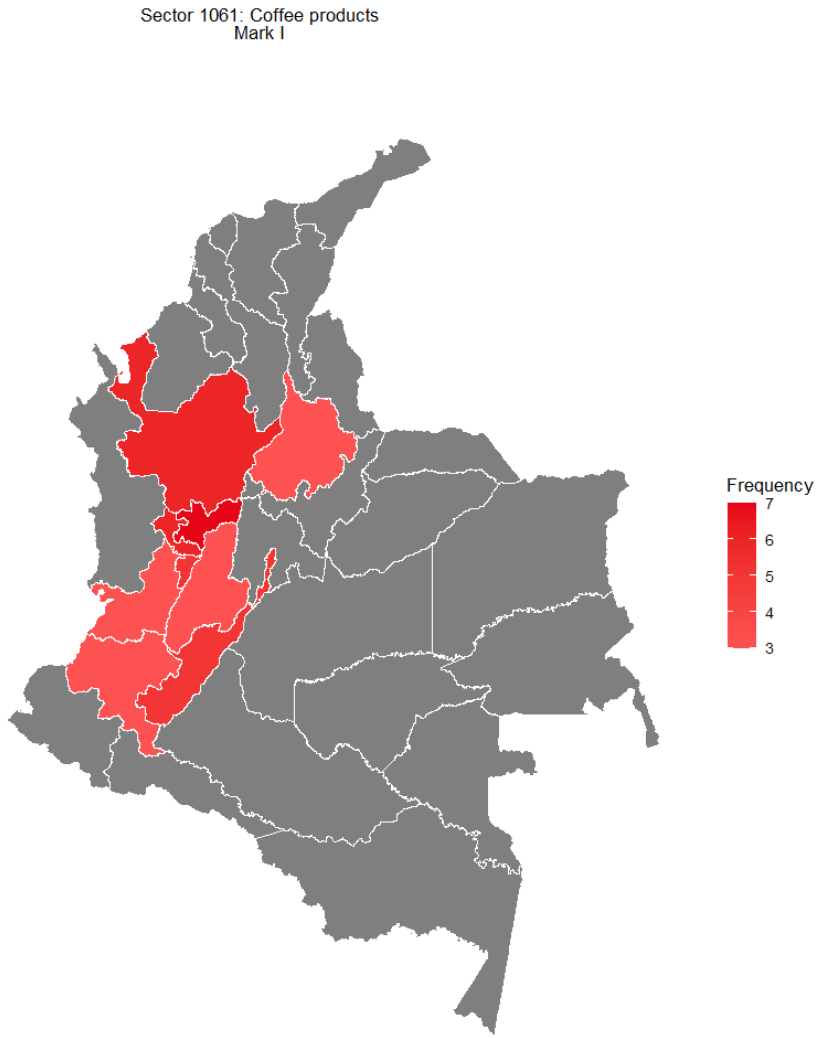
- **Groceries, meat, coffee**: Mark I. **Exception** in **Chocolates.** (*Nutresa?*)
- **First-gen manufacture**: Mark II. **Exception** in **Elaboration and finishing of clothing**
- **Petroleum**: Mark II (*Ecopetrol?*)
- **Furnitures and wood products**: Mixed results
- **Metals and minerals**: Mixed results, but more complex minerals/metals as Mark II

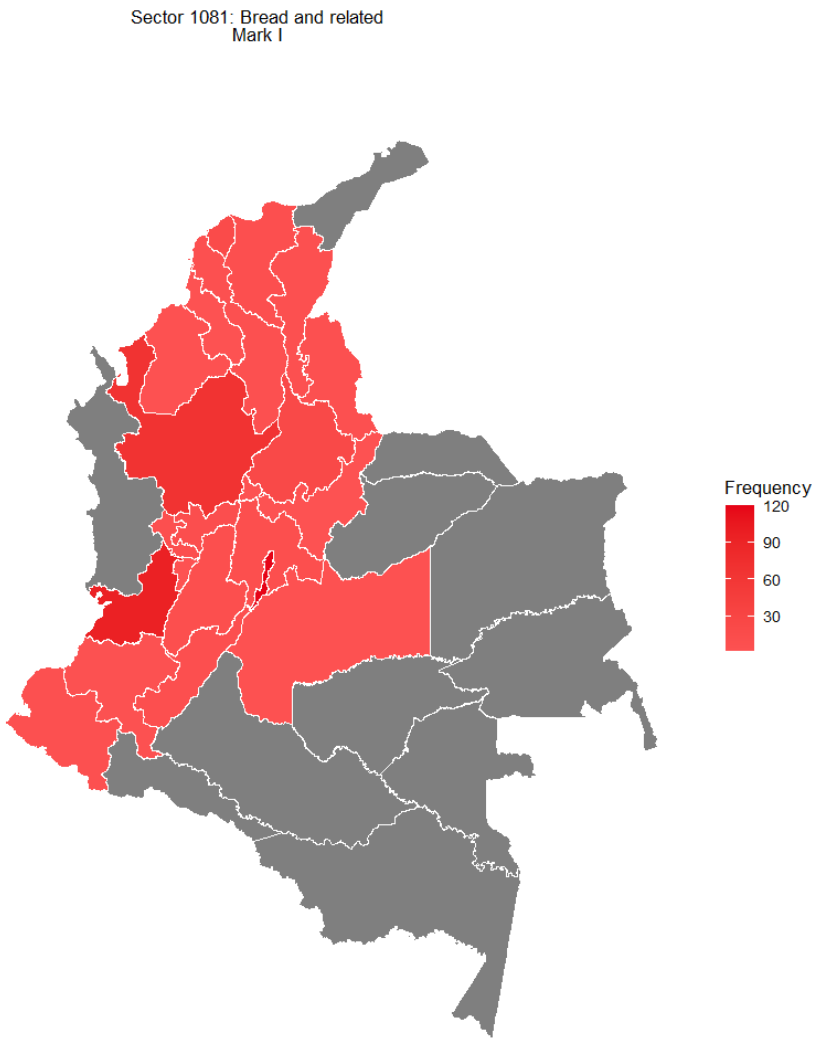
Spatial distribution

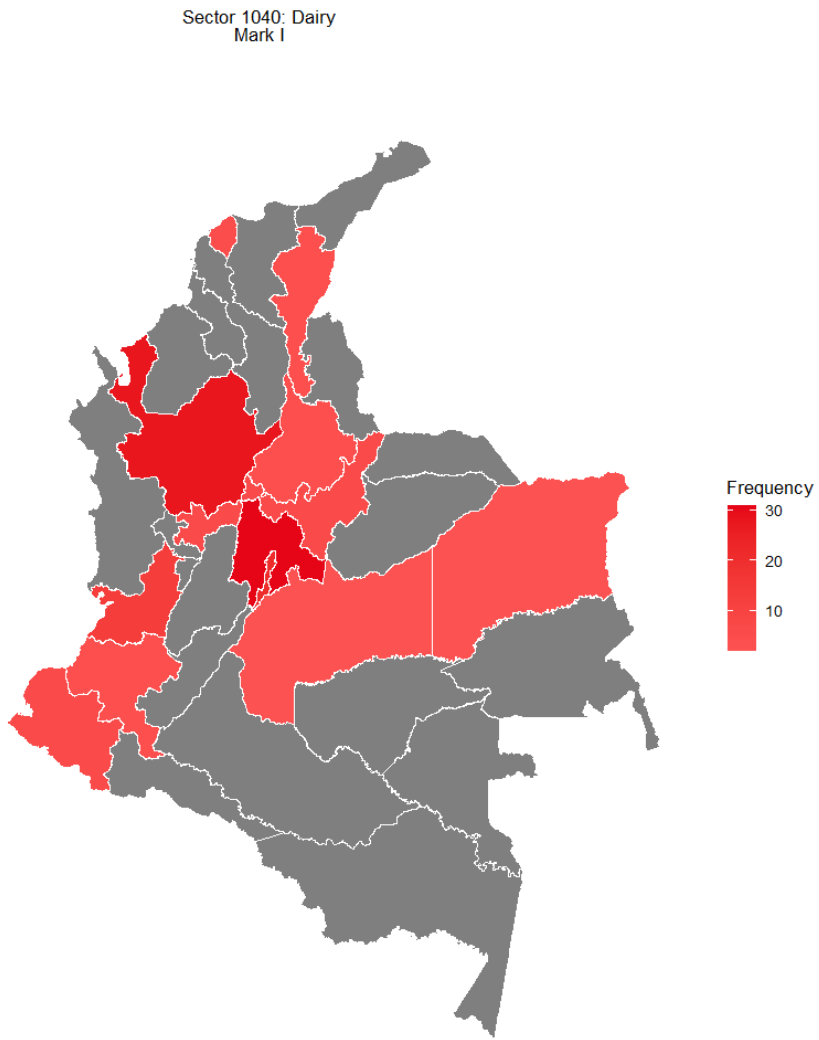
- The article has +20 maps!
- **Main finding**: Centre-periphery scheme. Central Andean persists, Cauca follows. The Caribbean falls behind.
- **Antioquia** as the leader. **Historical factors seem to persist** (Luzardo-Luna, 2019)
- Mark II industries are less disperse in the territory than Mark I
- Institutionality, transport access and urban centres act as determinants of localization, coherent with the literature
- Yes, airports and roads are important. Magdalena navigation is also crucial, but...

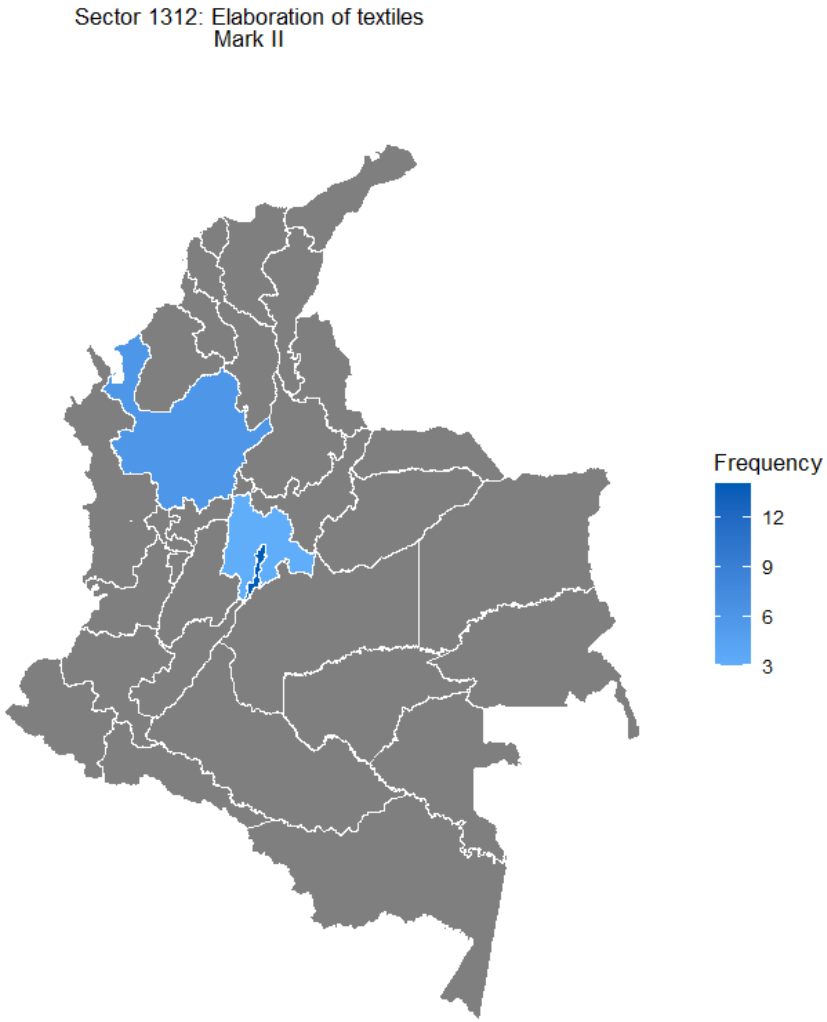
Spatial distribution

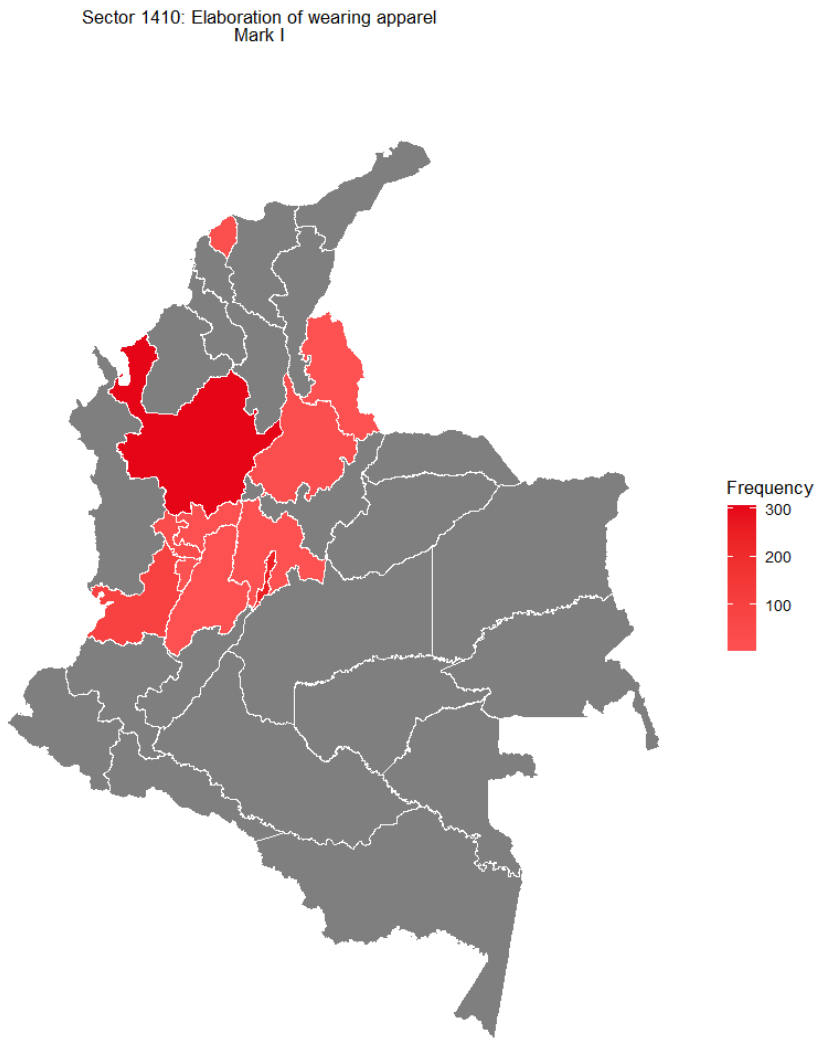
- **Institutionality seems to be the deciding factor**
- Where will the rule of law be enforced?
- Why no industries in southern Colombia? Access to **transport** and **institutionality**
- Why departments like Sucre, Cordoba or Cesar have little to no agglomerations? **Institutionality** and **human capital**
- The case of Antioquia: Prodigy kid since 1850; human capital, hard currencies, ports, access to Magdalena river, entrepreneurship spirit. (Luzardo-Luna, 2019)

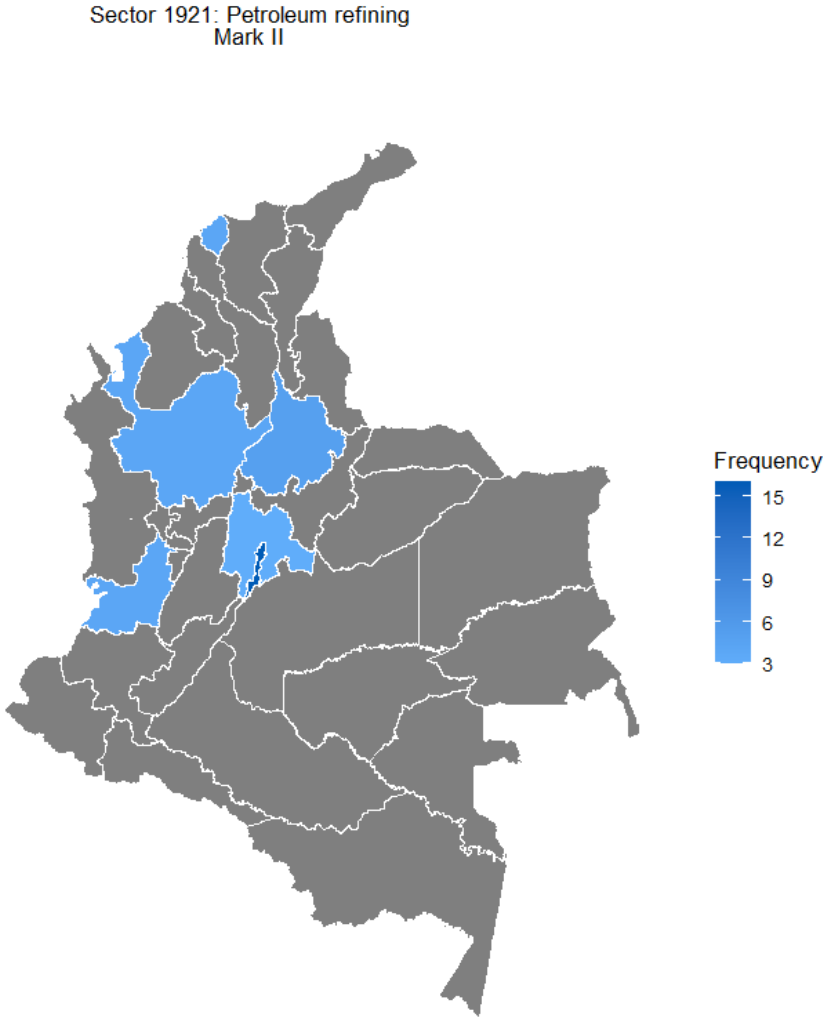

Sector 1061: Coffee products
Mark I
Frequency
7
6
5
4
3


Sector 1081: Bread and related
Mark I
Frequency
120
90
60
30

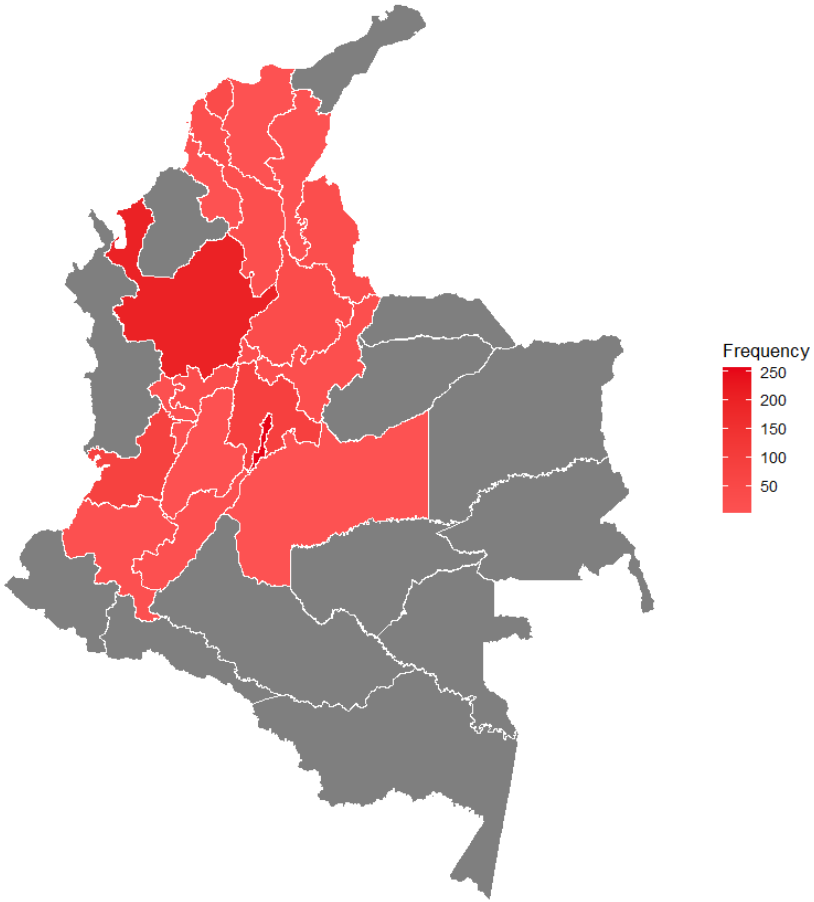

Sector 1040: Dairy
Mark I
Frequency
30
20
10


Sector 1312: Elaboration of textiles
Mark II
Frequency
12
9
6
3

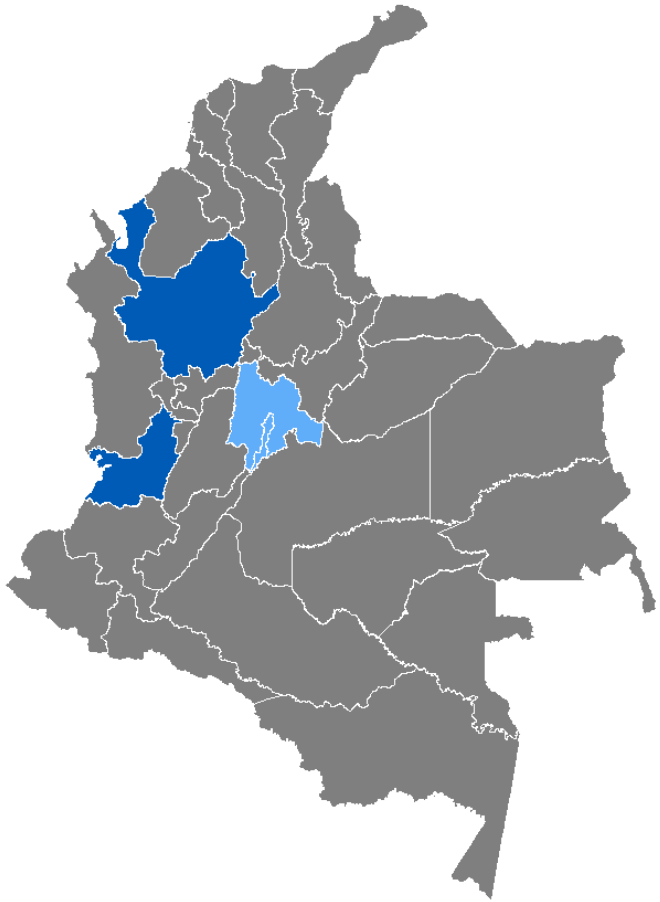

Sector 1410: Elaboration of wearing apparel
Mark I
Frequency
300
200
100


Sector 1921: Petroleum refining
Mark II
Frequency
15
12
9
6
3

Ferrous Metals and minerals for construction and foundries
(Selected industries) - Mark I



Sector 2429: Non-ferrous metals and other minerals
Mark II



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Conclusions

Some broad conclusions: