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Productivity Dynamics in Italian Manufacturing Firms: Preliminary Results

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1. Roadmap

- Where are we ?
  $\Rightarrow$ Some proposed regularities in Industrial Dynamics literature
- Our results on the Italian Database MICRO.1
- MICRO.1 $\Rightarrow$ A longitudinal panel data on Italian firms
- Other relevant measures of investigation
  $\Rightarrow$ Productivity and Profitability
- The Subbotin family of distribution
- Empirical Analysis

  $\rightarrow$ Parametric and Non-Parametric Analysis

2. Regularities in growth and size distributions of firms

Some stylized facts often put forward in the literature:

- Aggregate Analysis
- COMPUSTAT U.S. database on publicly traded firms

Size $\begin{cases} \Rightarrow \text{Stationarity of size distribution} \\ \Rightarrow \text{Log-normal shape} \end{cases}$

Scaling relation $\begin{cases} \Rightarrow \text{Negative relation b/w size} \\ \text{and variance of growth rates} \end{cases}$

Growth rates $\begin{cases} \Rightarrow \text{Unit-root nature of the growth process} \\ \Rightarrow \text{Growth rates display a Laplace shape} \end{cases}$

3. The Data

- MICRO.1 (Italian Statistical Office).
- Longitudinal data for about 8000 firms with number of employees greater than 19. Period 1989 – 1997.
- Balanced Panel $\Rightarrow$ possibility of keeping track of the same firm during the interval
- More variables available
- Firms are classified according to their sector of principal activity $\Rightarrow$ ATECO ($\sim$ SIC) code

4. Evidence on Italian MICRO.1

Size
- $\Rightarrow$ Stationary but heterogenous across sectors
- $\Rightarrow$ No Pareto tails (in most sectors)

Scaling relation
- $\Rightarrow$ Absence of relation b/w size and variance of growth rates

Growth rates
- $\Rightarrow$ Unit-root nature of the growth process
- $\Rightarrow$ Growth rates display a Laplace shape

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5. Productivity

What is it ?

- Measure of technical efficiency of production process;
- Output per worker or output per labor-hour
  $\rightarrow$ Labour Productivity (π_l)

What for ?

- Relation with the growth process of the firm
- So far attention mostly limited to investigate growth rate, due to scarce data availability

Purpose

- Employ Longitudinal Micro-level data (LMD) to investigate the behavior of variables closely related to the growth process of firms.

5.1. Measure of Productivity

Labour productivity (π_l) defined as value added (VA) over number of employees (L)

$$\pi_{l,i} = VA_i / L_i \tag{1}$$

From balance sheet report $\Rightarrow$ VA is the difference b/w total revenue and cost of input (excluding the cost of labour).

$$VA_i = S_i - C_{material} \tag{2}$$

- Simplest and most reliable measure of productivity
- It does not require any production function estimation

Normalization procedure:

$$\pi_{l,i}(t) = \log(\pi_{l,i}(t)) - < \log(\pi_{l,i}(t)) >_i$$

Growth rates: $g_{ij}(t) = \pi_i(t) - \pi_i(t-1)$

Empirical Evidence on Labour Productivity

Non-Parametric Analysis

- Labour Productivity distributions: Levels and growth rates

Parametric Analysis

- AR coefficients

Capital productivity (π_K) defined as the ratio between value added and fixed assets (K):

$$\pi_k = VA/K \tag{3}$$

Problems due to:

- Capital evaluation $\Rightarrow$ Which to choose? How to measure "internal" resources ?
- Balance sheet reporting $\Rightarrow$ Historical cost Vs. Residual value and different depreciation procedure

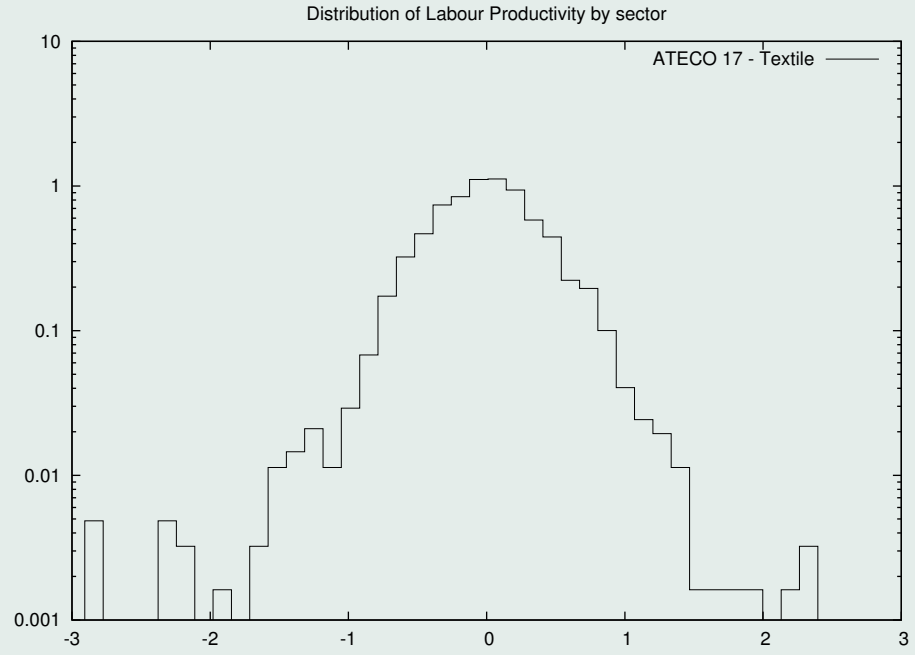


Figure 1: Distribution of Labour Productivity ATECO 17 - Textile (on log scale)

- Widespread heterogeneity within sectors

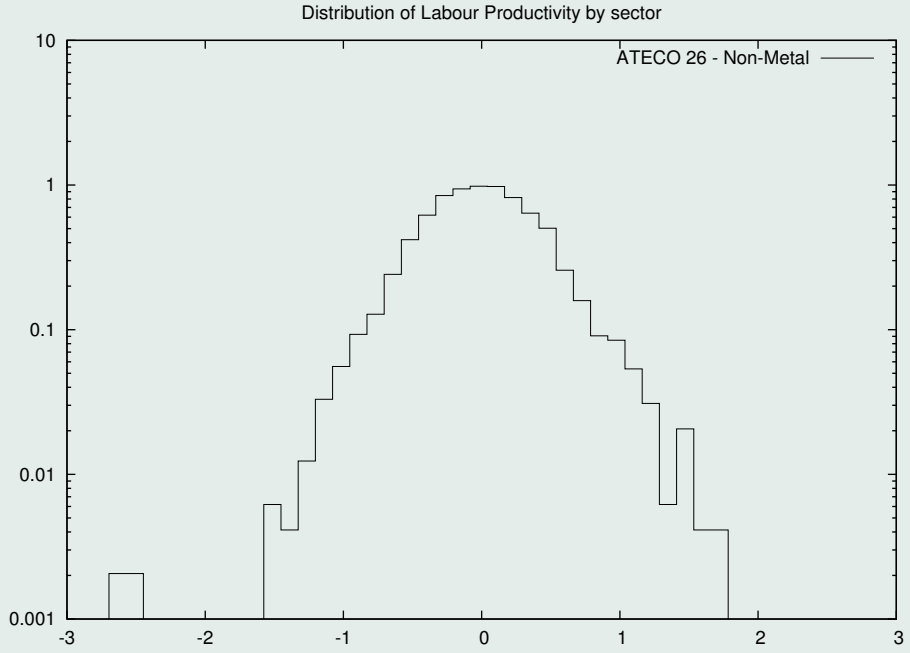


Figure 2: Distribution of Labour Productivity rate ATECO 26 - Non Metal (on log scale)

- Fat tailed distribution

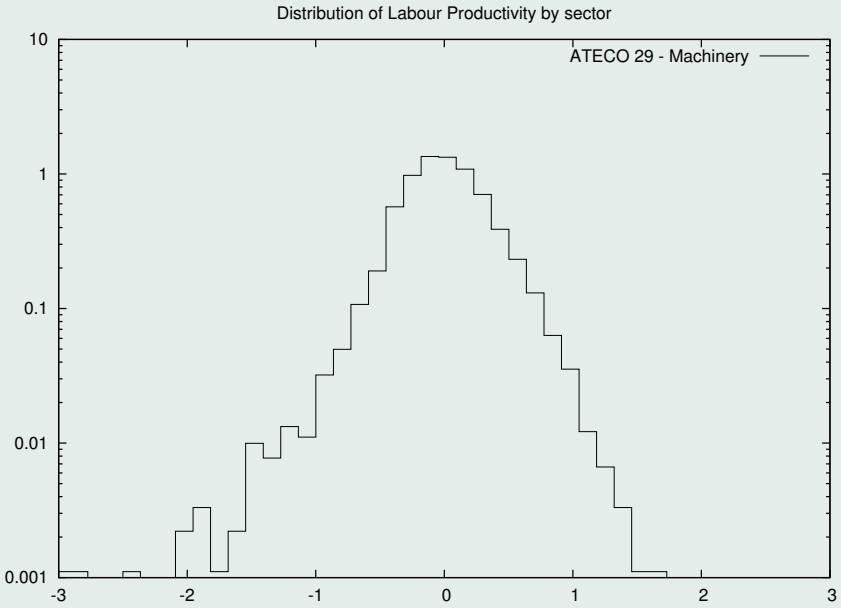


Figure 3: Distribution of Labour Productivity rate ATECO 29 - Machinery (on log scale)

- Skewed distribution

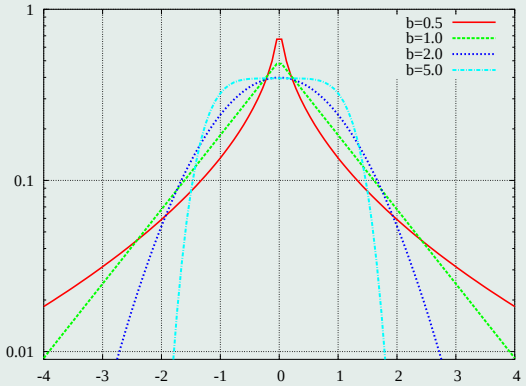
  $\Rightarrow$ heterogeneity across sectors

6. The Subbotin Distribution

Its functional form reads:

$$f_{\mathrm{S}}(x) = \frac{1}{2ab^{1/b}\Gamma(1/b+1)}\, e^{-\frac{1}{b}\left|\frac{x-\mu}{a}\right|^b} \tag{4}$$

where μ is a positioning parameter, a a width parameter and b a shape parameter. Notice that if $b = 1$ we recover the Laplace, if $b = 2$ the Gaussian and for $b \to \infty$ we have a Uniform distribution.



Subbotin distribution for different b

Mikhail Fyodorovich Subbotin (1883-1966)

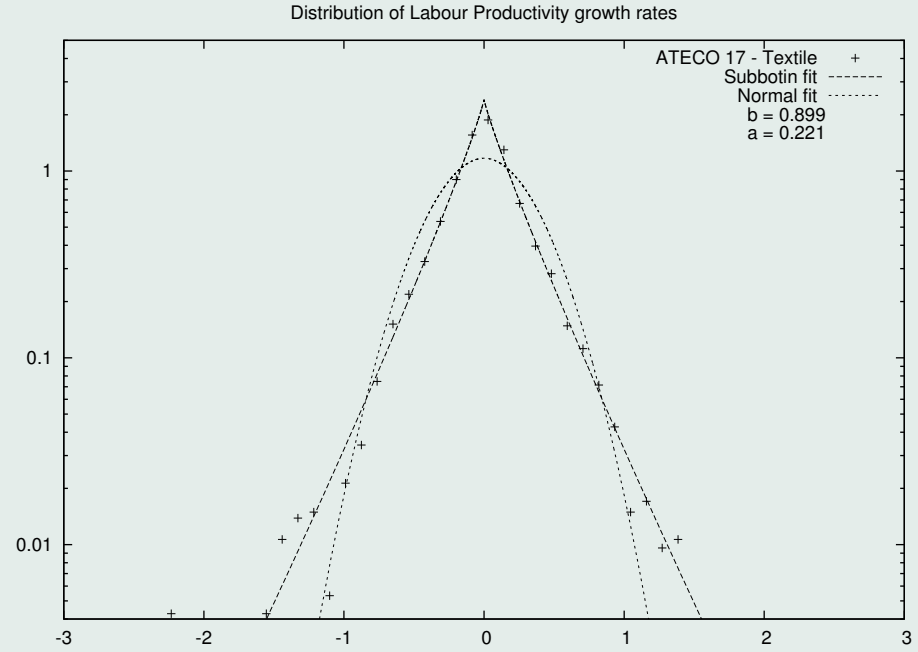


Figure 4: Distribution of Labour Productivity growth rate ATECO 17 - Textile (on log scale)

- Growth rates of π_l are tent-shape distributed $\rightarrow b \approx 1$

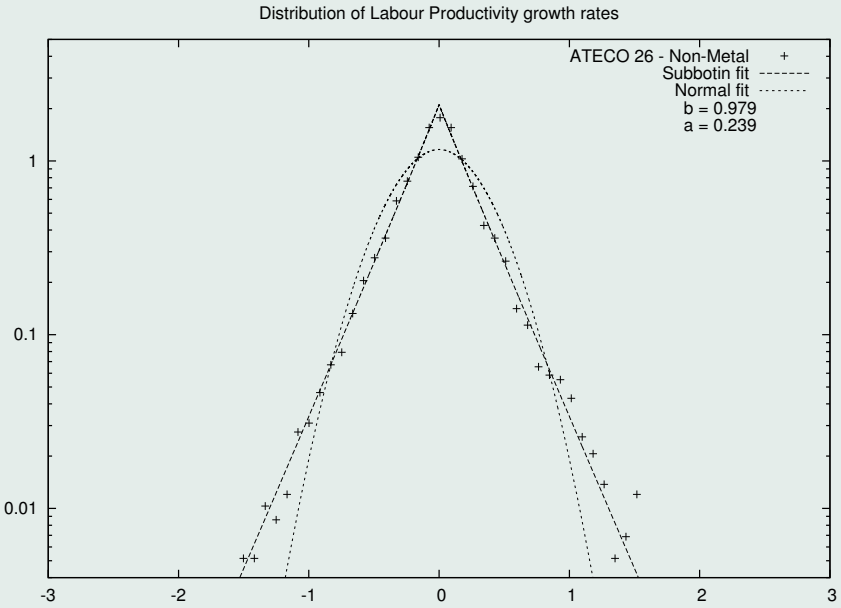


Figure 5: Distribution of Labour Productivity growth rate ATECO 26 - Non Metal (on log scale)

- Fat tails
- Note the order of magnitude of the very “worst” and “best” in the same sector

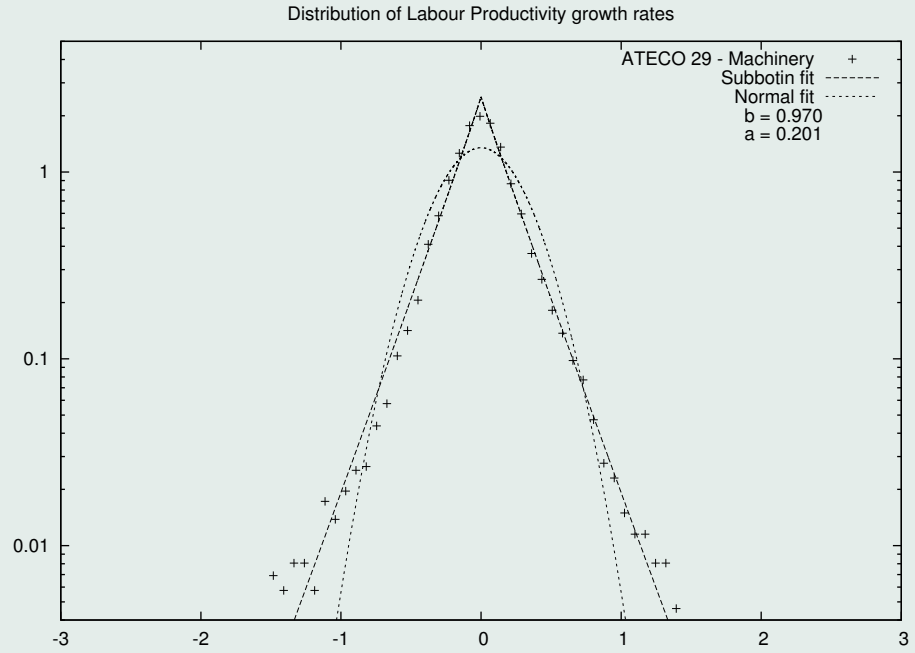


Figure 6: Distribution of Labour Productivity growth rate ATECO 29 - Machinery (on log scale)

- Symmetry of the distribution
  $\Rightarrow$ Homogeneity across sectors

Industrial Sectors	Ateco codes	Levels AR(1) coeff.	Levels Std. Dev.	Differences AR(1) coeff.	Differences Std. Dev.
Food Products and Beverages	15	0.8619	0.0092	-0.2641	0.0208
Textiles	17	0.8699	0.0076	-0.2770	0.0171
Apparel and Fur Dressing	18	0.9285	0.0087	-0.3428	0.0250
Leather; Luggage and Footwear	19	0.8932	0.0158	-0.3123	0.0398
Wood Manufacturing	20	0.8357	0.0154	-0.3254	0.0312
Paper and Allied Products	21	0.8772	0.0140	-0.2348	0.0030
Printing and Publishing	22	0.8391	0.0127	-0.1596	0.0319
Chemicals and Allied Products	24	0.7947	0.0132	-0.1883	0.0234
Rubber and Plastics Products	25	0.8920	0.0108	-0.2831	0.0244
Other Non-Metallic Mineral Prod.	26	0.9057	0.0077	-0.3065	0.0195
Basic Metals	27	0.8583	0.0135	-0.1645	0.0270
Metal Products, except Machinery	28	0.8572	0.0079	-0.3299	0.1580
Industrial Machinery and Equip.	29	0.8098	0.0079	-0.3177	0.0143
Electrical Machinery and Appar.	31	0.8534	0.0119	-0.1072	0.0236

Autocorrelation of Productivity: Levels and Growth Rates

- Strong persistence in Labour Productivity
- Mean reversion tendency

7. Measure of Profitability

Gross Margin (GM_i) is the result generated by the productive activity of a company:

$$GM_i = \underbrace{S_i - (C * M_i}_{VA} + W * L_i) \tag{5}$$

- S_i revenue from sales;
- $C * M_i$ cost of direct materials;
- $W * L_i$ cost of labour.

GM only accounts for profits exclusively related to the industrial activity $\Rightarrow$ do not consider "corrections" due to tax smoothing procedure or financial situation.

Major findings on Profitabilities

We consider the distribution of GM and its persistence.

- Wide distribution of profitabilities across firms characterize all sectors (quite stable over time)
- Stability over time
- Some (mild) regression to the mean

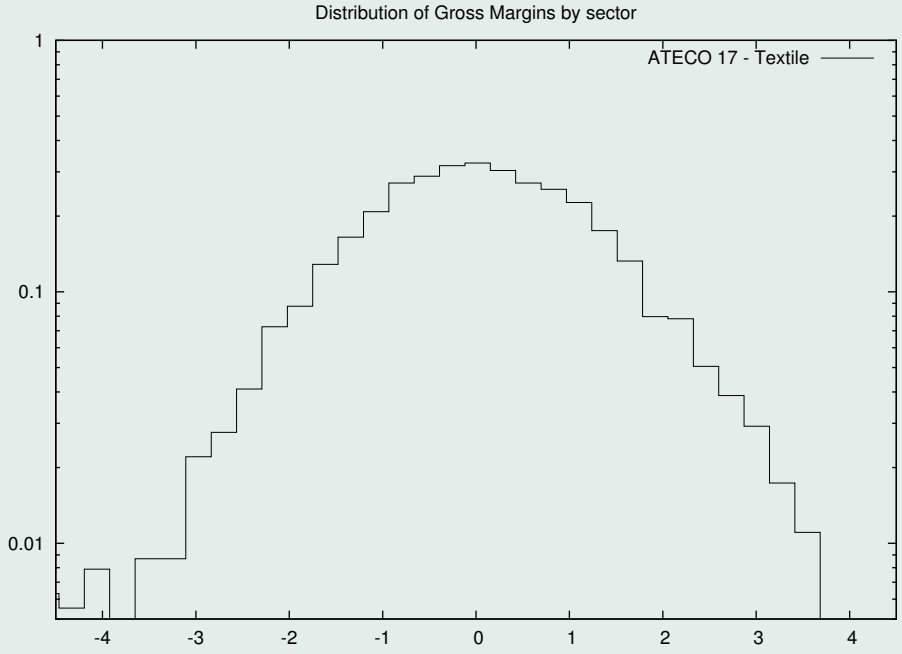


Figure 7: Distribution of Gross Margins ATECO 17 - Textile (on log scale)

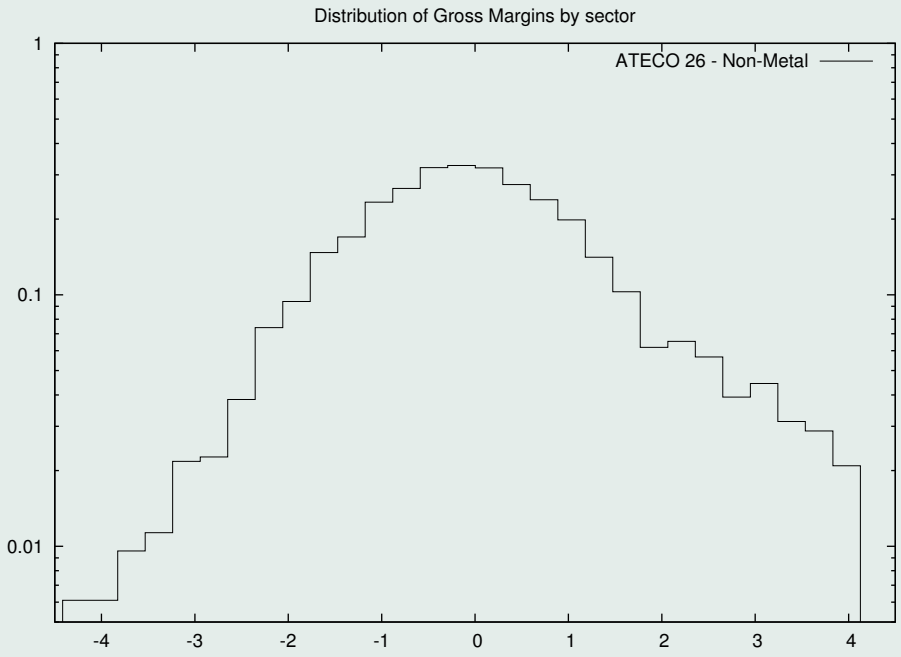


Figure 8: Distribution of Gross Margins ATECO 26 - Non Metal (on log scale)

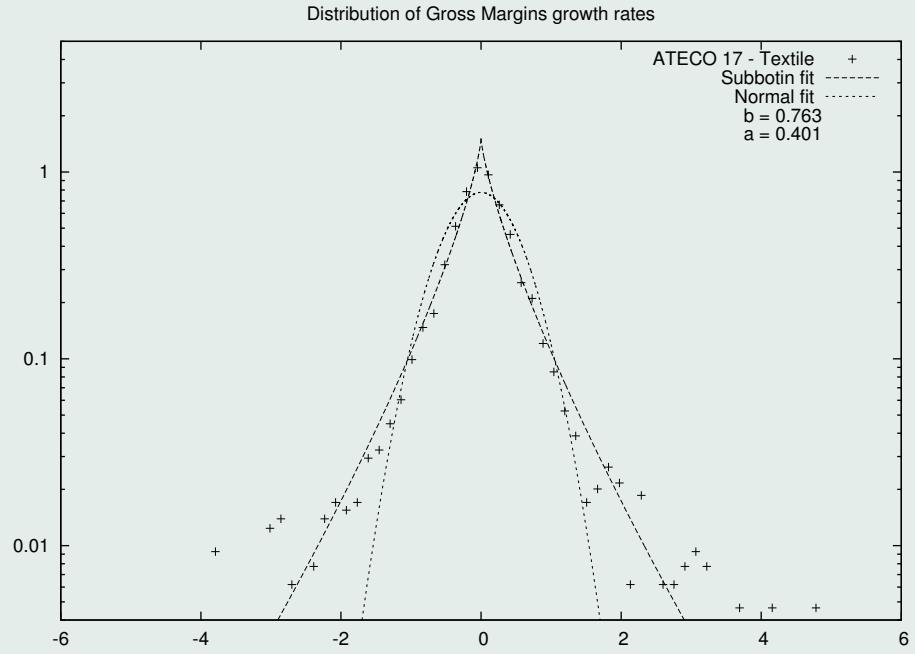


Figure 9: Distribution of Gross Margins growth rate ATECO 17 - Textile (on log scale)

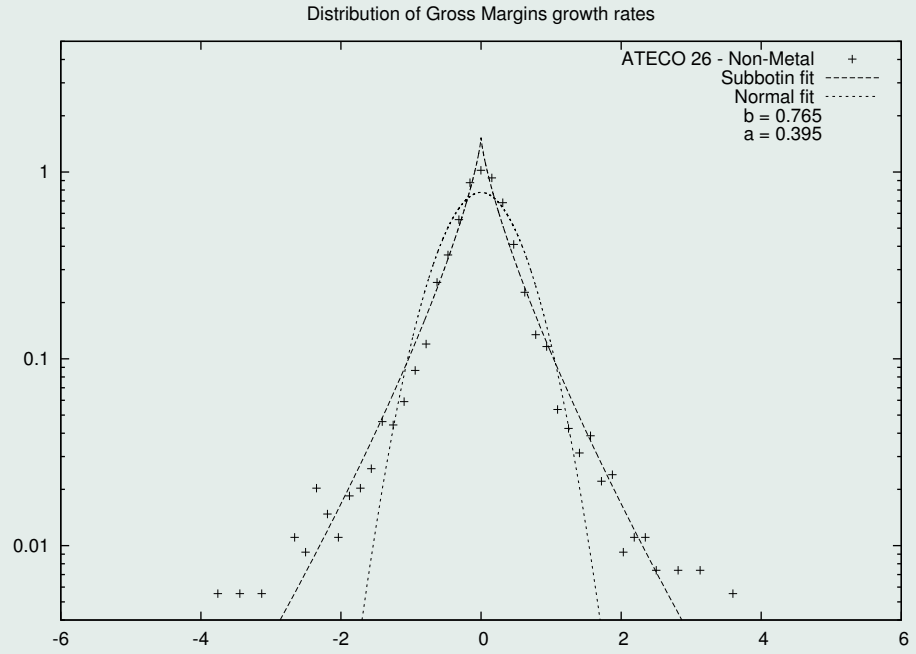


Figure 10: Distribution of Gross Margins growth rate ATECO 26 - Non Metal (on log scale)

Industrial Sectors	Ateco codes	Levels		Differences	
		AR(1) coeff.	Std. Dev.	AR(1) coeff.	Std. Dev.
Food Products and Beverages	15	0.9516	0.0060	-0.3424	0.0190
Textiles	17	0.9117	0.0067	-0.2953	0.0163
Apparel and Fur Dressing	18	0.9328	0.0087	-0.3992	0.0254
Leather; Luggage and Footwear	19	0.8781	0.0144	-0.2984	0.0307
Wood Manufacturing	20	0.9430	0.0115	-0.3658	0.0332
Paper and Allied Products	21	0.9432	0.0104	-0.2935	0.0298
Printing and Publishing	22	0.9471	0.0098	-0.3917	0.0293
Chemicals and Allied Products	24	0.9370	0.0081	-0.3315	0.0216
Rubber and Plastics Products	25	0.9203	0.0085	-0.2917	0.0208
Other Non-Metallic Mineral Prod.	26	0.9430	0.0067	-0.3337	0.0190
Basic Metals	27	0.9149	0.0101	-0.3245	0.0248
Metal Products, except Machinery	28	0.9213	0.0064	-0.2957	0.0155
Industrial Machinery and Equip.	29	0.9207	0.0055	-0.3215	0.0137
Electrical Machinery and Appar.	31	0.9649	0.0086	-0.2382	0.0265

Autocorrelation of Gross Margins: Levels and Growth Rates

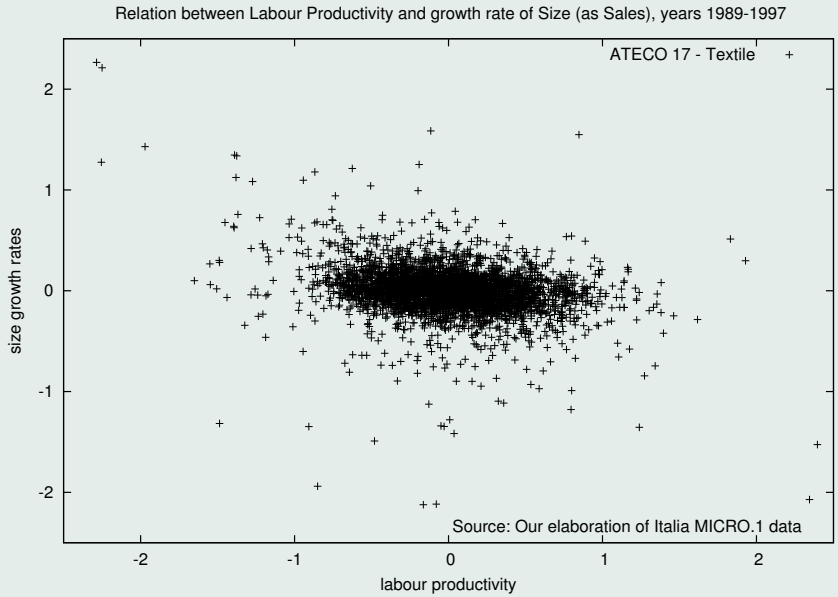


Figure 11: Relation b/w Labour Productivity and size growth rate ATECO 17 - Textile (on log scale)

Relation between growth and relative productivity is weak or non existent

$\Rightarrow$ More efficient firms do not grow more

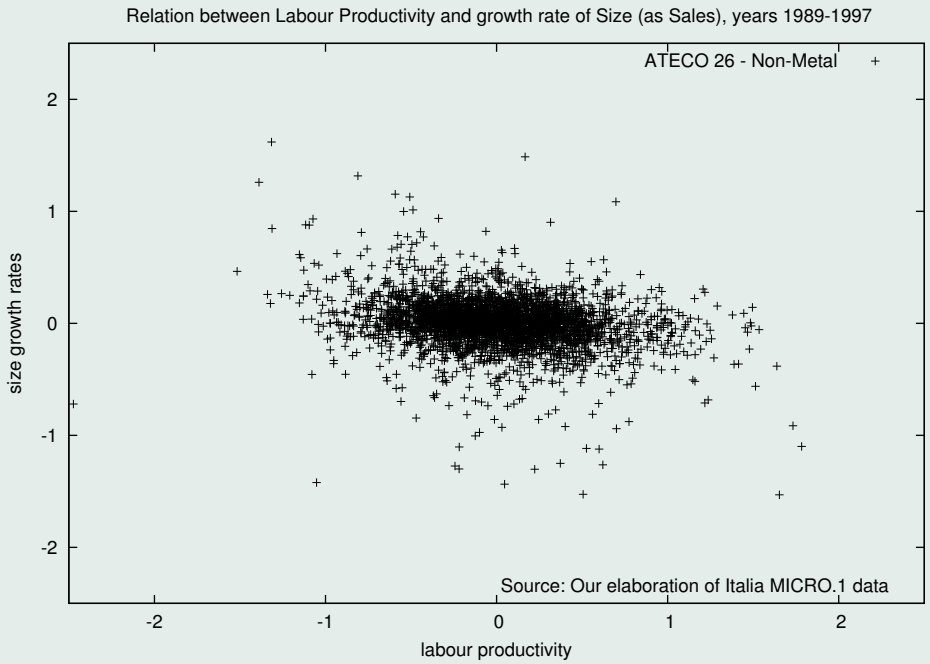


Figure 12: Relation b/w Labour Productivity and size growth rate ATECO 26 - Non Metal (on log scale)

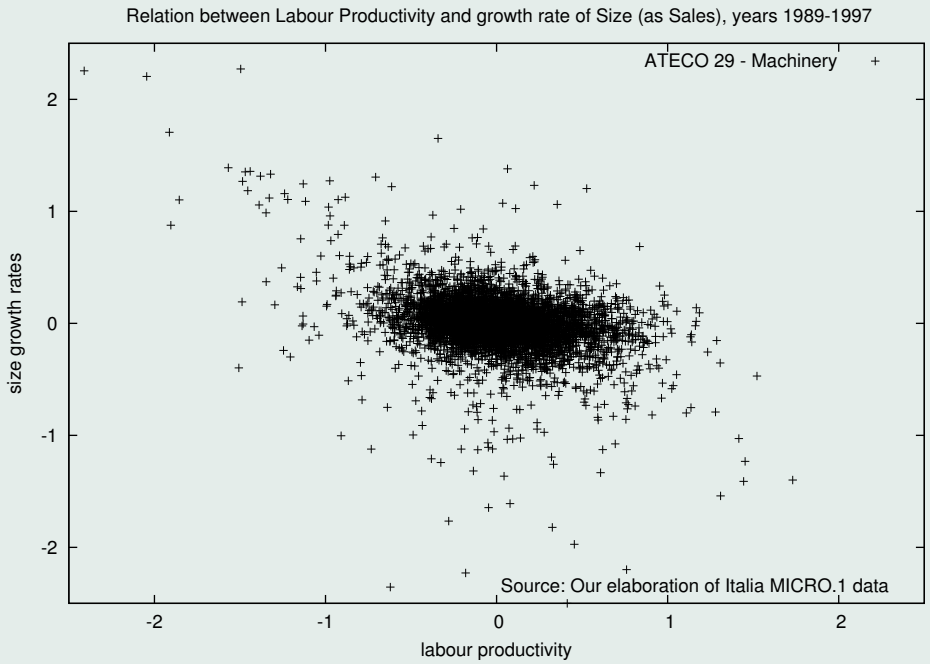


Figure 13: Relation b/w Labour Productivity growth rate ATECO 29 - Machinery (on log scale)

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Essential References

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