UNIVERSIDAD DEL NORTE

Vigilada Mineducación

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

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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)

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

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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

Innovation

Taxonomies of innovation:

- Radical (Schumpeter, 1942): Something new
- Incremental (Kirzner, 1973): Enhancements of existing elements

Other taxonomies (OECD):

- Market, product, process, organizational

Market Structure and Innovation

Mark I

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

Mark II

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

(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**

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).

Two alternatives

- Pavitt: **Kondratiev waves** (Archibugi, 2001), high-tech and specialized sectors
- Schumpeter: **Early/Late stages of an industry** (Malerba, 2005), very flexible.

Colombia's case

A periphery economy:

- 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 **EDIT** ("*Encuesta de Desarrollo e innovación tecnológica*") and **EAM** (*Encuesta Anual Manufacturera*) surveys by DANE (2019;2020)
- EAM is a **census**; EDIT samples EAM **industries** –> Inner join
- Criteria: Employees and profits. Small firms and the informal economy are excluded
- Each firm has a *"Numero de Orden"* (NORDEMP)
- Scope: secondary sector, three to four ISIC digits. 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

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

Dimensions

Technological Opportunities (*TO*)

- Maleki et al. (2018)
- Relative change of protection mechanisms
- Conventional and non-conventional

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

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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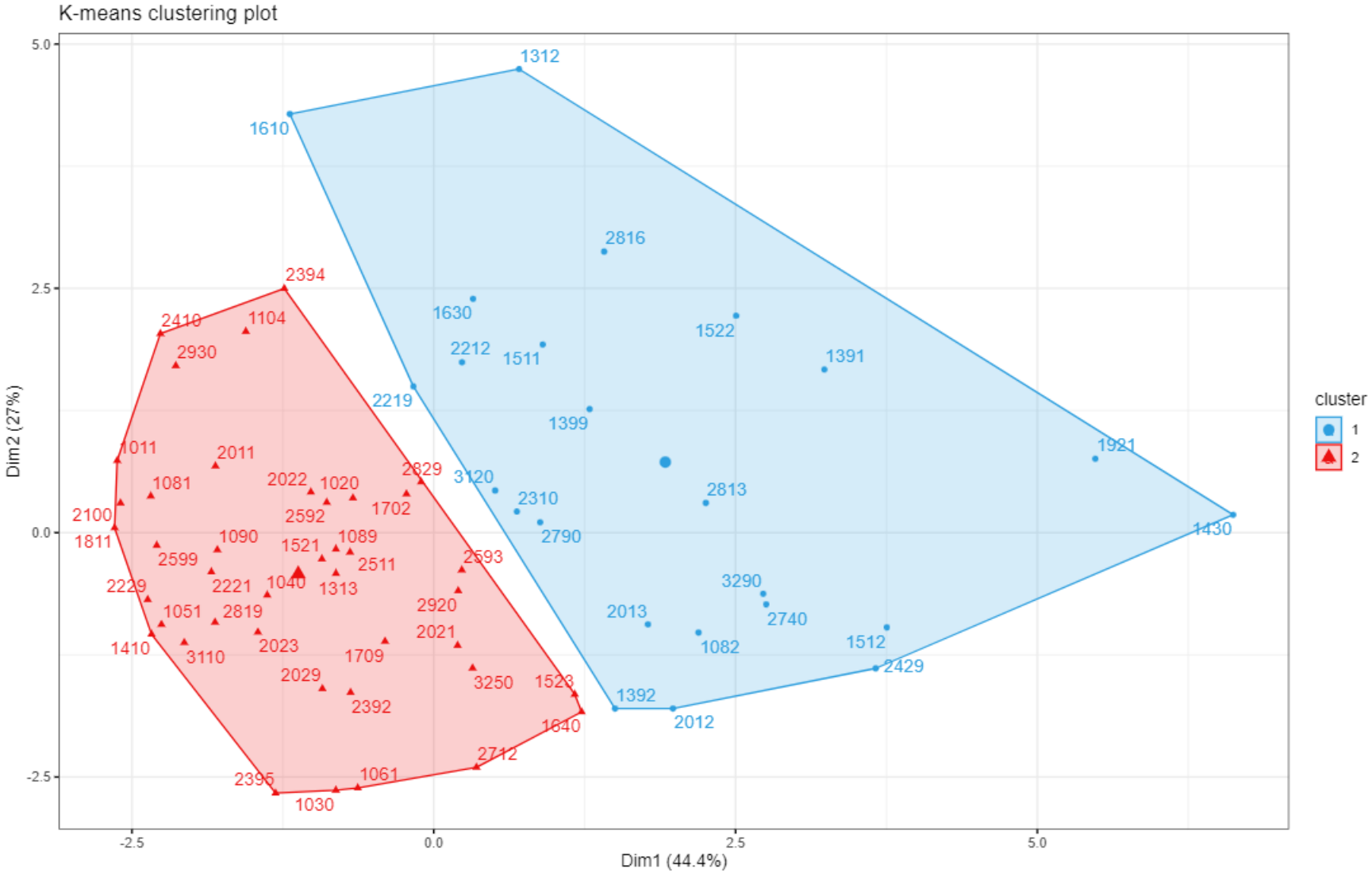
Warming up

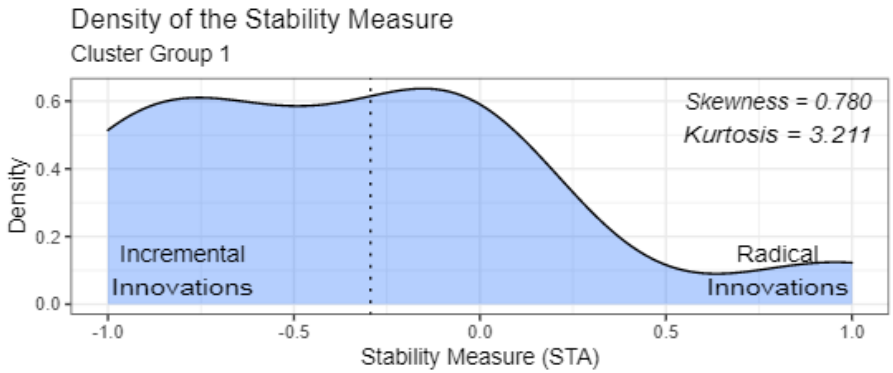
- Some data limitations –> Data availability
- Some industries report zero innovation spending, or have a small amount of firms
- Filter for industries with less than 20 firms. Resulting **n = 5986**
- k-means cluster –> Lloyd algorithm and 10 repetitions

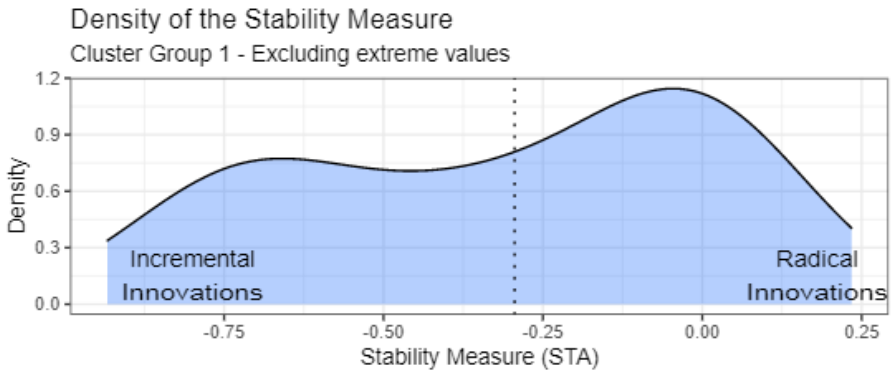
Figure: Preliminary characterization of Colombian Manufacture using a two groups k-means clustering method

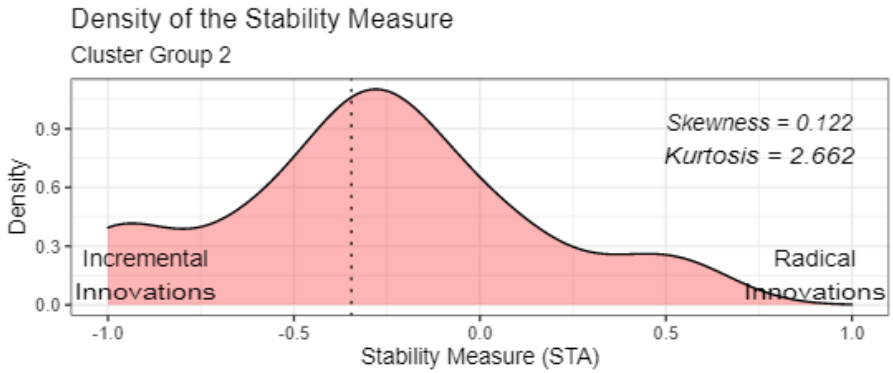


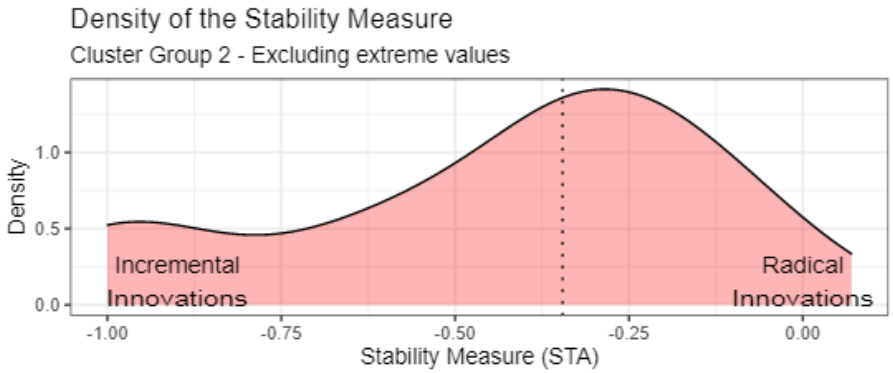
Results

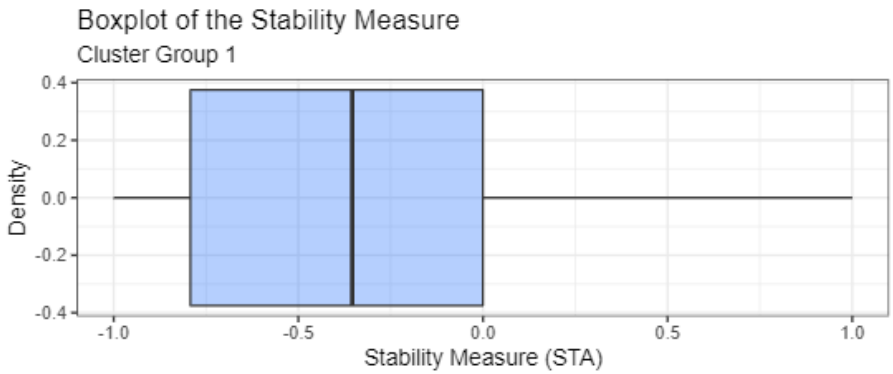
- Dim1 and Dim2
- Two groups: Cluster Group 1 (CG1) and Cluster Group 2 (CG2)
  - CG1 –> n = 794
  - CG2 –> n = 5192

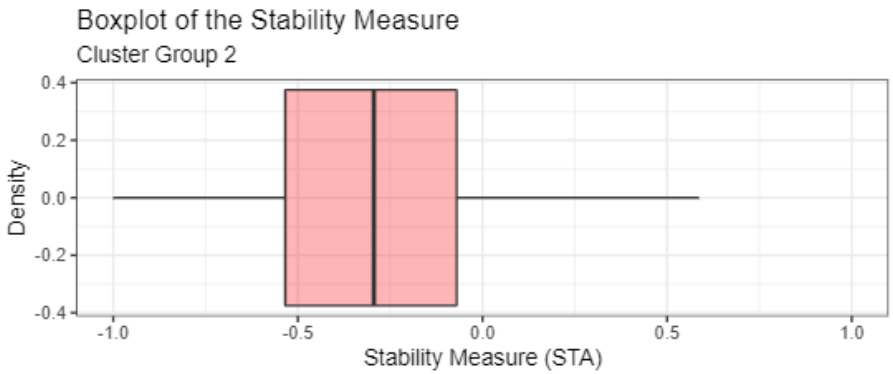

Density of the Stability Measure
Cluster Group 1
Skewness = 0.780
Kurtosis = 3.211
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

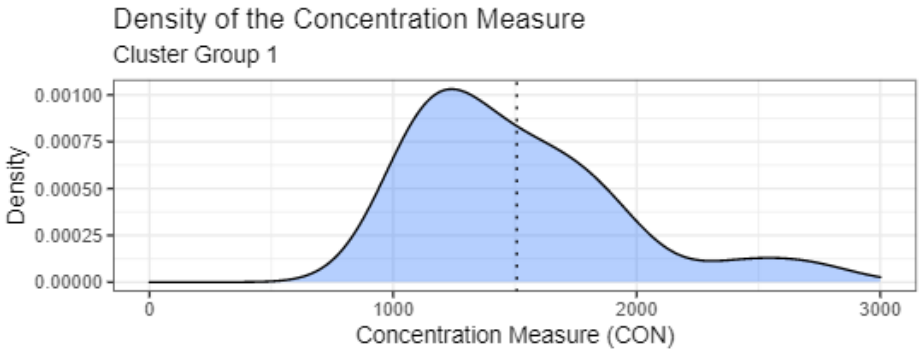

Density of the Stability Measure
Cluster Group 1 - Excluding extreme values
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

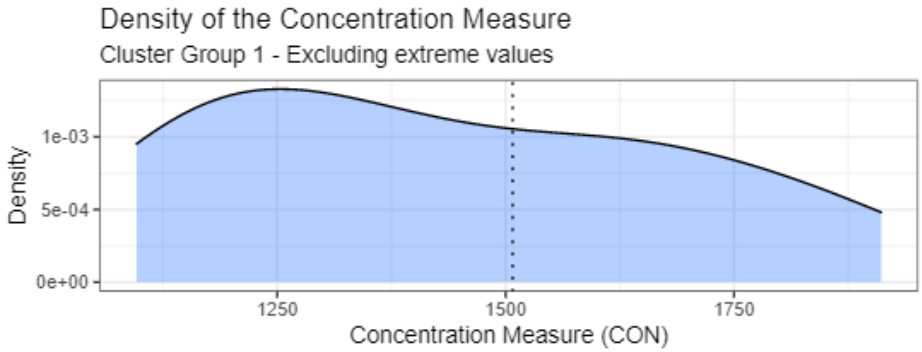

Density of the Stability Measure
Cluster Group 2
Skewness = 0.122
Kurtosis = 2.662
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

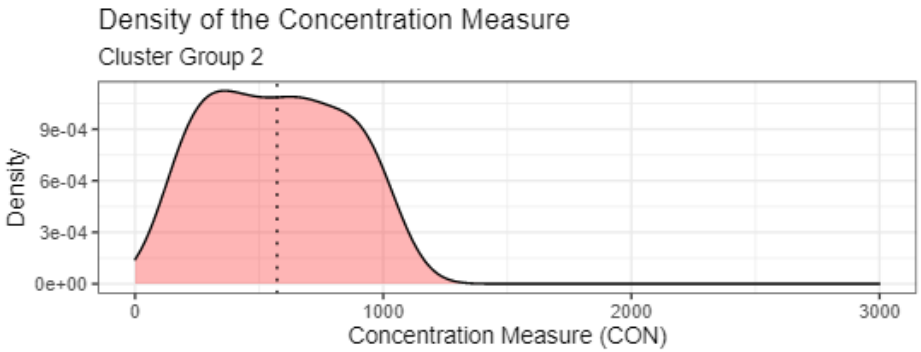

Density of the Stability Measure
Cluster Group 2 - Excluding extreme values
Incremental Innovations
Radical Innovations
Density
Stability Measure (STA)

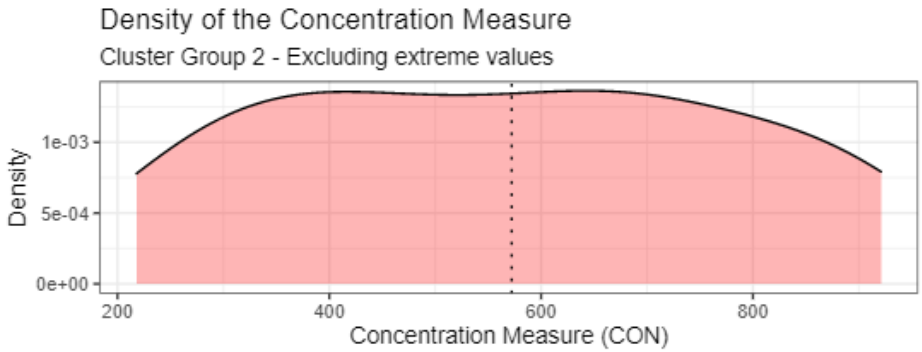

Boxplot of the Stability Measure
Cluster Group 1
Density
Stability Measure (STA)

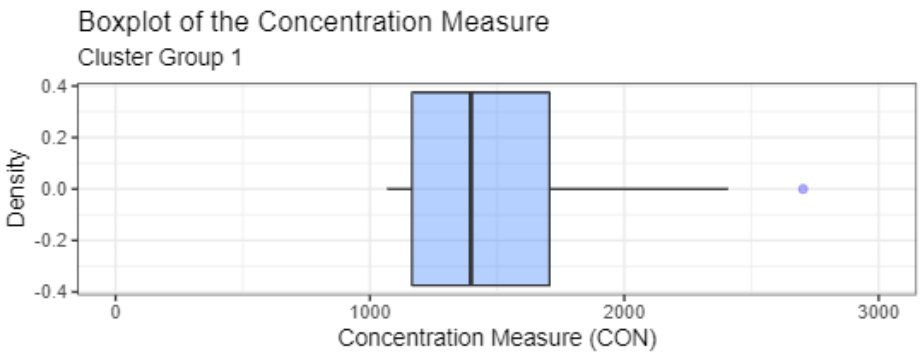

Boxplot of the Stability Measure
Cluster Group 2
Density
Stability Measure (STA)

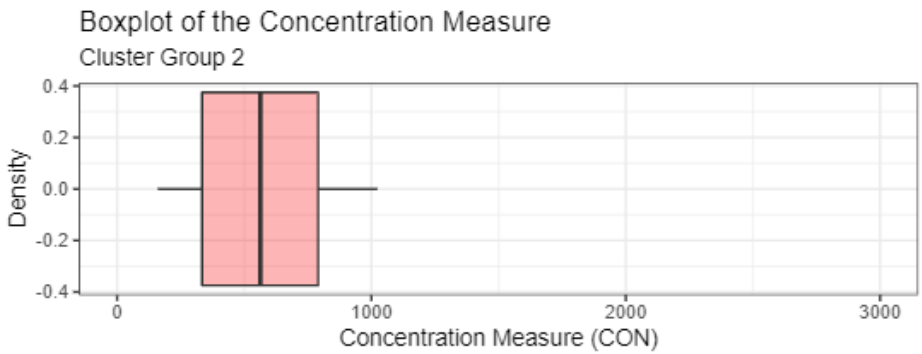

Density of the Concentration Measure
Cluster Group 1
Density
0.00100
0.00075
0.00050
0.00025
0.00000
0
1000
2000
3000
Concentration Measure (CON)

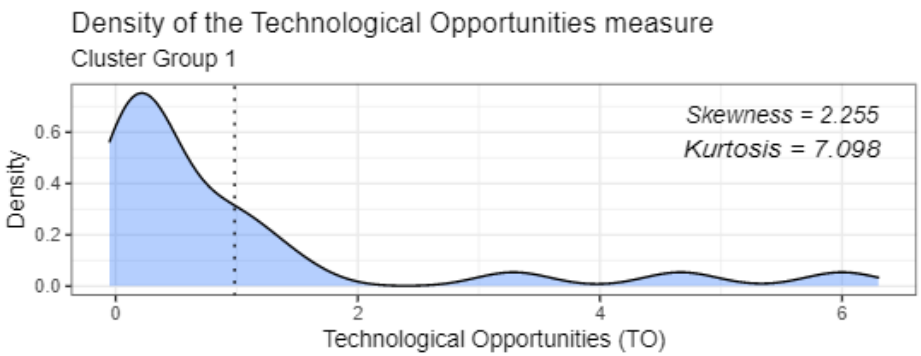

Density of the Concentration Measure
Cluster Group 1 - Excluding extreme values
Density
1e-03
5e-04
0e+00
1250
1500
1750
Concentration Measure (CON)

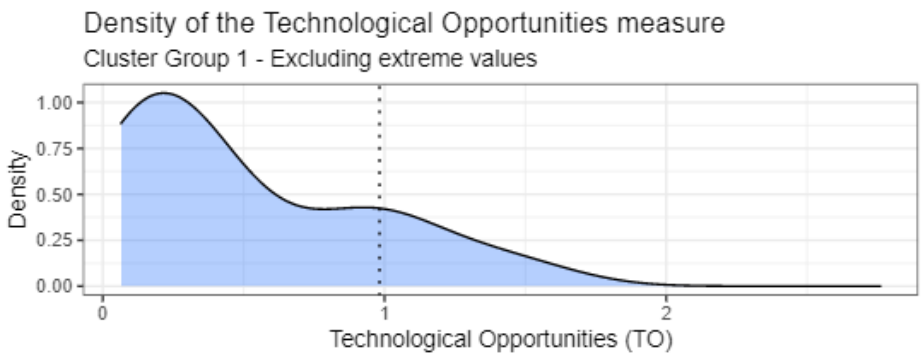

Density of the Concentration Measure
Cluster Group 2
Density
9e-04
6e-04
3e-04
0e+00
0
1000
2000
3000
Concentration Measure (CON)

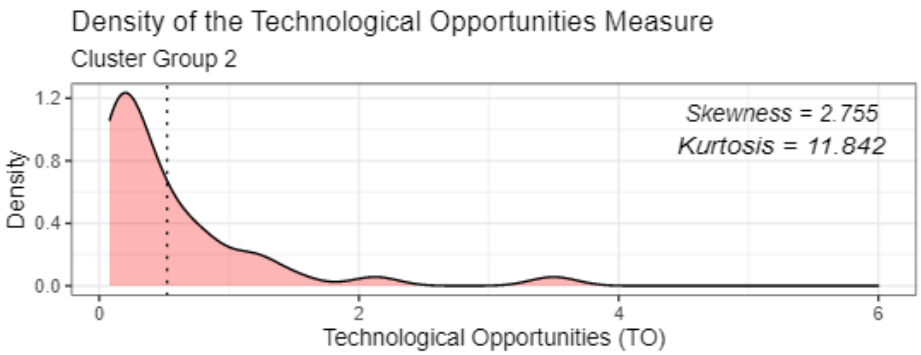

Density of the Concentration Measure
Cluster Group 2 - Excluding extreme values
Density
1e-03
5e-04
0e+00
200
400
600
800
Concentration Measure (CON)

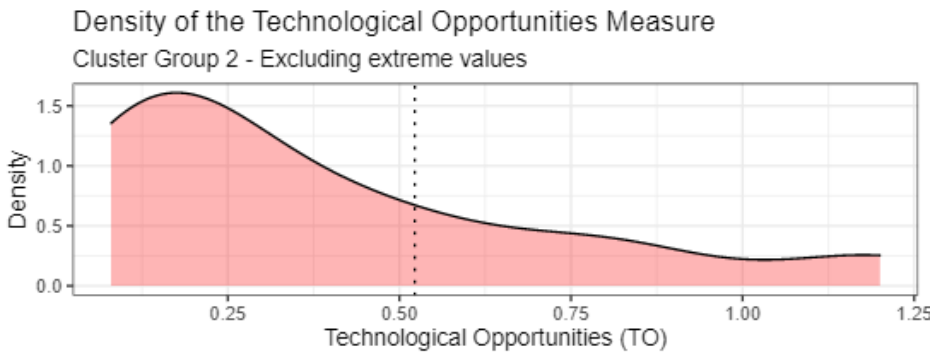

Boxplot of the Concentration Measure
Cluster Group 1
Density
0.4
0.2
0.0
-0.2
-0.4
0
1000
2000
3000
Concentration Measure (CON)


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

Policy implications

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

Policy implications

Policy guidelines:

- Differentiated approach
- Identify strategic sectors
- Incentive architecture around flagships
- Domino-effects and chained sectors
- Goods as final goods, or as inputs?

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Conclusions

Some broad conclusions:

- We have been able to **characterize** industries. Schumpeterian patterns persist
- We found **who drives innovation** across CG1 and CG2
- Concentration is the spearhead of the study
- But other dimensions also shed light!
- Policy implications... not one size fits all, context matter, strategic sectors need strategic solutions, focus on incentives.

Conclusions

- Some limitations... we can extend based on this work
- Include static components, the **how** of incentives and future econometric approaches