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Publications Working Papers Teaching Slides CV-Eng CV-Ita

Research Interests: Empirical I.O., Industrial Dynamics, International trade, Theory of the Firm

Links: **My page at Ideas Repec** **Google Scholar**

Breve Bio

- Esperienze lavorative
  - Dal 2015 prof. associato, Università di Bologna
  - Dal 2012 ricercatore TI, Università di Bologna
  - 2008-2012 ricercatore TD, Scuola Sup. Sant'Anna
  - 2007-2008 docente a contratto, Università di Bolzano
- Formazione
  - PhD 2006 Scuola Sup. Sant'Anna Pisa
  - 2005 Visiting Scholar, Wharton School (UPenn)
  - 2002 Laurea, Univ. di Firenze
- Visiting positions
  - Feb-Apr 2017 École Politechnique Fédérale de Lausanne, EPFL (CH).
  - Set-Ott 2015 Judge School of Business, University of Cambridge (UK).
  - Apr 2015 Department of Economics, University of Notre Dame, Indiana, USA.
- Progetti e finanziamenti
  - Francia-INSEE: trade, technology & employment dynamics (04-2016)
  - Cassa di Risparmio di Forlì (Organization of Industries, innovation and trade)
  - Partecipazione a vari progetti MIUR ed Europei, i.e. FINNOV, ISIGrowth
  - Collaborazione scientifica con ISTAT (J. Ec Soc Measur, 2013)

Insegnamento

- Triennale: Microeconomia (UniPi, UniBo); Econ Internaz (UniBo); Competition in Tourism Destinations (Unibo);
- Magistrale: Advanced Micro (UniBozen); Economics of Competition Policy (UniBo); Econ. Industriale Avanzata (Unibo); Green Technology and Innovation (Unibo)
- Dottorato: Consumer and Production theory, Industrial Dynamics (Sant'Anna, Pisa)
- Collegio dei docenti PhD in Economics, Unibo

Ricerca

- Industrial Dynamics
- Firm growth
- Innovation
- International Trade
- Theory of the firm

} Firm heterogeneity

Stylized facts on heterogeneity

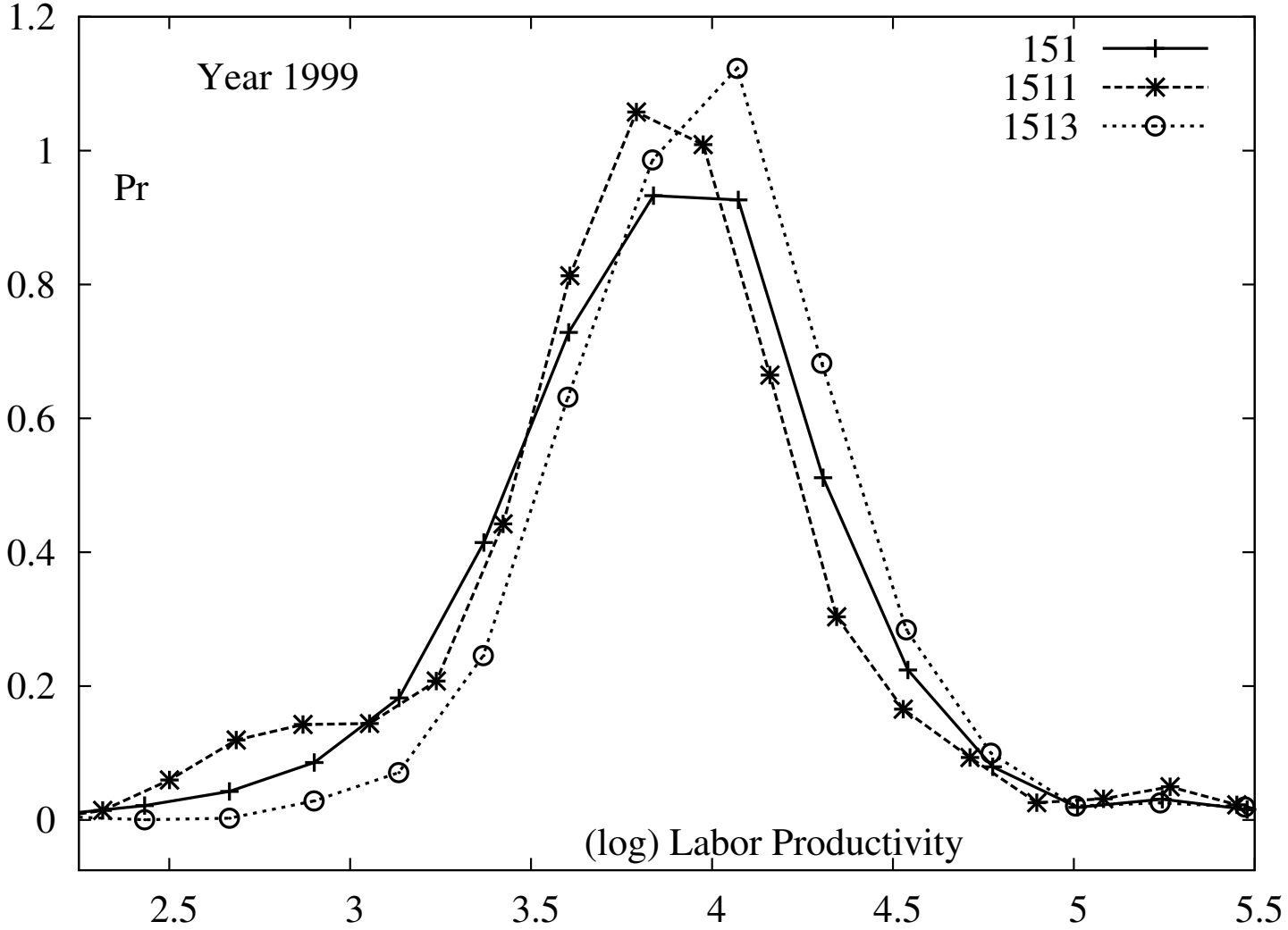
Robust evidence across many industries and countries (USA, Canada, UK, France, Italy, Netherlands, etc) consistently finds:

- wide asymmetries in productivity across firms
- equally wide heterogeneity in relative input intensities
- highly skewed distribution of efficiency, innovativeness and profitability indicators;
- different export status within the same industry
- firms responds differently to a common shock
- **high intertemporal persistence in the above properties**
- **high persistence of heterogeneity also when increasing the level of disaggregation**

Disaggregation does not solve the problem

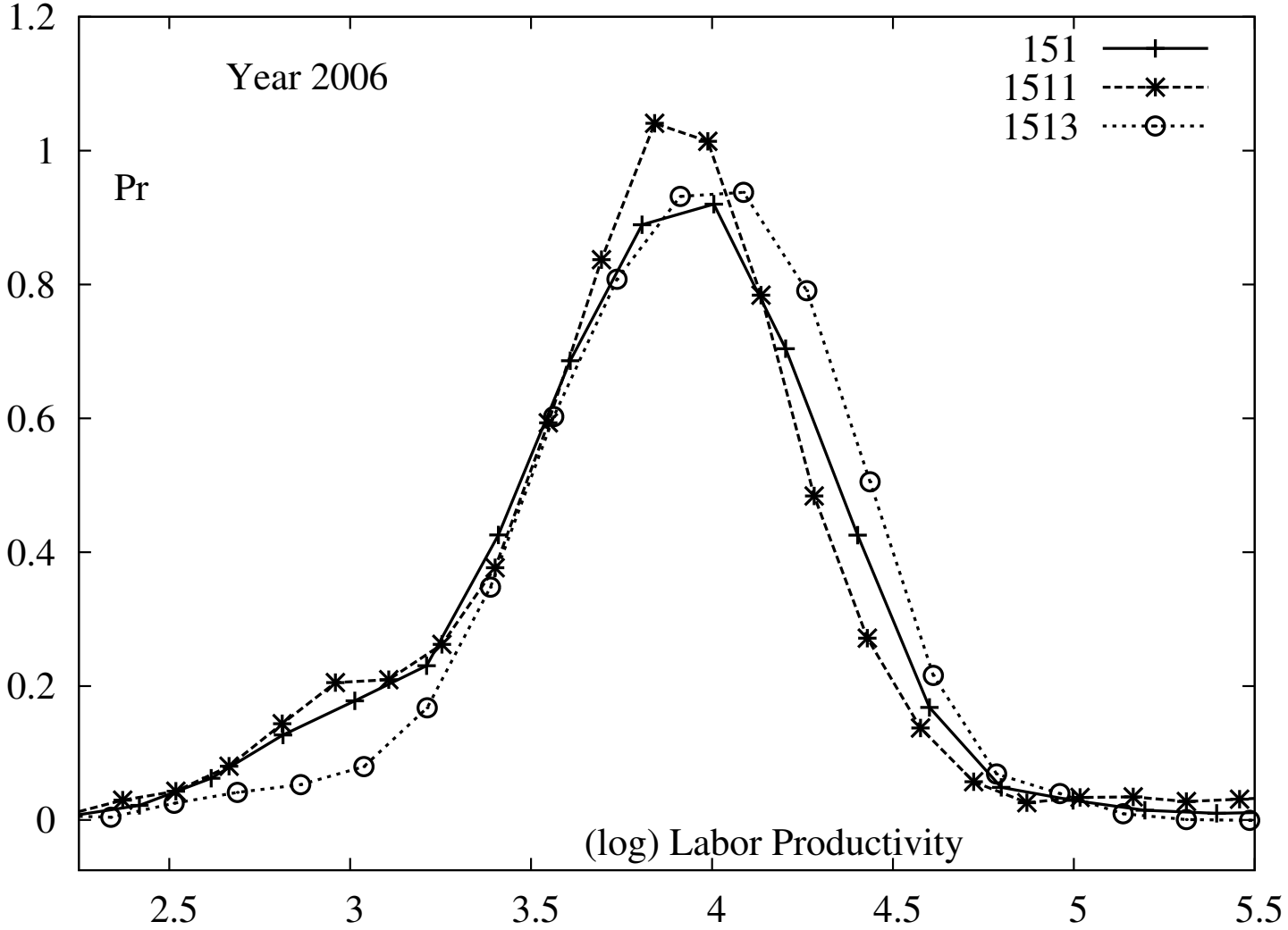
"*We [...] thought that one could reduce heterogeneity by going down from general mixtures as "total manufacturing" to something more coherent, such as "petroleum refining" or "the manufacture of cement." But something like Mandelbrot's fractal phenomenon seems to be at work here also: the observed variability-heterogeneity does not really decline as we cut our data finer and finer. There is a sense in which different bakeries are just as much different from each others as the steel industry is from the machinery industry.*" (Griliches and Mairesse, Production function: the search for identification, 1999)

Heterog. performances Meat Products (1999)



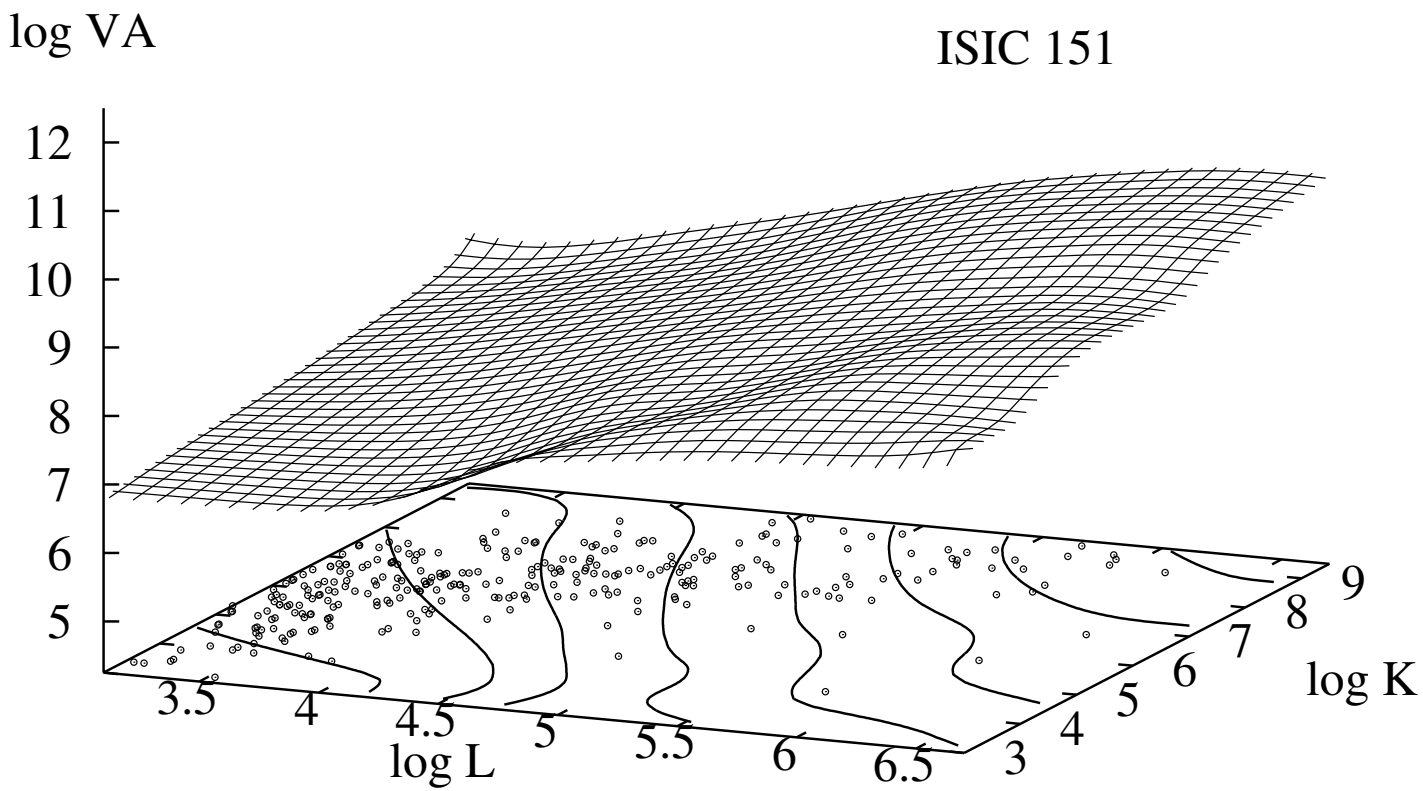
exp(3) ≈ 20 th. euro; exp(4.5) ≈ 90 th. euro

Heterog. in performances is persistent (year 2006)



$\exp(3) \approx 20$ th. euro; $\exp(4.5) \approx 90$ th. euro

Firm level heterogeneity



Implications of firm-level heterogeneity

- Interesting in itself, provide a more informative representation
- Rethinking of the standard theories. i.e. firm-level heterogeneity Vs representative firm. International trade: only very few exporters
- Macro: implications for the aggregate? How to evaluate gains from trade?
- Drivers of systematic outperformance (differences in knowledge, exporting activities, innovation, behavioral factors)
- Lack of strong selection: what implications for "selection of the fittest hp" in industrial dynamics
- Measurement issues: How to measure tech change with such widespread differences across firms?

Sources of firm level heterogeneity: theoretical and measurement issues

- Measurement issues
  - How to measure firm heterog when firms are different over several dimensions?
  - How does heterog vary over time?
  - How to measure tech. change in presence of heterog? (J. Industrial Econ, 2016)

  ▸ Zonotope
- Investment in tangible assets
  - Propose a new method to identify inv. spike which corrects for size-inv. relation
  - Improvements in firm performance, but less so in Italy (Empirical Economics, 2016) ▸ Investment
- Underlying knowledge bases
  - Firms' performance are persistently different
  - Difference in the underlying knowledge bases is related to observed differences in performance (ICC 2006; Cambridge J Econ, 2010; CUP Chapter, 2013)
- Patterns of diversification as shaped by different bases of knowledge
  - Matching of firm-level, product-level (custom data) and patent data
  - New methodology to link the patent to relevant product(s)
  - Study coherence in diversification both in terms of patents and products (SBE, 2017)

Productivity and firm growth

- Productivity stagnation and low growth of business firms. Ineffectiveness of ri-allocation of market shares in boosting productivity (between effect); week link between higher productivity and higher growth (Small Business Economics, 2012; Physica A, 2005)
- In a comparative perspective (France) investments in tangible assets of Italian firms are less effective in increasing productivity (Empirical Economics, 2016)
- If higher productivity $\not\Rightarrow$ higher growth, then one has to look also for *soft* or *behavioral* factors, i.e. "willingness to growth" or "born global") that might help explaining business performance (J. Evol Econ, forthcoming)

Firms in International Trade: from Micro to Macro

- Firms in International Trade & Exchange rates shocks
  - The role of intermediaries VS manufacturing exporters in international trade
  - Lower per-product fixed cost
  - Export share by Interm. is larger in countries with higher market costs
  - Exports to countries with large Interm share are less reactive to a RER variation (NBER, 2011; REStat 2015, still ongoing)
  - Contribute to explain the incomplete ERPT puzzle
  - Higher relevance of WhoI for countries with small firm bias (Italy)
- Technology and costs in international competitiveness
  - Patents and investments do matter, more relevant for the *intensive* (volumes) than the *extensive* (selection) margin
  - Wages: capture more differential skills (even controlling for labour productivity). Overall, not a hindrance to export strategy.
  - Product innovation is more relevant than process innovation in determining firms export success (ResPol 2015, still ongoing)
- Productivity sorting into export and import
  - Indirect (and direct) exporters and importers (RoWE, 2016)
  - Effects of ource-country characteristics on different modes of trade

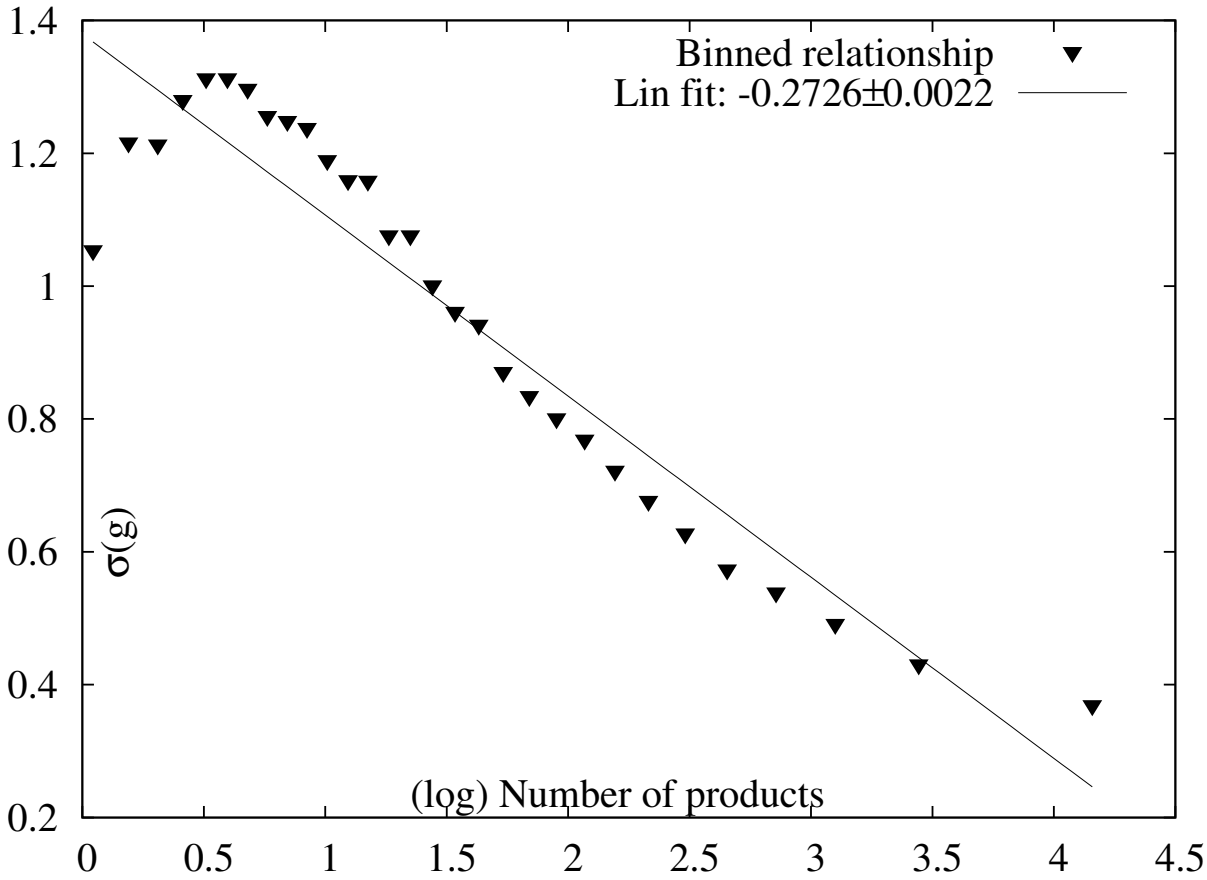
Empirical Industrial Organization

- Intra-industry firm heterogeneity
  - Performance of firms within narrowly defined industries is persistently different (Riv Pol Econ, 2005; ICC 2006)
  - Export activities are also related to firms' differences: Exporters are bigger, more productive, pay higher wages
  - Italian specificity: on average, growth rates of exp and non-exp are not distinguishable (J. Ind Comp Trade, 2012)
- Industrial dynamics
  - Firm Growth and productivity growth (Physica A, 2005)
  - Reallocation of market share (Small Business Econ, 2012)
  - Firm exit: Financial and economic determinants of firm default (J. of Evolutionary Economics, 2011)
- Size-wage premium (Cambridge J. Econ, 2010; Bulletin Econ Research, 2014)

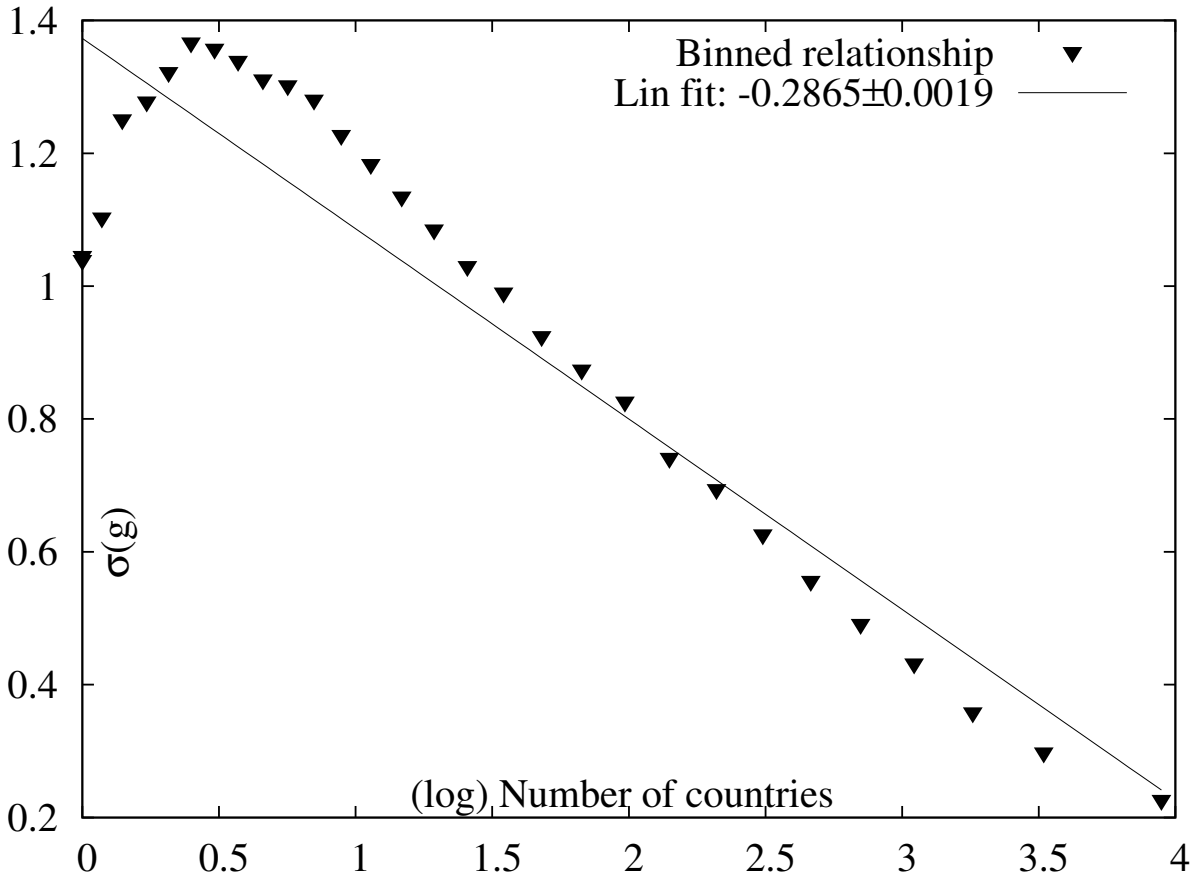
Ongoing and future research

- The market value of innovation (patents), using transaction level data from customs (French data)
- Export and firm diversification. GDP Vs Aggregate export volatility (Italian data)
- Intermediaries in international trade: margins of adjustments (Italian data)
- Persistence of profits in the long run (US, Compustat)
- Voluntary and Non-voluntary firm-exit (AIDA, BvD data)
- Coordination of a project on French firm-level data (INSEE): Commerce, technologie et dynamique d'emploi (joint with Moschella, Treibich, etal)
- Export and productivity sorting in developing economies (India)
  - The role of "learning by exporting" in developing countries
- Software development for the zonotope project (JIndEc article)
  - R (Open Source) and Stata (proprietary) packages

Volatility and product diversification: binned relationship



Volatility and country diversification: binned relationship



Terza Missione

Valorizzazione economica della conoscenza

- Attività di supporto a imprenditorialità
  - Alma E-Club, Club dell'Imprenditorialità di Unibo
  - Attività di Business Angel legata alla rete ex-Alunni Sant'Anna (mmimicro)
- Corsi di formazione congiunti Italia-Tunisia, per la formazione di funzionari tunisini (in francese)

Terza Missione formativa, culturale e sociale (Public Engag.)

- Incontri pubblici: Notre Dame University; Sant'Anna Science Cafe'; Camaldoli
- Orientamento allo studio
  - Lezioni ai Licei Bolognesi
  - Summer School of "school of Excellence network" (Normale, Sant'Anna)
- Pubblicazioni non scientifiche: Voci Dizionario-Enciclopedia Treccani; ItalianiEuropei

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Our attempt

Go Back

- Can we give a representation of the production technology(ies) of an industry without denying heterogeneity, but fully taking it into account?
- ... and without imposing any hypothesis on functional forms or input substitutions?
- Can we produce empirical measures of the technological characteristics of an industry which explicitly take into account heterogeneity?
- we make an attempt going back and developing upon W. Hildenbrand "Short-run production functions based on microdata" *Econometrica*, 1981

Hildenbrand's analysis

Go Back

- Represent firms in one sector as empirical input-output vectors of production at full capacity
- with some weak additional assumptions (divisibility) derives the empirical production possibility set for the industry (geometrically, a zonotope)
- and shows the following main properties of the derived efficiency frontier:
  - returns to scale are never constant
  - the elasticities of substitution are not constant

Our contribution

Go Back

Building upon Hildenbrand (1981) we derive:

- indicators of industry heterogeneity
- rigorous measures of technical change at the industry level which do not assume any averaging out of heterogeneity
  - rate and direction of technical change
- Industry dynamics: how firm entry and exit affects heterogeneity and tech change
- We provide an application on Italian industrial census data
- Compare with existing measure of productivity

Production activities and Zonotopes

Go Back

- The *ex post* technology of a production unit is a vector

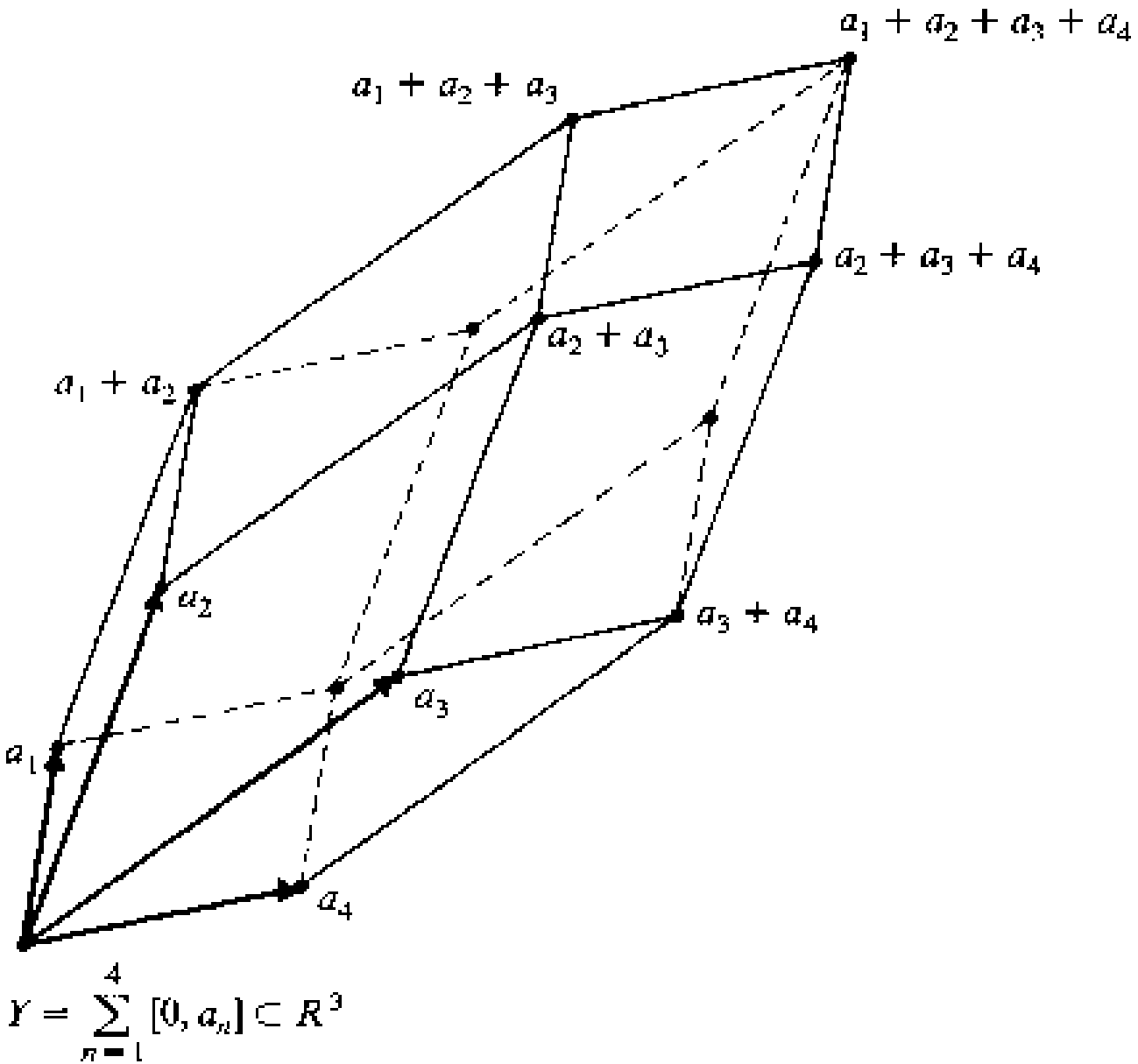
$$a = (\alpha_1, \ldots, \alpha_l, \alpha_{l+1}) \in \mathbb{R}_+^{l+1},$$

  i.e. a **production activity** a that produces, during the current period, α_{l+1} units of output by means of $(\alpha_1, \ldots, \alpha_l)$ units of input.
  - Holds also also for the multi-output case
- The **size** of the firm is the length of vector a, i.e. a multi-dimensional extension of the usual measure of firm size.
- The short run production possibilities of an industry with N units at a given time is a finite family of vectors $\{a_n\}_{1 \leq n \leq N}$ of production activities
- Hildenbrand defines the **short run total production set** associated to them as the Zonotope

$$Y = \{y \in \mathbb{R}_+^{l+1} \mid y = \sum_{n=1}^{N} \phi_n a_n, 0 \leq \phi_n \leq 1\}.$$

The Zonotope

Go Back



Volume of Zonotopes and Gini index

Go Back

- The **volume** of the zonotope Y in $\mathbb{R}^{l+1}$ is given by:

$$Vol(Y) = \sum_{1 \leq i_1 < \ldots < i_{l+1} \leq N} \mid \Delta_{i_1,\ldots,i_{l+1}} \mid$$

where $\mid \Delta_{i_1,\ldots,i_{l+1}} \mid$ is the module of the determinant $\Delta_{i_1,\ldots,i_{l+1}}$.

- Interested in getting an **absolute** measure of the heterogeneity in techniques; independent both from the number of firms making up the sector and from the unit in which inputs and output are measured.
- This absolute measure is the **Gini volume** of the Zonotope (a generalization of the well known Gini index):

$$Vol(Y)_G = \frac{Vol(Y)}{Vol(P_Y)} \quad , \tag{1}$$

where $Vol(P_Y)$ is the volume of the parallelotope P_Y of diagonal $d_Y = \sum_{n=1}^{N} a_n$, that is the maximal volume we can get when the industry production activity $\sum_{n=1}^{N} a_n$ is fixed.

Unitary production activities

Go Back

- What is the role of size in industry heterogeneity?

- Compare volume of the original zonotope, Y, to that where all firms have the same size $\overline{Y}$
- Zonotope $\overline{Y}$ generated by the normalized vectors $\{\frac{a_n}{\|a_n\|}\}_{1\leq n\leq N}$, i.e. the unitary production activities.
- The Gini volume $Vol(\overline{Y})_G$ evaluates the heterogeneity of the industry in a setting in which all firms have the same size (norm is equal to one)
- The only source of heterogeneity is the difference in adopted techniques
  - Differences in firm size do not contribute to the volumes
- Intuitively, if the Gini volume $Vol(Y)_G$ is bigger than $Vol(\overline{Y})_G$ then big firms contribute to heterogeneity more than the small ones
  - and viceversa

Solid Angle

Go Back

- In geometry, a solid angle (symbol: Ω) is the two-dimensional angle in three-dimensional space that an object subtends at a point.
- It is a measure of *how large* the object appears to an observer looking from that point.
- It can considered as the multi-dimensional analog of the support of the distribution of one variable
- An object's solid angle is equal to the area of the segment of a unit sphere that the object covers, as shown in figure 1.

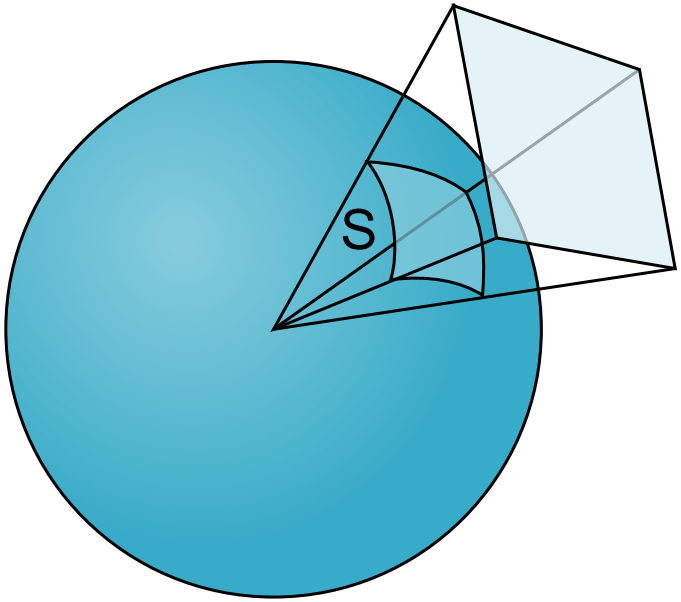


Figure: The solid angle of a pyramid generated by 4 vectors

External activities

Go Back

- **External** production activities define the span of the solid angle
- Normalized production activities $\{\frac{a_n}{\|a_n\|}\}_{1\leq n\leq N}$ generate an arbitrary pyramid with apex in the origin.
- Note: in general, not all vectors a_i, $i = 1, \ldots, N$ will be edges of this pyramid.
  - It might happen that one vector is *inside* the pyramid generated by others

$\Rightarrow$ **external** vectors $\{e_i\}_{1\leq i\leq r}$ are edges of the pyramid.

- All the others will be called **internal**.
- Define the external Zonotope Y_e generated by vectors $\{e_i\}_{1\leq i\leq r}$.
- Pairwise comparison of $Vol(Y_e)_G$ and $Vol(Y)_G$ shows relative importance of the *density* of internal activities in affecting heterogeneity.

Angles and technical change

Go Back

- Our measure of efficiency of the industry is the angle that the main diagonal, d_Y, of the zonotope forms with the space generated by all inputs
- This can be easily generalized to the case of multiple outputs

  $\Rightarrow$ Appendix for the general case
- In a 2-inputs, 1-output setting, if $d_Y = (d_1, d_2, d_3)$, this is equivalent to study

$$\text{tg}\theta_3 = \frac{d_3}{\|(d_1, d_2)\|} \tag{2}$$

- If the angle increases, then productivity increases

Direction of Technical change

Go Back

- How relative inputs use varies over time
- Consider the angles that the input vector forms with the input axis
- In the two-inputs, one-output case

$$\text{tg}\varphi_1 = \frac{d_2}{\|d_1\|} \tag{3}$$

- If input 1 is labor and input 2 is capital, an increase in φ_1 suggests that technical change is biased in the labor saving direction.

A toy illustration

Go Back

Production schedules of 10 hypothetical firms composing an industry, 2-inputs, capital and labor, and one output.

	Year 1			Year 2			Year 3			Year 4		
Firm	L	K	VA	L	K	VA	L	K	VA	L	K	VA
1	7	4	9	7	4	9	**7**	**4**	**9**	**7**	**4**	**9**
2	1	4	5	1	4	5	**1**	**4**	**5**	**1**	**4**	**5**
3	**6**	**2**	**9**	**6**	**2**	**9**	**6**	**2**	**9**	**6**	**2**	**9**
4	**1.5**	**8**	**10**	**1.5**	**8**	**10**	**1.5**	**8**	**10**	**1.5**	**8**	**10**
5	5	2	8	5	2	8	5	2	8	5	2	8
6	**1**	**3**	**8**	**1**	**3**	**8**	**1**	**3**	**8**	**1**	**3**	**8**
7	**2**	**2**	**7**	**2**	**2**	**7**	**2**	**2**	**7**	**2**	**2**	**7**
8	3	5	7	3	5	7	3	5	7			
9	**2.5**	**2**	**2**	**2.5**	**2**	**2**						
10	**5**	**6**	**4.0**	4	4	6	**4**	**4**	**6**	**4.0**	**4**	**6**

Table: Production schedules in year 1 to 4, Number of employees (L), Capital (K) and Output (VA). External production activities in bold.

Heterogeneity and Technical change in a toy example

Go Back

	Year 1	Year 2	Year 3	Year 4
$Vol(Y^t)_G$	0.09271	0.07196	0.06518	0.06880
$Vol(\overline{Y}^t)_G$	0.09742	0.07905	0.06795	0.07244
$Vol(Y_e^t)_G$	0.12089	0.09627	0.07297	0.07297
Solid Angle	0.28195	0.22539	0.15471	0.15471
$\text{tg}\theta_3^t$	1.3532	1.4538	1.51066	1.55133
$\text{tg}\varphi_1^t$	1.11765	1.09091	1.11475	1.05455
Malmquist Index		1.00460	1.02656	1.02859

Gini volume for the zonotopes Y^t; the zonotopes $\overline{Y}^t$ generated by the normalized production activities $\{\frac{a_j^t}{\|a_j^t\|}\}_{1\leq j\leq 10}$; the zonotopes Y_e^t generated by the external production activities; the solid angle; and the angles that account for the rate and direction of technical change.

What we do:

Go Back

1. Compare observed investment patterns in the French and Italian manufacturing sector
2. Introduce a new way to measure spikes without size dependence
3. Evaluate the dynamics of investment spikes and a set of firm performance variables

Results

$\Rightarrow$ Determinants of investment similar in both countries, but weaker effects on the performance of Italian firms

$\Rightarrow$ The costs and gains from investment differ by sector

The French and Italian datasets

Go Back

The Italian Micro.3 database (Istat)

- (open) panel combining information from census and corporate annual reports about all the firms with 20 employees or more operating in any sector of activity over 1996-2006.

The French EAE database (SESSI/INSEE)

- Longitudinal data on a virtually exhaustive panel of industrial French firms located on the national territory with 20 employees or more over 1996-2007.

$\Rightarrow$ Focus on the manufacturing industry i.e. ISIC (rev.3.1) 171 to 366

$\Rightarrow$ We also perform the analysis at the Pavitt sectoral level (Pavitt, 2004)

$\Rightarrow$ Exclude firms experiencing a radical restructuration during the period

'Observed' investment: acquisitions of tangible fixed assets

Let's look at it!

The variables

Go Back

Investment rate:	I_t/K_{t-1}
Number of employees:	$Empl_t$
Growth of employment:	$Empl.Growth_t = log(Empl_t) - log(Empl_{t-1})$
Labour productivity:	$Prod_t = VA_t/Empl_t$
Growth of labour productivity:	$Prod.Growth_t = log(Prod_t) - log(Prod_{t-1})$
Total sales:	$Sales_t$
Growth of total sales:	$Sales.Growth_t = log(Sales_t) - log(Sales_{t-1})$
Profit rate:	$Profit_t = GOM_t/Sales_t$

Investment lumpiness

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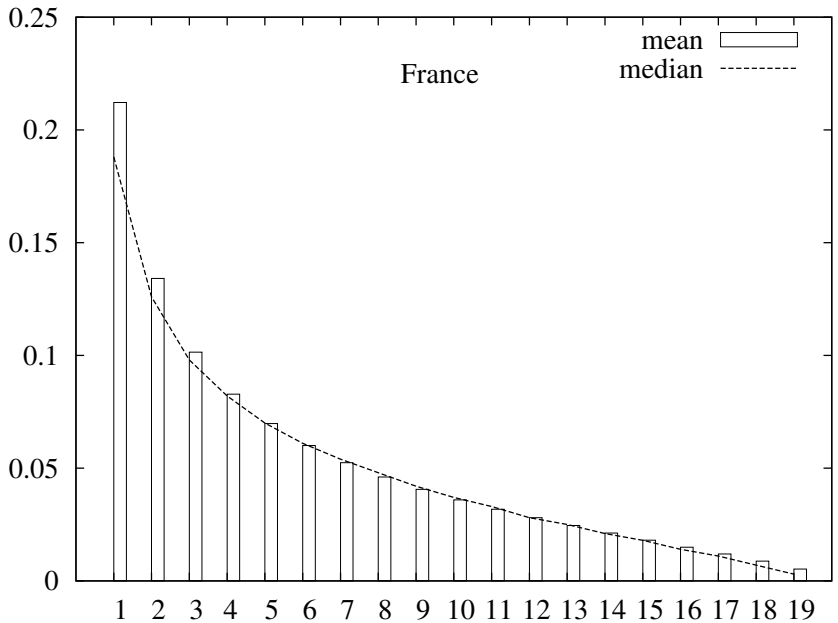
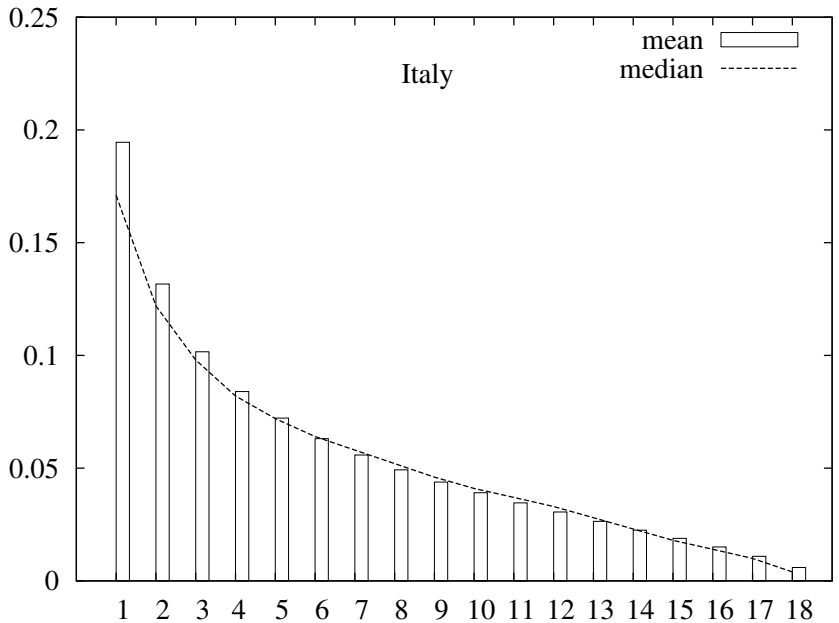
Figure: **Left**: Investment shares by rank from 1989 to 2007 in France ; **Right**: in Italy (1990- 2006).





- Biggest three episodes account for 1/2
- Most episodes of small scale

What is an investment spike?

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1. An investment spike is an irregular investment episode at the firm level and a rare event

   $\Rightarrow$ Thus spikes must account for a disproportionate share of total industry investments.

   $\Rightarrow$ The firm is not simply "adjusting" or replacing its capital stock

2. Several ways to define a spike with respect to the history of investment of a firm

   - **Absolute threshold**: Investment rate higher than a fixed threshold 20%, 35% Cooper et al (1995)
   - **Relative threshold**: Investment rate higher than the median (times a constant) Power (1998)
   - Adjusted measure to account for the size dependency of the investment rate Nilsen et al (2009), this paper

The size bias issue

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From the Gibrat law (firm growth is independent of its size) we would expect investment rates to be independent of firm size. BUT small firms are more likely to display high investment rates

$\Rightarrow$ the probability that a small firm has an investment ratio above a fixed threshold, is much larger than for a large firm (under-represent big firms)

$\Rightarrow$ This motivates that the threshold for an investment spike should also be decreasing in $K_{i,t-1}$

- **The linear fit** (Nilsen et al. 2009) sets a threshold rule that is negatively related with firm size according to a *log-linear function* in size ($K_{i,t-1}$):

$$E[(I_{i,t}/K_{i,t-1})|K_{i,t-1}] = \hat{\gamma}_0 + \hat{\gamma}_1 \ln K_{i,t-1}$$

$$I_t/K_{i,t-1} > \max[\alpha E[(I_{i,t}/K_{i,t-1})|K_{i,t-1}], 0.20]$$

Note : the parameters are computed for each Pavitt sector and each year

- **The exponential fit** : same with an exponential relation

The size bias issue II

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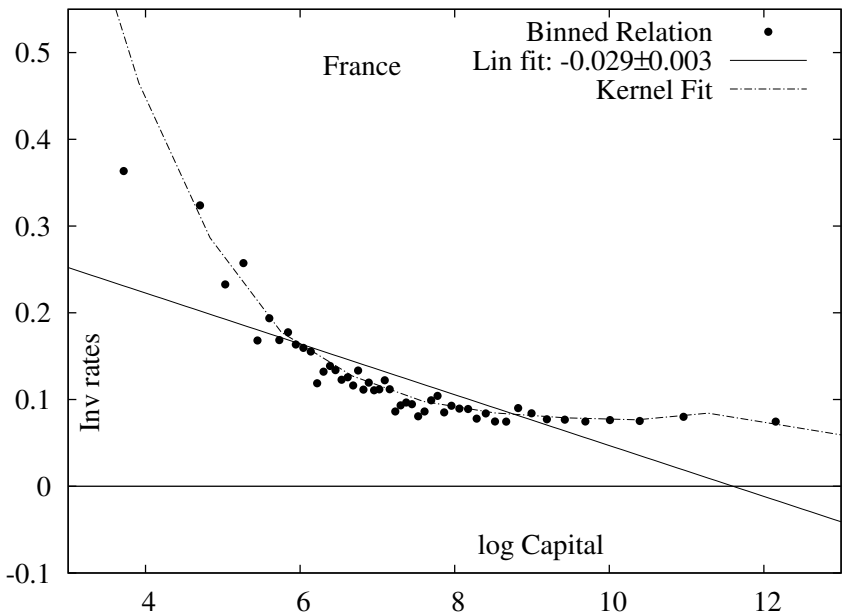
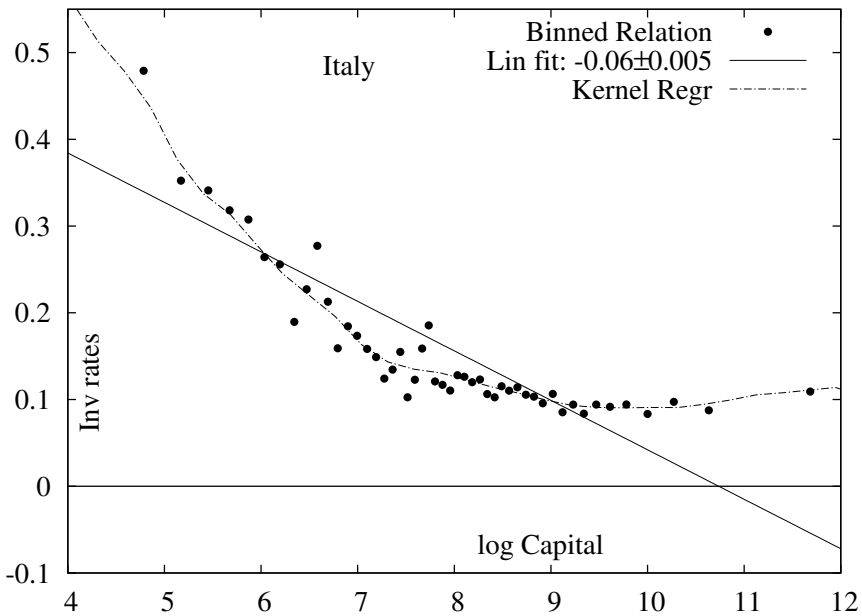
Figure: Linear vs kernel fit and spike threshold, 2003





- **The kernel fit** : no premises on the shape of the relationship, no minimum threshold:

$$I_t/K_{i,t-1} > \alpha E[(I_{i,t}/K_{i,t-1})|K_{i,t-1}]$$

Note : We estimate the kernel density function f : $I_t/K_{i,t-1} = f(\ln K_{i,t-1}) + e_{i,t}$