

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

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2. Theory and Literature
3. Methodology
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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*
- ▶ Then, countries are heterogeneous at a regional and sectorial level. Differentiated approaches needed.
- ▶ 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

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



# 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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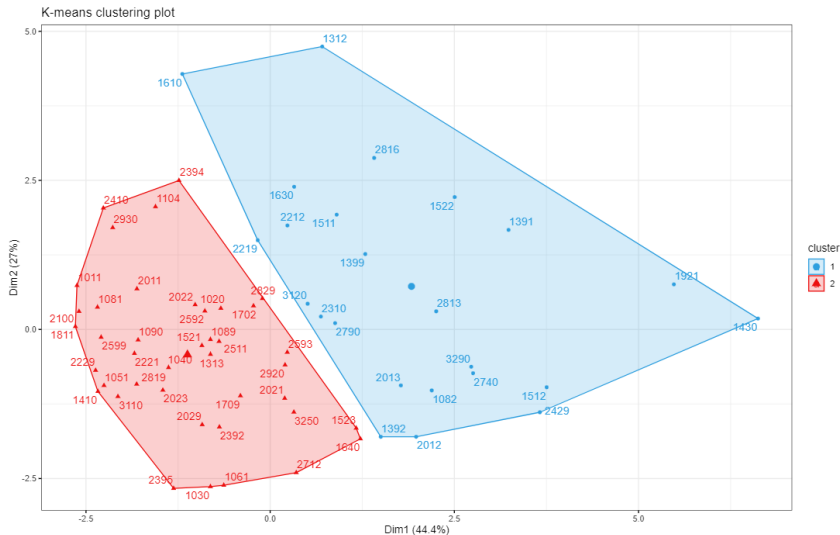
# Warming up



- ▶ 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  $\rho$  between measures ( $< |0.1|$ )

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

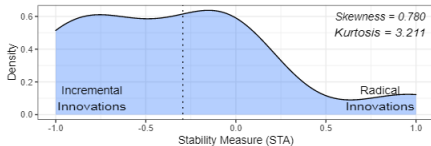


# Results

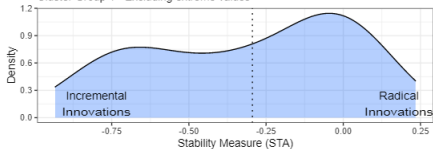


- ▶ Dim1 and Dim2
- ▶ Two groups: Cluster Group 1 (CG1) and Cluster Group 2 (CG2)
  - ▶ **CG1** → n = 794
  - ▶ **CG2** → n = 5192

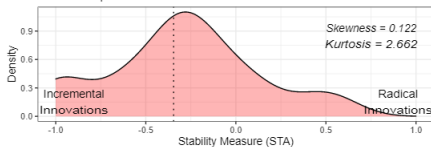
Density of the Stability Measure  
Cluster Group 1



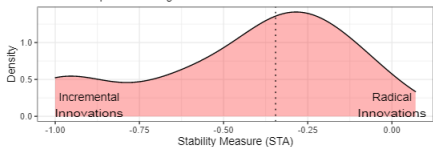
Density of the Stability Measure  
Cluster Group 1 - Excluding extreme values



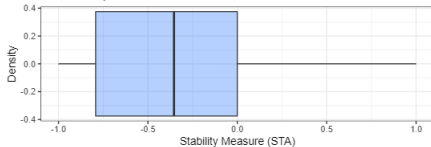
Density of the Stability Measure  
Cluster Group 2



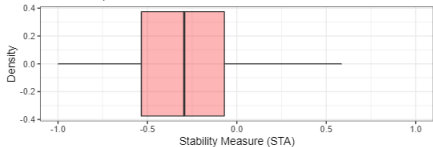
Density of the Stability Measure  
Cluster Group 2 - Excluding extreme values



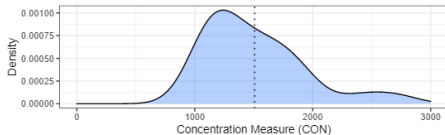
Boxplot of the Stability Measure  
Cluster Group 1



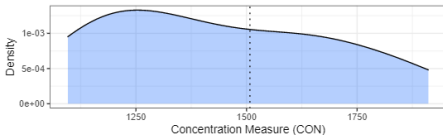
Boxplot of the Stability Measure  
Cluster Group 2



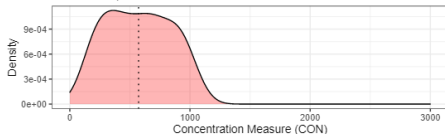
Density of the Concentration Measure  
Cluster Group 1



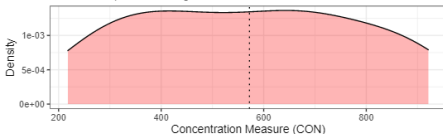
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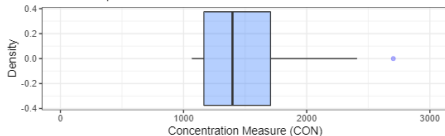
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Cluster Group 2



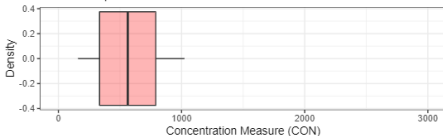
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Cluster Group 2 - Excluding extreme values



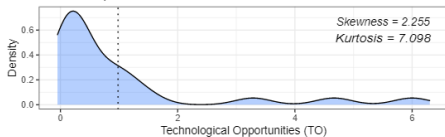
Boxplot of the Concentration Measure  
Cluster Group 1



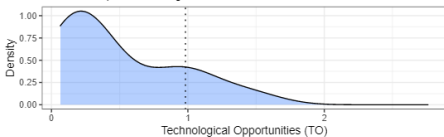
Boxplot of the Concentration Measure  
Cluster Group 2



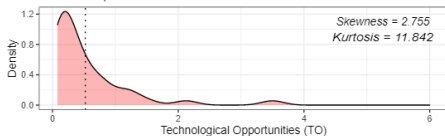
Density of the Technological Opportunities measure  
Cluster Group 1



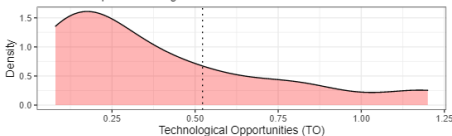
Density of the Technological Opportunities measure  
Cluster Group 1 - Excluding extreme values



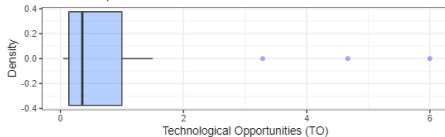
Density of the Technological Opportunities Measure  
Cluster Group 2



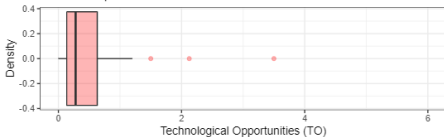
Density of the Technological Opportunities Measure  
Cluster Group 2 - Excluding extreme values



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

## 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



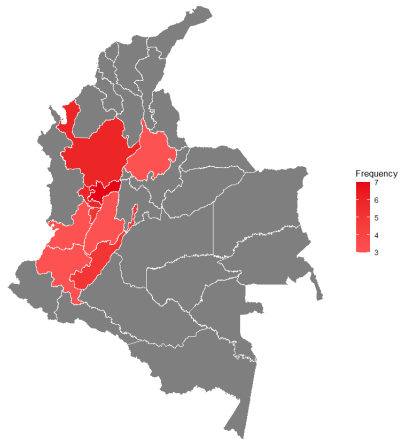
- ▶ The article has +20 maps!
- ▶ **Main finding:** Centre-periphery scheme. Central Andean persists, Cauca follows. The Caribbean falls behind.
- ▶ **Antioquia** as the leader. **Historical factors seem to persist** (Luzardo-Luna, 2019)
- ▶ **Mark II** industries are less disperse in the territory than **Mark I**
- ▶ Institutionalality, 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

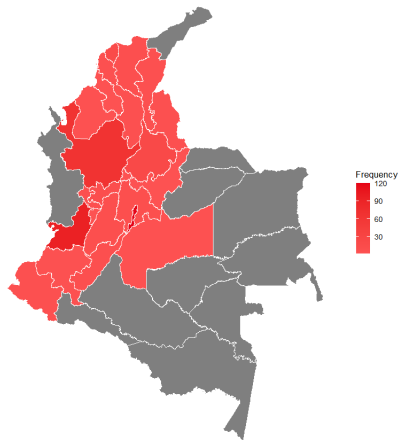


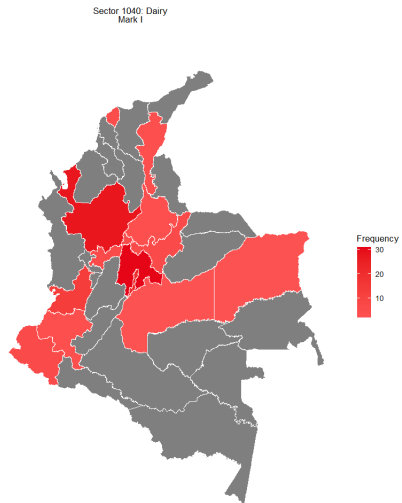
- ▶ **Institutionality seems to be the deciding factor**
- ▶ Where will the rule of law be enforced?
- ▶ Why no industries in southern Colombia? Access to **transport** and **institutionality**
- ▶ Why departments like Sucre, Córdoba or Cesar have little to no agglomerations? **Institutionality** and **human capital**
- ▶ The case of Antioquia: Prodigy kid since 1850; human capital, hard currencies, ports, access to Magdalena river, entrepreneurship spirit. (Luzardo-Luna, 2019)
- ▶ So... **not one size fits all** in this matter.

Sector 1061: Coffee products  
Mark I



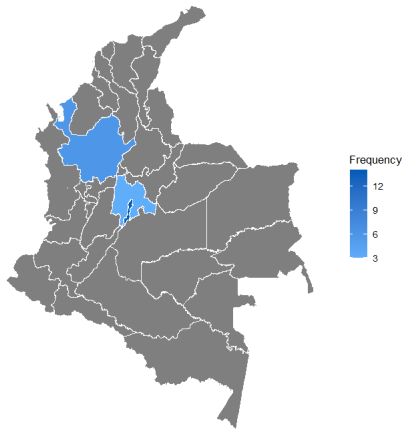
Sector 1081: Bread and related  
Mark I



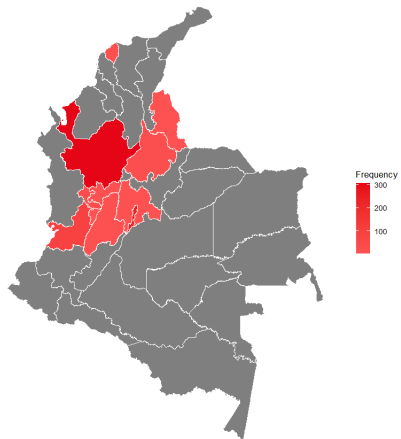




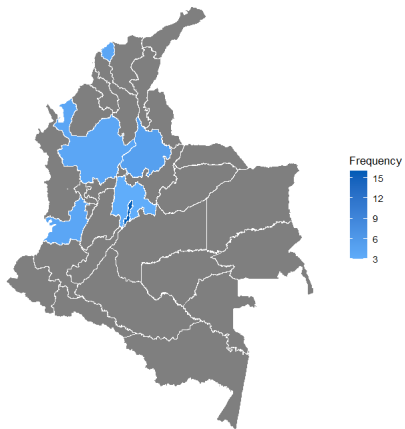
Sector 1312: Elaboration of textiles  
Mark II



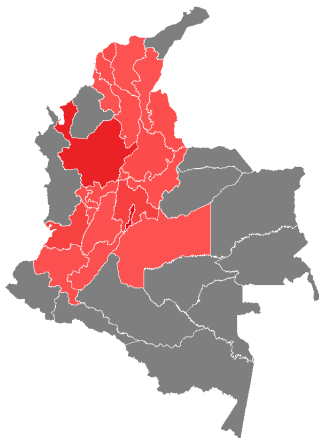
Sector 1410: Elaboration of wearing apparel  
Mark I



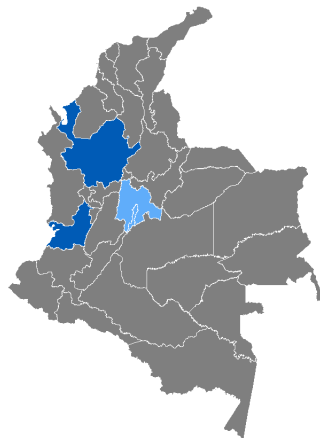
Sector 1921: Petroleum refining  
Mark II



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:

- ▶ We have been able to characterize Colombian industries
- ▶ we found what type of firm drives innovation on each industry. **CG1** has been labeled as **Mark II**. **CG2**, the densest group, gravitates toward **Mark I**.
- ▶ Measures are consistent to what was exposed in the theory and literature. Similarly, results echo with previous works.
- ▶ Intra-sectorial trends and geographical aspects are important for policy elaboration.
- ▶ Spatial distributions shows that **Mark I** industries are more disperse in the territory than **Mark II** ones

# Conclusions

- ▶ Policy recommendations agree on the need for heterogeneity in design, echoing with what was said about innovation systems.
- ▶ In other words, incentive architectures and other policy measures should acknowledge differences in geography, institutions, transport access, human capital, among others
- ▶ Where to channel all of this? MinCiencia's **PEDCTI** report
- ▶ The way forward... Econometric models, dynamic models, groundwork for policy-making