

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?**
- ▶ Could it be a small firm.... Or a large corporation?
- ▶ **How?** using Schumpeterian patterns of innovation: **Mark I** and **Mark II**
- ▶ **Method?** Cluster algorithm
- ▶ **Measures?** Three indicators
- ▶ **Data sources?** EDIT and EAM surveys

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The Problem



- ▶ Characterization exercises "*have been standing the test of time quite well*" (Fontana et al., 2012).
- ▶ However, no records of said exercises in some countries.
- ▶ Attempts in Colombia with Schumpeter? **Yes, but** not in characterization (Umaña-Aponte et al., 2013; Marroquín, 2010; Arroyo-Mina & Guerrero, 2018; Langebaek-Rueda & Vásquez, 2007).
- ▶ Attempts to characterize? **Yes, but** not with Schumpeter (Cerón et al., 2010; Ovallos-Gazabón & Amar-Sepúlveda, 2014).

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

Schumpeterian Patterns of Innovation



Mark I

- ▶ Small firms are the drivers of innovation (Schumpeter, 1911).

Mark II

- ▶ Large firms are the drivers of innovation (Schumpeter, 1942).

Market Structure and Innovation



Elements to consider:

- ▶ 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**

Market Structure and Innovation



Mark I

- ▶ Perfect competition, **radical** innovations

Mark II

- ▶ Monopoly/Oligopoly, **incremental** innovations

Quantification of Schumpeterian Patter



A lot, but mostly:

- ▶ **Stability**
- ▶ Entry/Exit rate
- ▶ **Market Concentration**
- ▶ Appropriability
- ▶ **Technological Opportunities**

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)
- ▶ Schumpeter: **Early/Late stages of an industry** (Malerba, 2005)

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 primary sector, commodities and first gen manufactures

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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

$$TO = \frac{PM_{1718} + NCPM_{1718}}{PM} \quad (2)$$

Dimensions

Stability (*STA*)

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

$$STA = S_r - S_i \quad (3)$$

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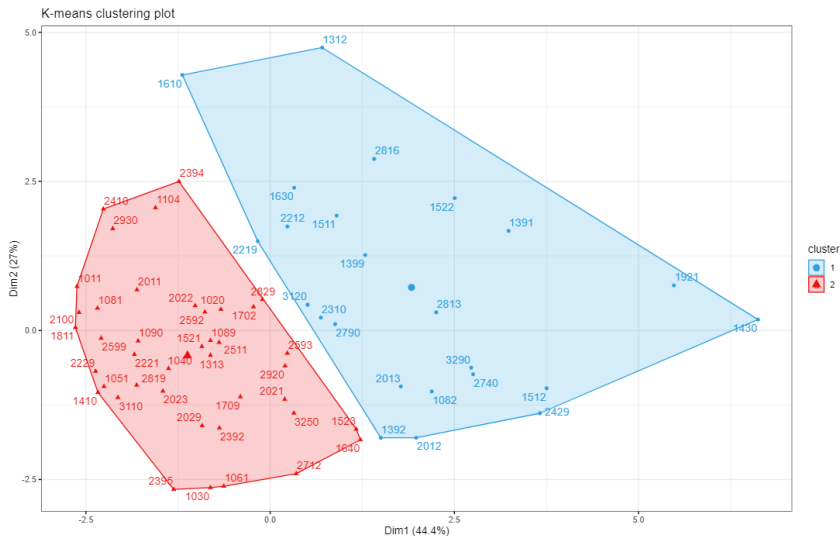
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Warming up



- ▶ 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



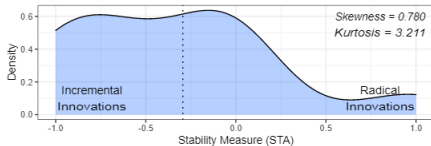
Results



- ▶ Dim1 and Dim2
- ▶ Two groups: Cluster Group 1 (CG1) and Cluster Group 2 (CG2)
 - ▶ **CG1** → $n = 794$
 - ▶ **CG2** → $n = 5192$

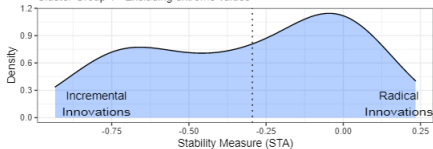
Density of the Stability Measure

Cluster Group 1



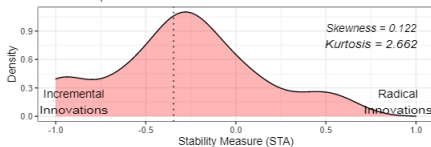
Density of the Stability Measure

Cluster Group 1 - Excluding extreme values



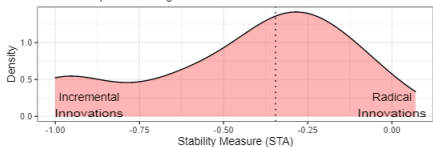
Density of the Stability Measure

Cluster Group 2



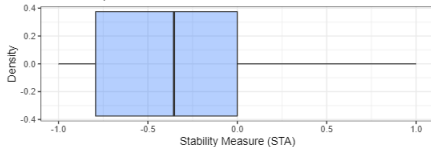
Density of the Stability Measure

Cluster Group 2 - Excluding extreme values



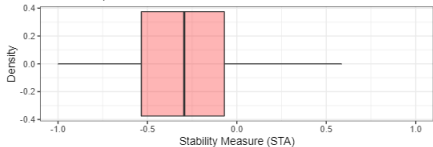
Boxplot of the Stability Measure

Cluster Group 1

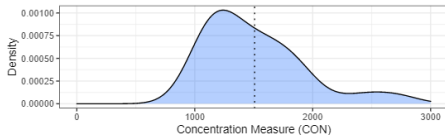


Boxplot of the Stability Measure

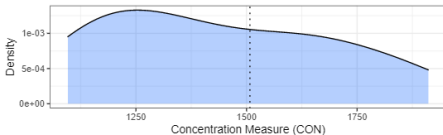
Cluster Group 2



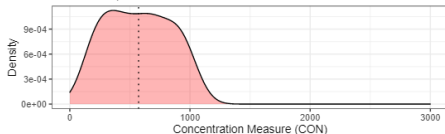
Density of the Concentration Measure
Cluster Group 1



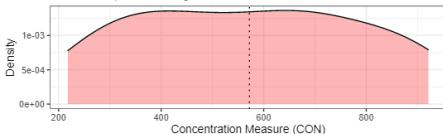
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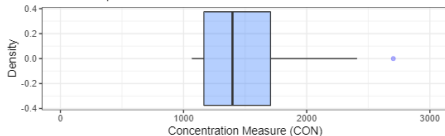
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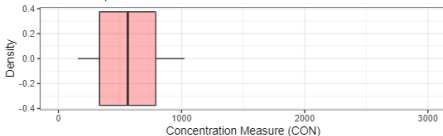
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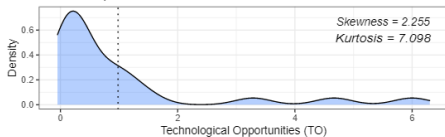
Boxplot of the Concentration Measure
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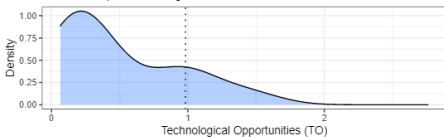
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Cluster Group 2



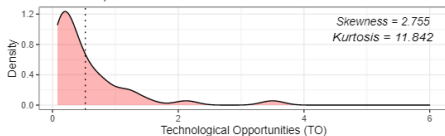
Density of the Technological Opportunities measure
Cluster Group 1



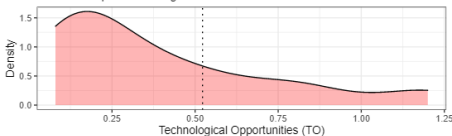
Density of the Technological Opportunities measure
Cluster Group 1 - Excluding extreme values



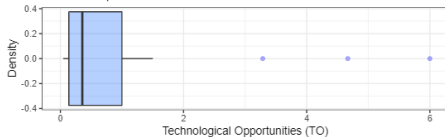
Density of the Technological Opportunities Measure
Cluster Group 2



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



Boxplot of the Technological Opportunities Measure
Cluster Group 1



Boxplot of the Technological Opportunities Measure
Cluster Group 2

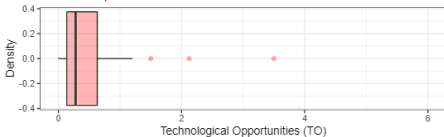


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General Implications



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