Turbulence underneath the big calm? The micro-evidence behind the Italian productivity dynamics

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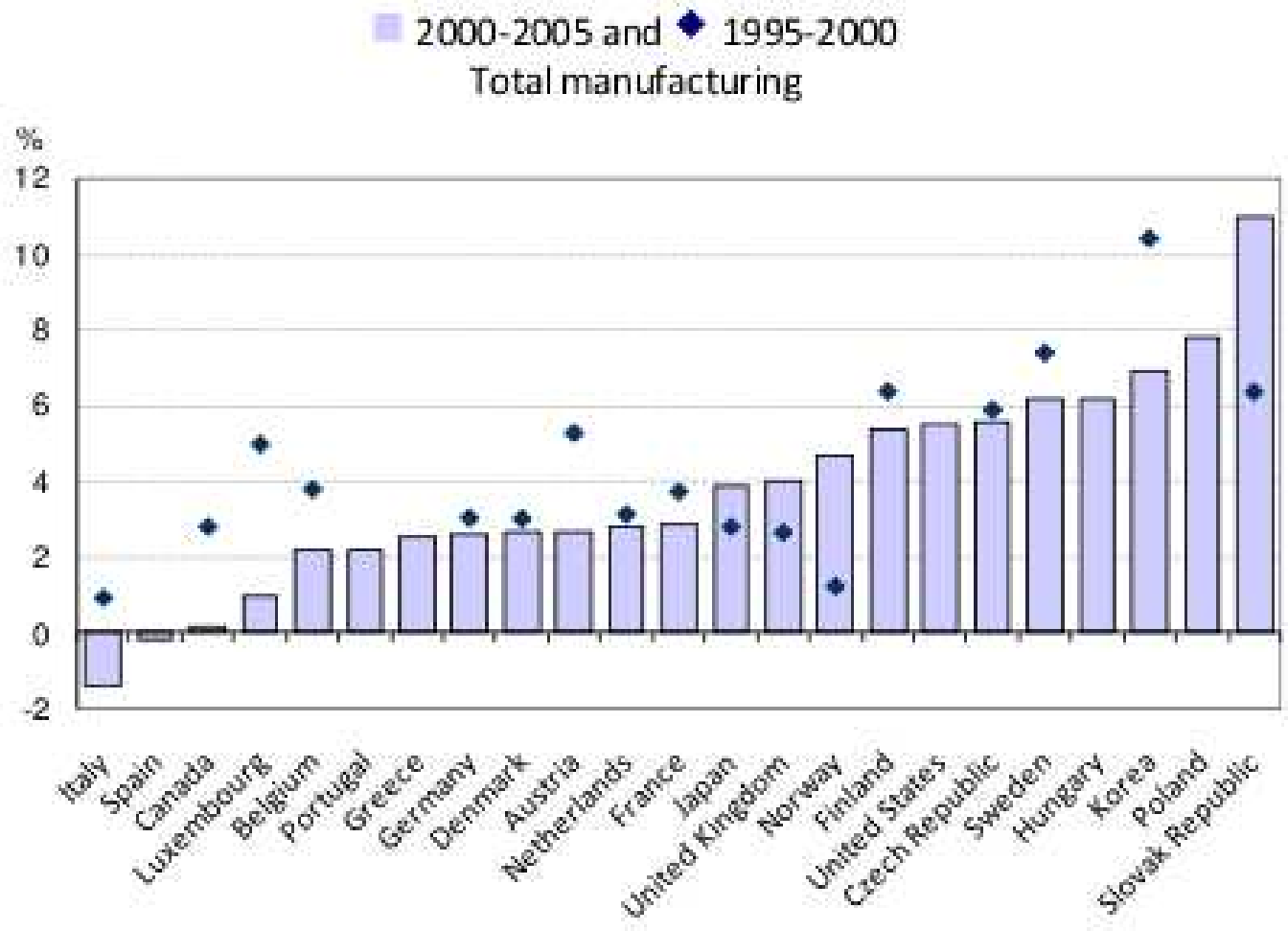
Outline

Motivation

- Flat aggregate manufacturing productivity in the last 15 years in Italy.
- What is the dynamics of firms behind the flat aggregate trend?
  - Which factors drove productivity growth of the few ‘virtuous’ firms?
- What was the effect of the euro introduction on the firm level distribution of productivity?
  - Any evidence of pro-competitive effects of euro adoption through reallocation of market shares?

Growth of manufacturing labor productivity (OECD, 2008)



Related Literature

- Model of industry dynamics
  - Jovanovic (1982); Hopenhayn (1992); Ericson and Pakes (1995). Also encompassing intern. trade (Melitz; 2003; Melitz and Ottaviano; 2008).
- Heterogeneous firms literature
  - Dunne et al. (1989); Haltiwanger et al. (1999); Bartelsman and Doms (2000)
- How to account for these differences across firms
  - Winter (1987); Teece et al. (1994); Dosi and Grazzi (2006)
- Decomposition of sectoral productivity growth
  - Baily et al. (1992); Foster et al. (2001); Baldwin and Gu (2006); Bottazzi et al. (2010)
- Euro introduction: trade liberalization with perfectly fixed exchange rates. A (very) long transient?
  - Lilien (1982); Davis et al. (1996); Bugamelli et al. (2010)

The Database Micro.3 1989-2004

- Micro.3 is the census of Italian firms bigger than 20 employees (change in data collection in 1998)
  - More than 40% of employment in the manuf. industry
  - More than 50% of value added in the manuf. industry
  - unbalanced panel of over 100,000 firms
- Integrated sources of data $\Rightarrow$ Istat Census (SBS like), Financial Statements, CIS, trade, patents.
- Censorship of any individual information; data accessible at Istat facilities.

$\Rightarrow$ A Plus From 1998 availability of financial statements that is a legal requirements for *all* incorporated firms.

VA per employee Micro.3 (top) Vs. Eurostat (bottom)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
15	54.9	55.1	56.6	57.6	58.9	58.3	58.0	61.1	60.1	58.9
17	43.0	40.6	42.2	40.8	40.8	43.2	42.0	41.8	40.2	41.4
18	32.3	32.1	30.8	32.3	31.7	34.6	35.9	35.8	34.7	36.4
19	37.4	35.4	31.2	32.6	34.4	37.1	37.2	37.2	36.7	38.3
24	84.1	77.0	76.3	79.6	79.7	82.0	77.6	83.5	78.4	82.1
25	52.2	51.6	50.3	49.4	50.9	49.8	48.1	50.7	49.0	49.0
27	67.2	56.5	60.6	58.1	56.5	58.7	53.7	55.1	55.5	60.2
28	46.3	46.9	45.1	44.0	44.6	45.6	45.7	47.3	45.7	45.8
29	53.5	52.3	50.9	50.7	51.0	53.0	52.3	52.8	50.7	52.3
33	49.8	47.6	48.1	49.4	48.4	51.5	52.2	56.5	51.3	55.2
34	46.6	39.6	52.1	43.8	44.1	45.7	40.7	48.6	42.0	52.1
35	52.2	43.8	43.3	43.7	46.2	54.2	51.8	54.3	51.4	58.5
36	39.1	37.7	37.6	38.4	39.5	40.3	39.9	38.9	37.5	37.7

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
15	49.2	53.8	51.6	55.4	53.8	53.1	52.7	56.1	...	...
17	37.5	40.3	40.6	40.7	40.4	42.8	42.2	41.5	40.2	41.2
18	27.3	30.1	29.0	29.5	28.9	34.1	32.9	33.0	29	32.7
19	31.0	34.4	31.0	33.4	36.3	35.8	35.3	33.7	31.6	35.2
24	75.2	80.0	77.8	79.0	81.3	81.1	75.6	78.4	77.6	74.2
25	44.5	49.9	47.8	49.5	49.5	49.3	49.3	51.4	49.0	48.6
27	59.7	56.4	59.7	56.9	56.2	59.5	54.0	54.6	54.9	58.0
28	39.7	47.5	46.5	46.9	45.3	46.5	47.4	46.7	46.4	44.9
29	48.5	54.6	51.0	50.4	50.7	53.0	53.3	52.6	51.4	53.8
33	46.8	51.0	49.5	49.6	50.2	56.1	53.1	58.5	52.6	56.9
34	43.0	40.6	51.3	43.9	41.2	44.7	40.8	36.0	41.4	41.2
36	33.0	38.3	38.3	39.8	37.8	41.9	40.9	39.8	37.4	37.7

Averages and Distributions

- Micro.3 replicates the aggregate flat trend in productivity.
- Value added per worker is slightly bigger in Micro.3 $\Rightarrow$ Size-Productivity relation
- Composition bias effect
  $\Rightarrow$ In Micro.3 there are only firms bigger than 20 employees

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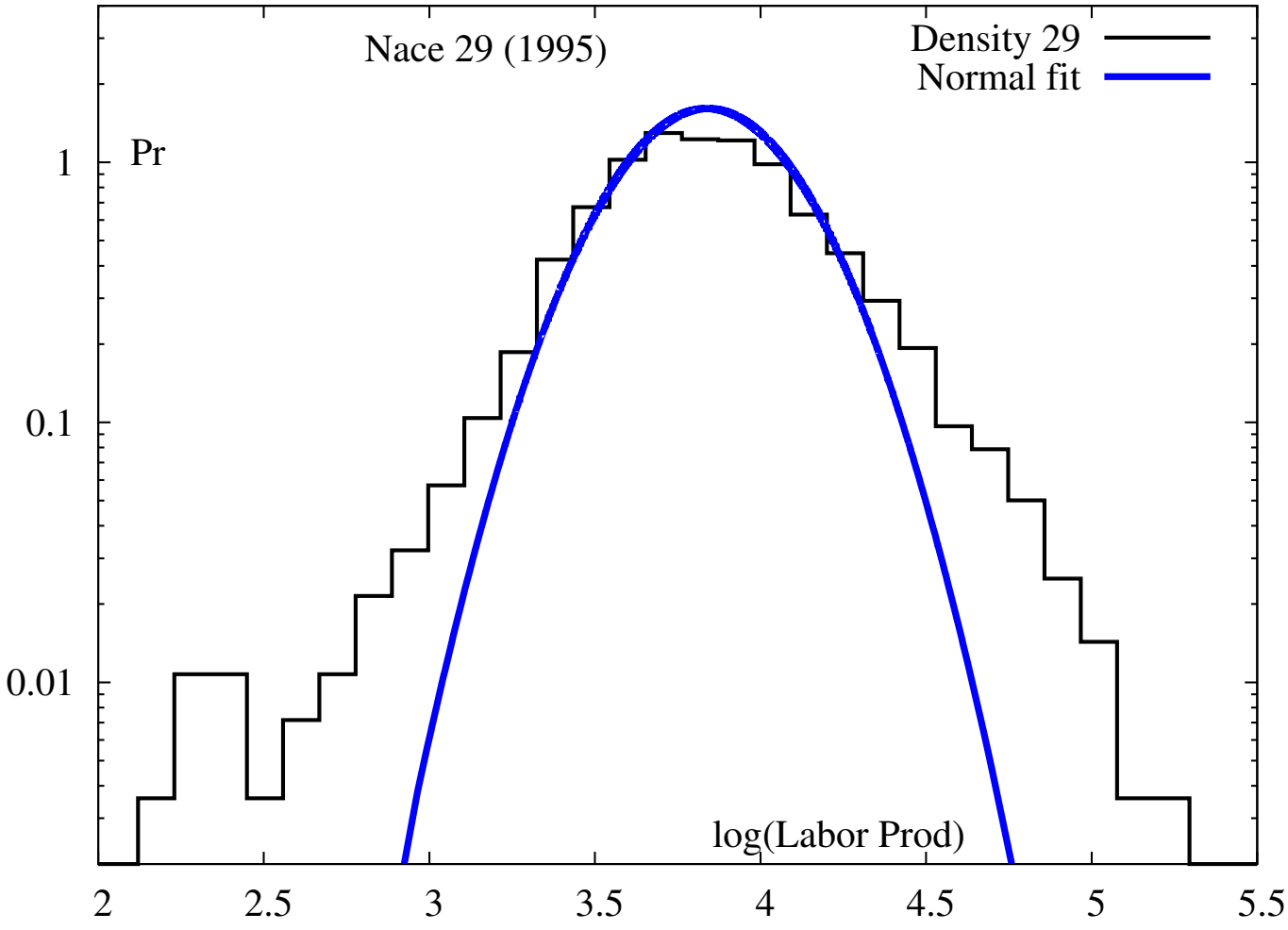
Distributional Analysis I

- (Why do we look at the distributions?)
- Heterogeneities in the distribution of labor productivity
- Heterogeneity is not a property of the level of aggregation 2 Vs. 3 digit sectors (see Griliches and Mairesse; 1999).
- No apparent shock after euro introduction.
  - nor in the central tendency
  - neither in the width of the support
- Asymmetries in the distribution of productivities

  $\Rightarrow$ distributional analysis part II

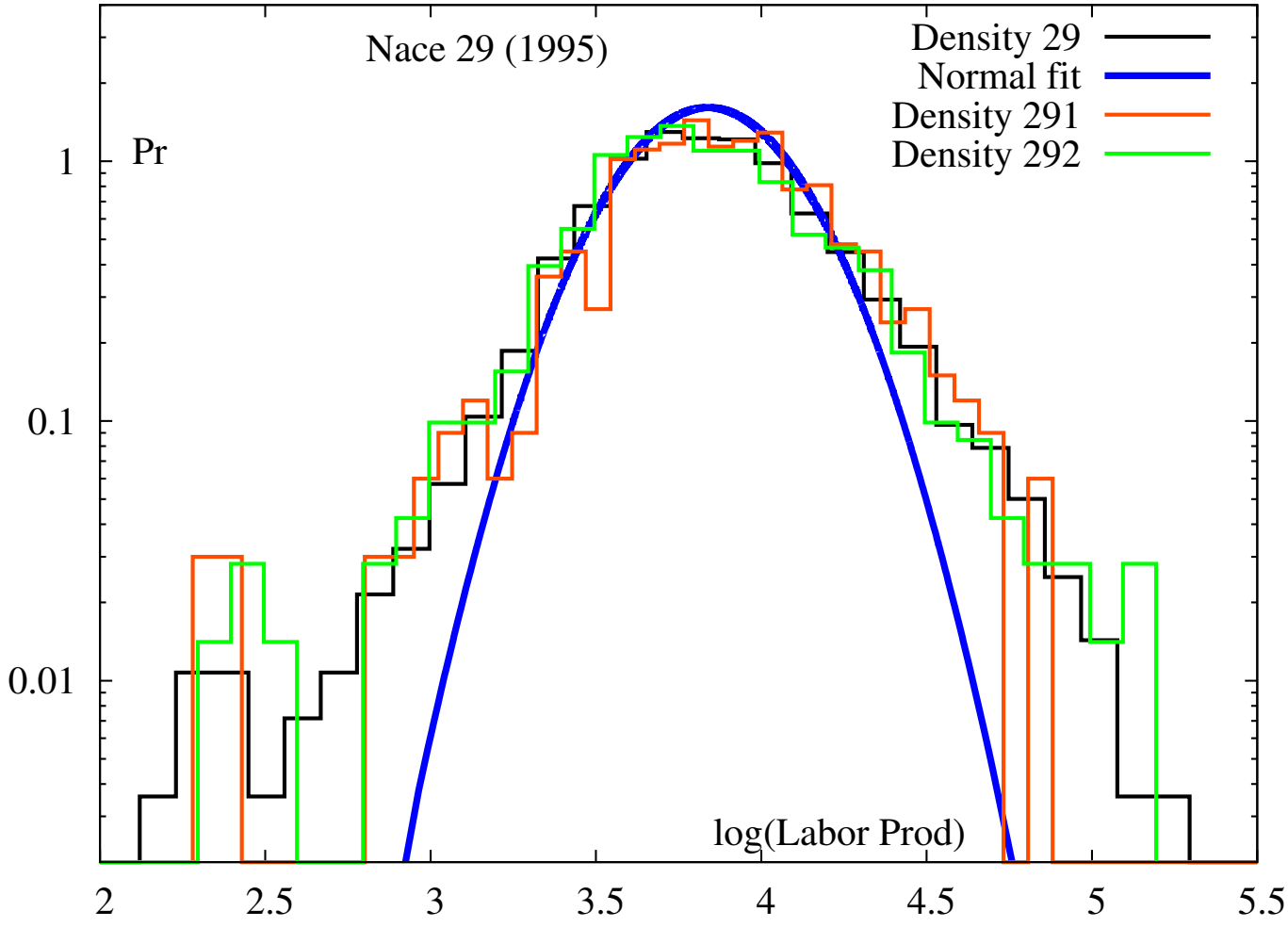
2 Digit NACE 29



Width of the support as compared to a normal fit (blue line)

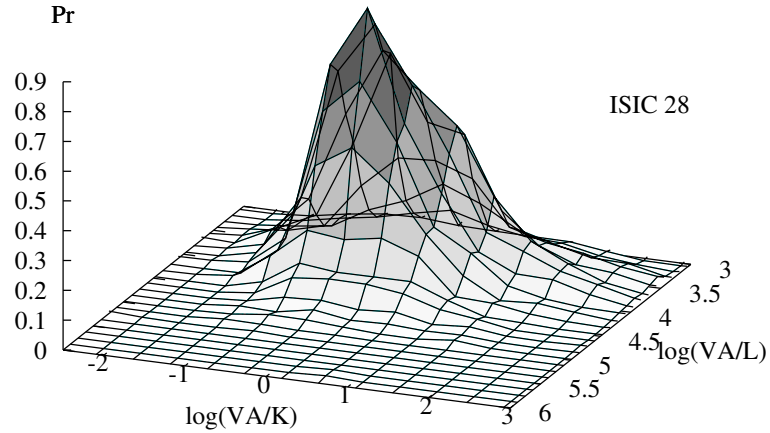
$\exp(2.5) \sim 12,000$ euro vs $\exp(5) \sim 150,000$ euro

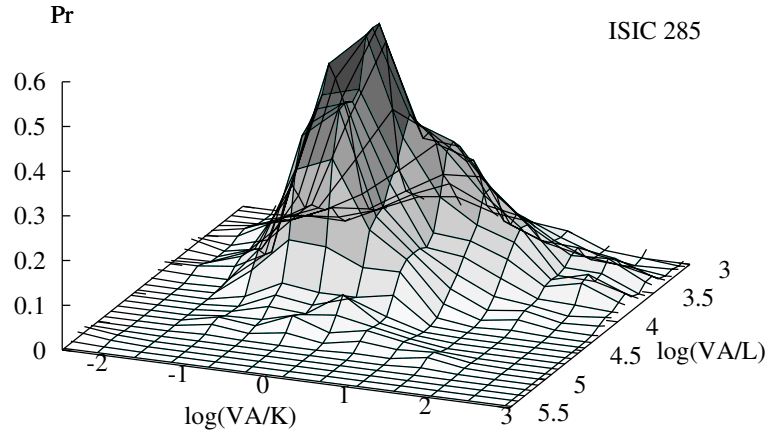
Distribution of Labor Productivity 2 and 3 Digit

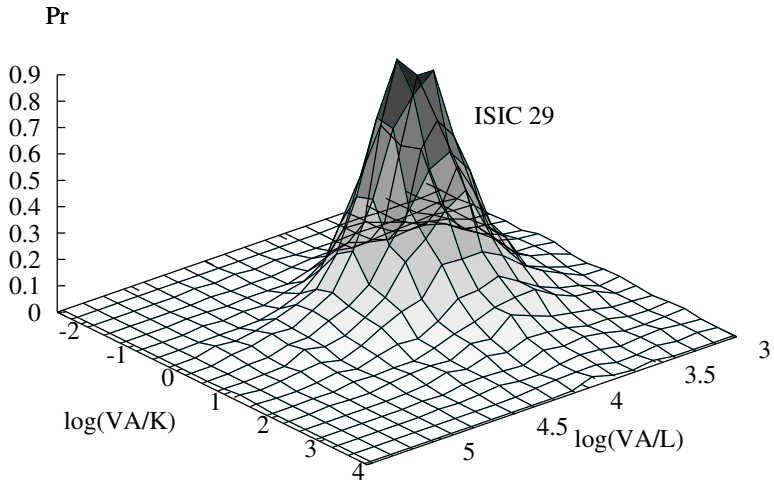


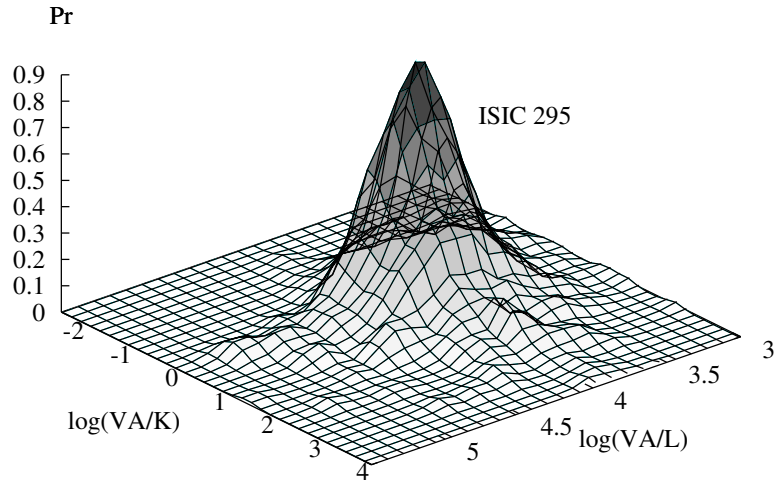
Labor productivity for NACE 29 and two nested 3 digit sectors.

Input intensities at 2 and 3 digit (Bottazzi et al.; 2005; Dosi and Grazzi; 2006)







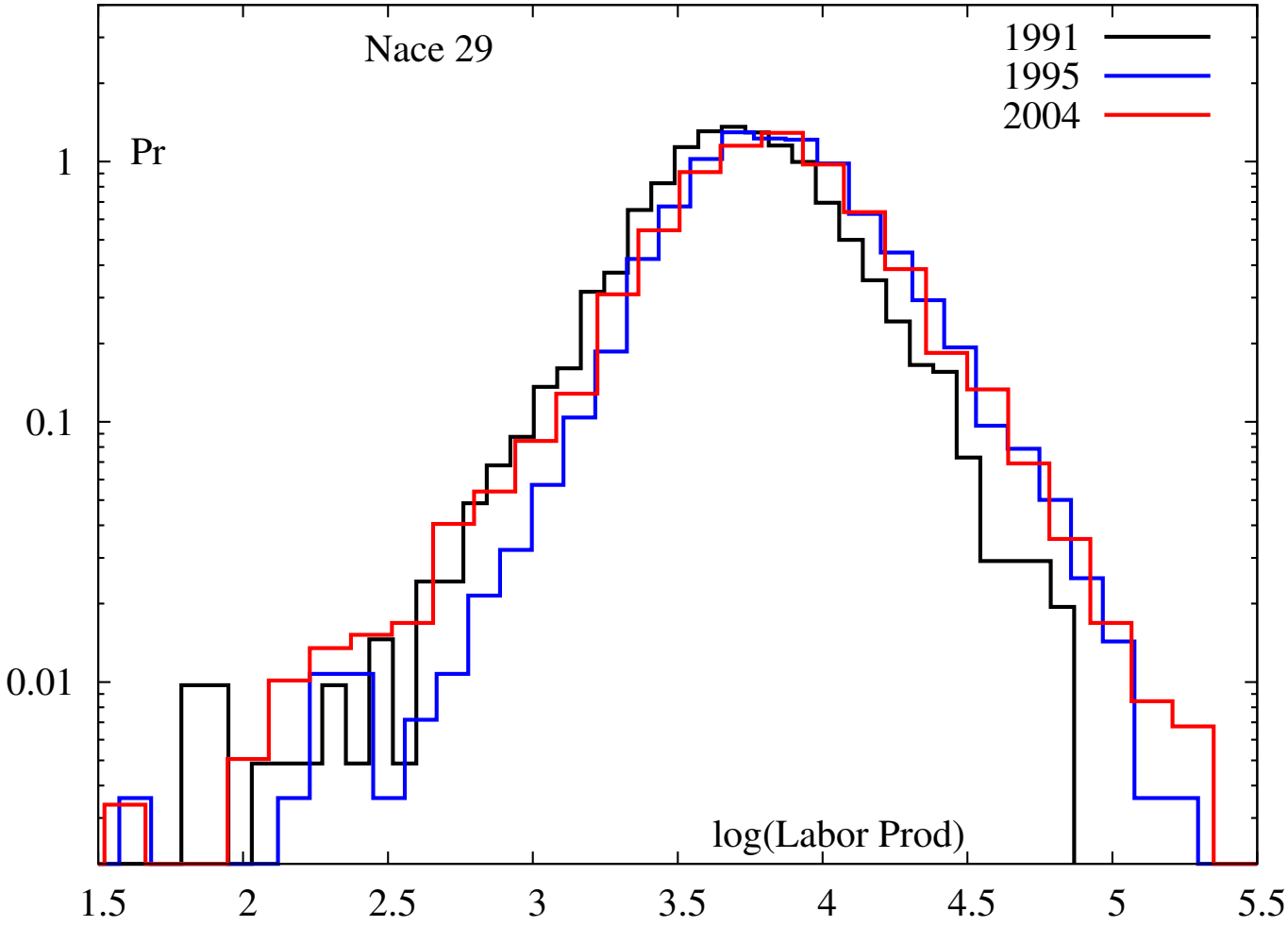


Input intensities and the 'puzzle' of disaggregation

"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 form each others as the steel industry is from the machinery industry."

From Griliches and Mairesse (1999)

Widening of the support over time



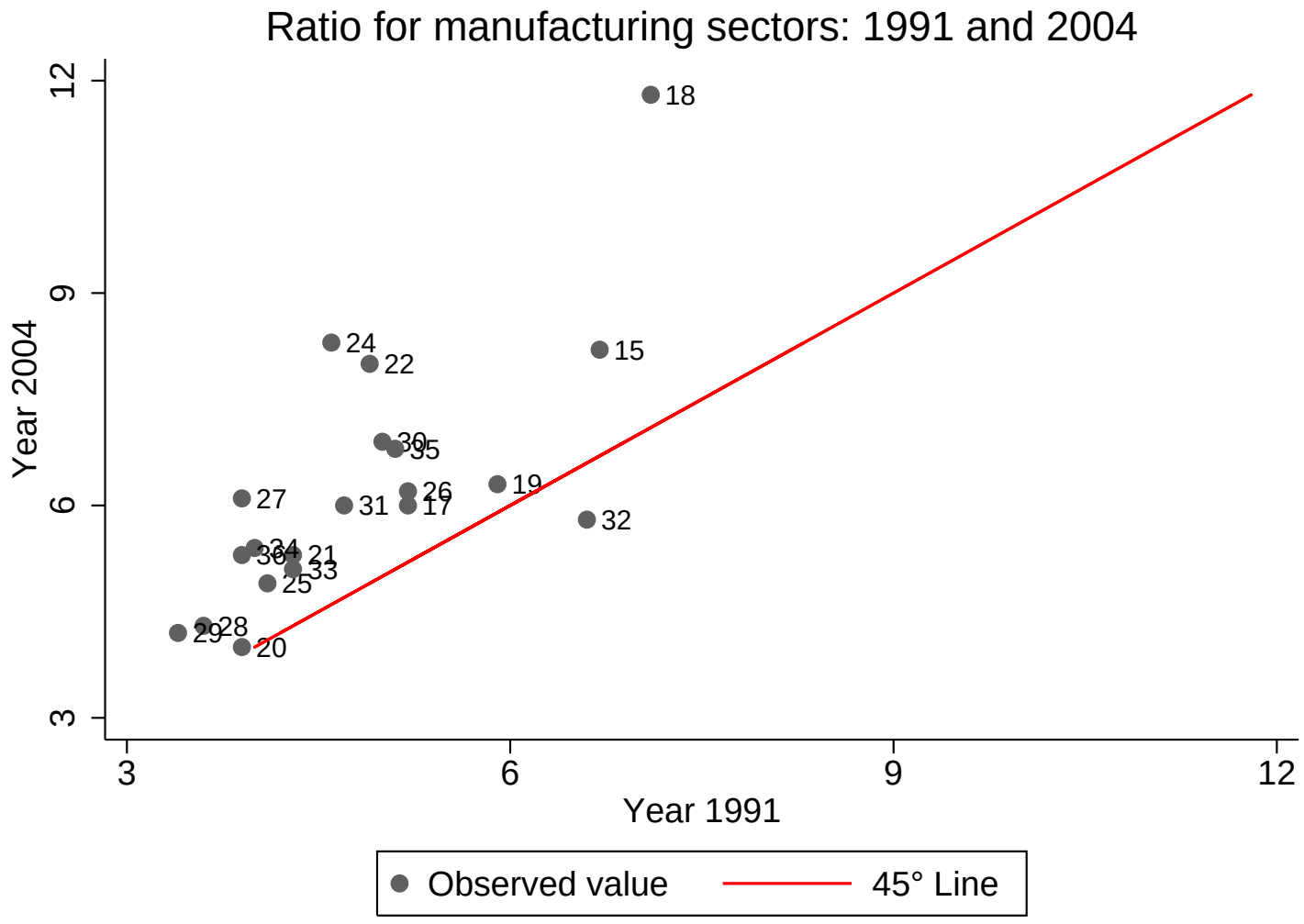
No shrink of the support over time (pre- post euro)

Top to Bottom productivity ratio

NACE	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04
15	6.7	6.3	7.2	6.4	5.9	6.1	7.6	8.0	8.2	7.9	8.1	8.3	7.9	8.2
17	5.2	6.0	6.4	6.2	6.3	6.2	5.7	6.3	6.2	5.7	5.9	5.6	5.7	6.0
18	7.1	7.6	8.2	7.1	7.4	8.5	7.0	9.1	10.9	11.5	11.1	10.9	10.6	11.8
19	5.9	6.7	6.0	6.1	6.0	6.6	6.1	6.0	6.3	6.5	5.9	6.6	6.3	6.3
20	3.9	4.2	4.1	4.1	5.1	4.7	4.5	4.1	4.3	5.1	4.4	4.6	4.6	4.0
21	4.3	3.9	4.5	5.0	5.5	6.6	5.2	6.1	5.3	6.4	5.2	4.7	4.5	5.3
22	4.9	5.5	5.8	5.3	5.6	6.6	6.8	7.4	8.2	6.8	6.5	7.8	8.1	8.0
24	4.6	4.8	5.2	5.9	6.2	6.3	5.8	8.3	7.8	8.6	8.5	7.0	7.7	8.3
25	4.1	4.3	4.9	5.0	5.1	5.2	4.6	4.6	4.5	4.9	4.2	4.5	4.4	4.9
26	5.2	5.6	5.6	5.3	5.3	5.6	5.4	5.0	5.4	6.0	5.4	5.8	5.9	6.2
27	3.9	5.2	4.5	4.7	5.4	5.6	4.7	4.7	4.9	5.0	5.0	4.9	4.9	6.1
28	3.6	3.7	3.8	3.9	4.1	4.2	4.1	4.3	4.2	4.5	4.3	4.2	4.2	4.3
29	3.4	3.6	3.9	3.6	3.5	4.4	3.9	4.3	4.2	4.3	4.2	4.1	4.2	4.2
30	5.0	6.6	5.9	5.0	6.0	8.3	12.1	8.7	12.3	11.2	17.7	8.3	5.6	6.9
33	4.3	4.6	4.8	4.8	5.1	4.7	5.5	4.9	5.7	5.8	5.3	5.9	5.3	5.1
34	4.0	4.0	4.9	4.8	4.2	4.1	4.2	5.1	5.4	5.2	5.5	5.2	4.4	5.4
35	5.1	8.8	7.2	5.1	5.2	6.3	4.4	5.4	7.1	6.7	7.1	8.5	7.0	6.8
36	3.9	3.9	4.4	4.1	4.3	5.5	4.1	4.7	5.1	5.2	4.8	4.9	5.3	5.3

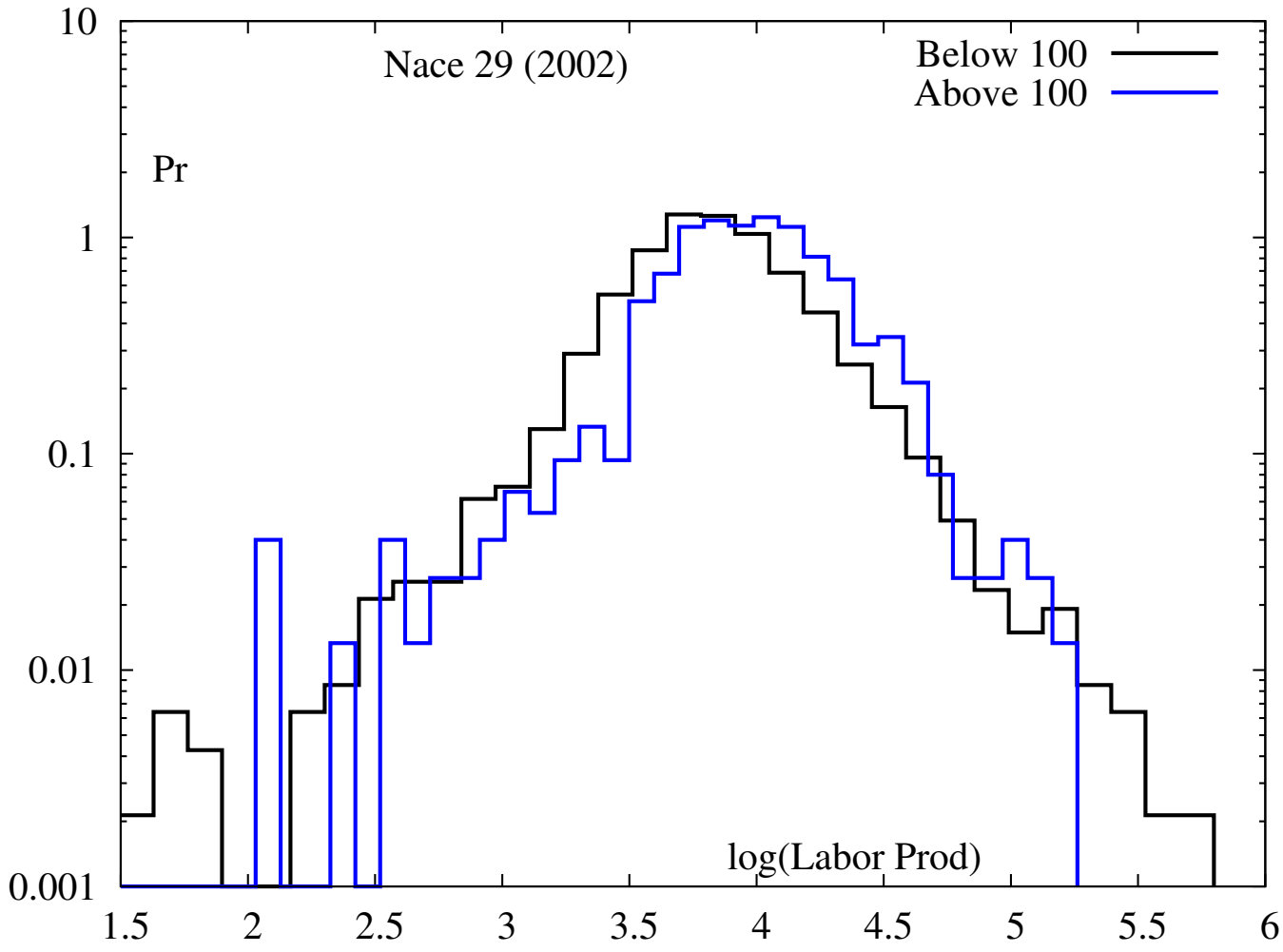
The support of the distribution widened over time

Top to Bottom productivity ratio



The support of the distribution widened over time

Below and above 100 employees



Size - Productivity relation holds: distribution shift to the right.

But does not cancel out heterogeneity: support remains very wide

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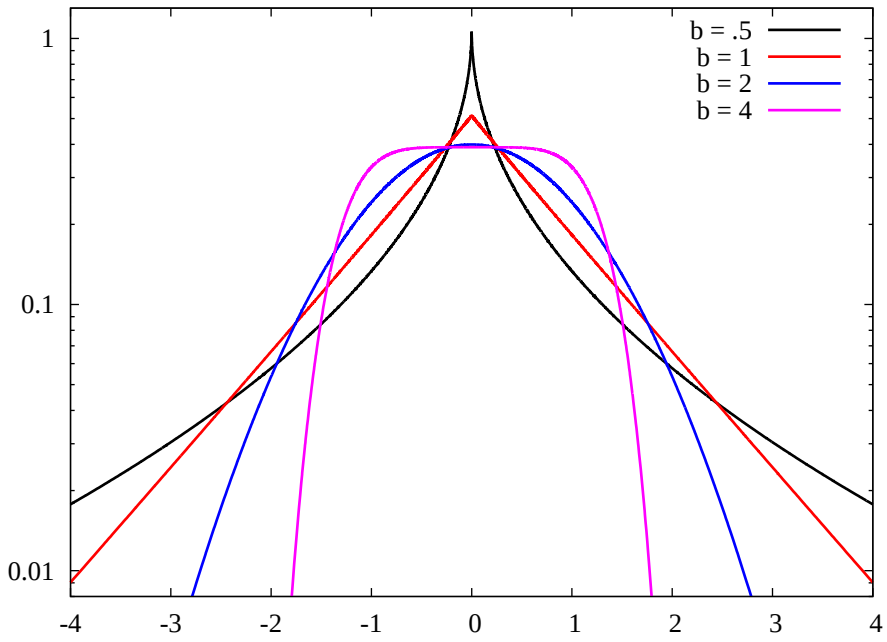
Distributional Analysis II - The Asymmetric Exponential Power

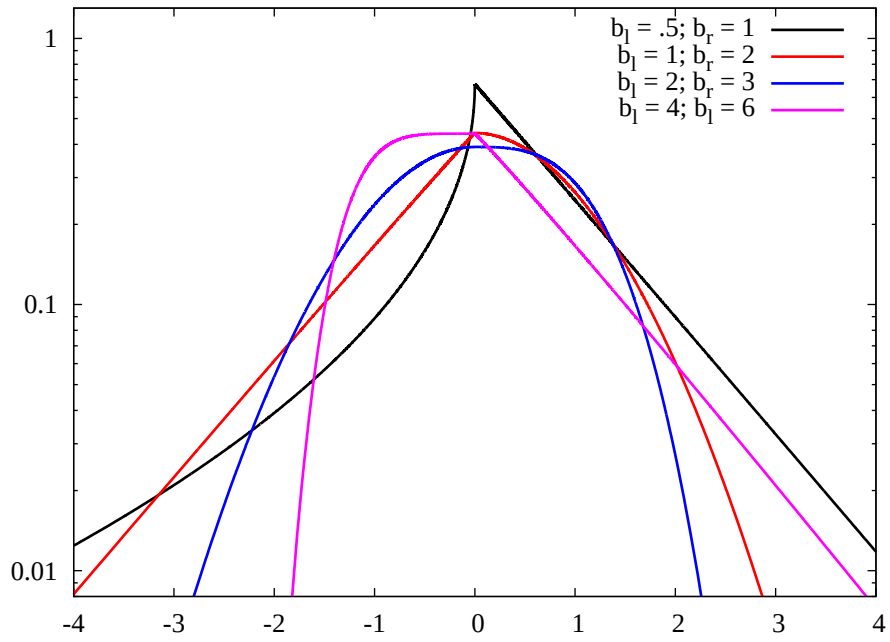
- Asymmetric Exponential Power distributions - AEP (Bottazzi and Secchi; 2011) characterized by two positive shape parameters b_r and b_l, describing the tail behavior in the upper and lower tail, two scale a_r and a_l, and a location parameter, m.
- When b's and a's are equal it reduces to a symmetric distribution
- Allow for more flexibilities

AEP and asymmetries

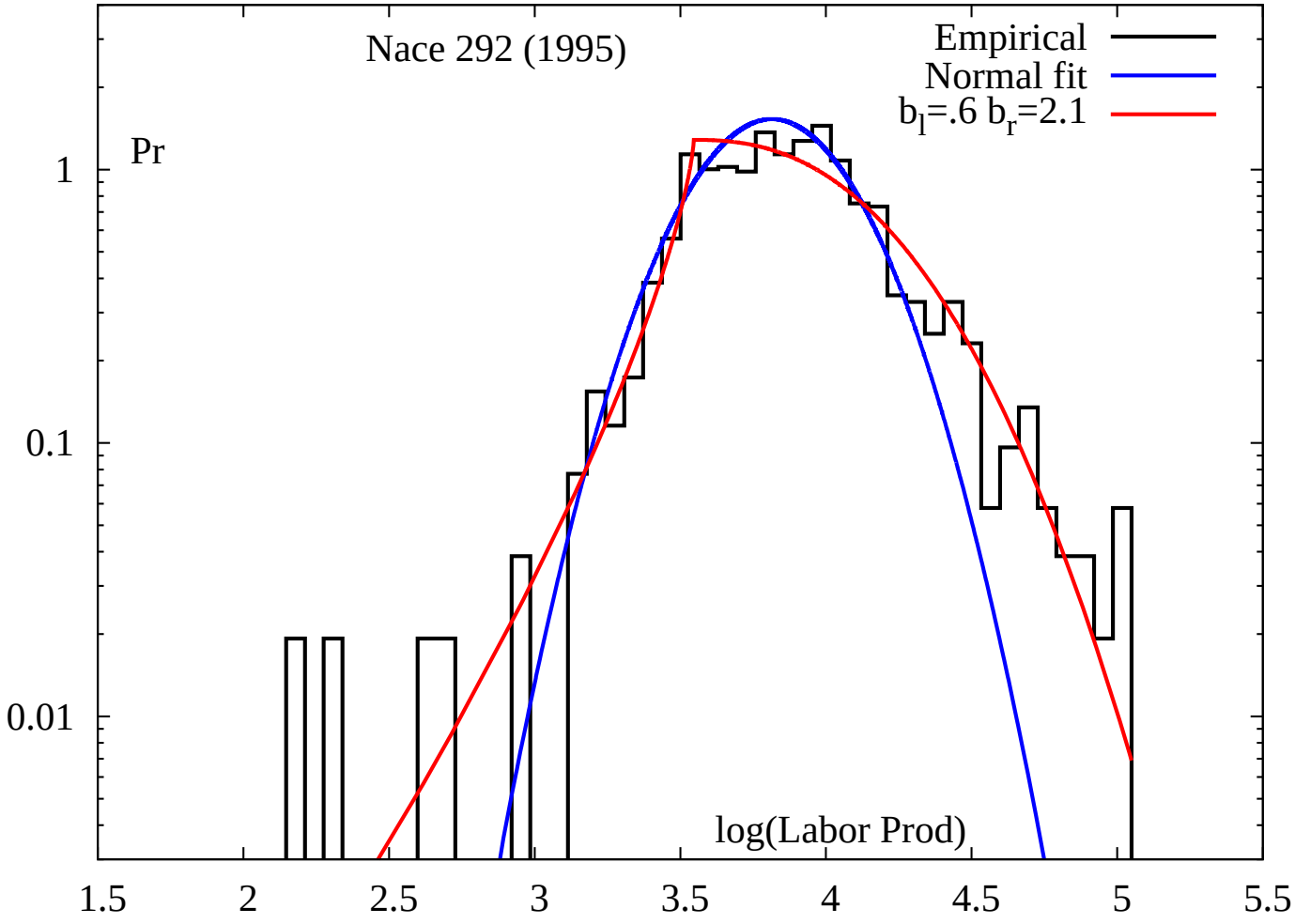
- Fat tails property in all sectors; b is smaller than 2.
- Asymmetry in the distributions of labor productivity
- Left coefficient is smaller than right one
  - $\Rightarrow$ higher heterogeneity in the left tail
  - $\Rightarrow$ The industry keeps to tolerate very low productive
  - $\Rightarrow$ The support widens over time firms.

Exponential Power and Asymmetric EP





3 Digit nested NACE 292



Width of the support and asymmetries

b_l and b_r parameters in 55 3-Digit sectors

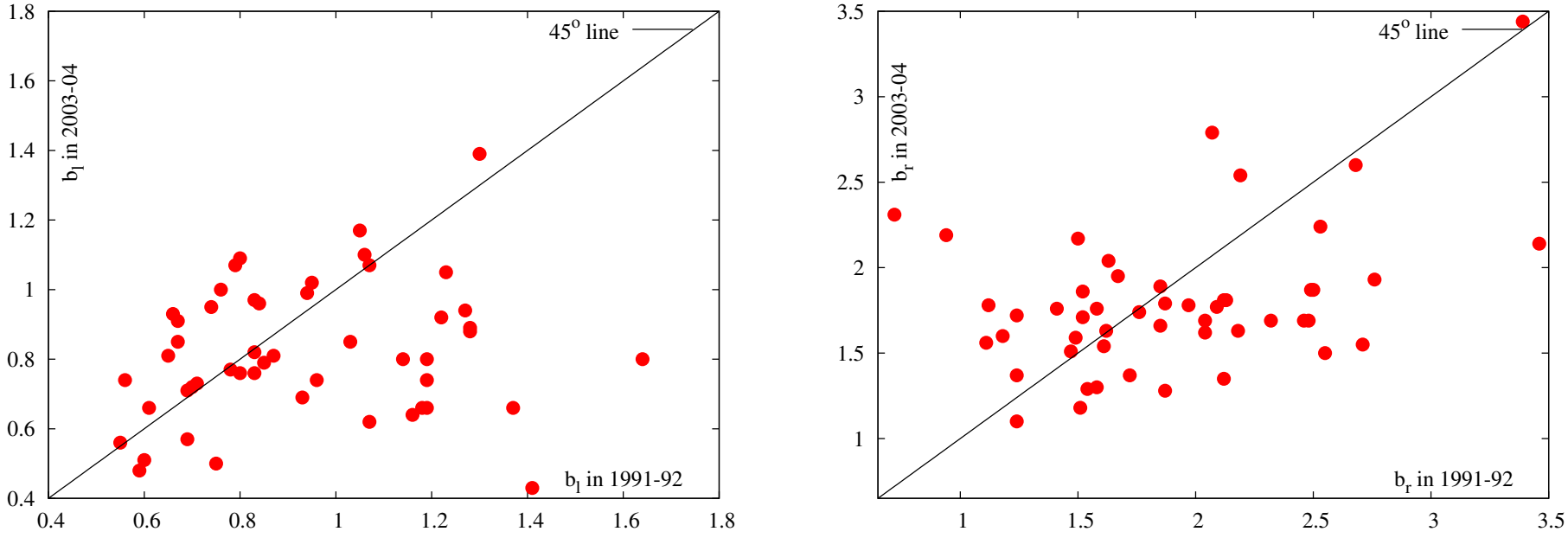


Figure : Estimated b_l (left) and b_r (right) coefficients in 1991-92 and 2003-4 for 3-Digit sectors.

Italian firms and patents

- Matching of Italian firms ($>$ 20 empl) with registered patents (USPTO and EPO)
- 31000 patents matched to 1883 different firms (comparable results to existing literature see Malerba and Orsenigo, 1999).
- (as for exporters) Patenters are more productive - and almost as profitable - than non patenters.

$\Rightarrow$ No apparent differences in terms of growth rates

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Test of stochastic (in)equality

- No apparent trend in the averages in the last 15 years...
- Test statistics for the shift of the distribution
  $\Rightarrow$ Fligner-Policello of stochastic (in)equality
- Most of the productivity growth over the whole sample (1991-2004) is concentrated in the sub-period 91-95.
- Some sectors do not display increase in productivity over whole sample period 1991-2004
- (one more reason to focus on the distribution)

Test of stochastic (in)equality II

- FP does not require equal shapes or normality
- F_a and F_b are productivity ditributions at a and b.
- The distribution F_a is said to dominate F_b if $\text{Prob}\{X_a > X_b\} > 1/2$. That is, if one randomly selects 2 firms, one from period a and one from b, the probability that the first displays a higher value of X is bigger than $1/2$
- The sign of the FP statistic tells us which of the two distributions is dominating
  - a positive (negative) sign means that productivity in period a has a higher probability to take on higher values than in the other period.

FP statistics

NACE	91-2 Vs 94-95	99-00 Vs 03-04	91-2 Vs 03-2004	NACE	91-2 Vs 94-95	99-00 Vs 03-04	91-2 Vs 03-04
15	**2.426**	**2.308**	**5.986**	27	**9.172**	**-3.179**	**9.188**
17	**11.172**	-0.260	**12.384**	28	**10.956**	**5.768**	**11.847**
18	**8.694**	**3.148**	**14.351**	29	**14.279**	-0.271	**8.509**
19	**8.561**	1.390	**12.696**	30	-1.223	1.302	0.793
20	**2.308**	1.327	**5.691**	31	**5.892**	**2.201**	**8.745**
21	**6.169**	1.707	**4.579**	32	**2.663**	**4.034**	**2.158**
22	0.068	-0.376	-1.791	33	**4.063**	**3.218**	**3.056**
23	0.117	0.176	1.656	34	**5.920**	1.425	**4.651**
24	**5.334**	-1.125	**3.994**	35	**2.453**	0.968	**2.909**
25	**4.021**	-0.242	0.423	36	**5.732**	**-3.477**	**4.746**

Rejection of the null means distributions stochasticly differ

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Decomposing sector Productivity Growth

- Investigating the properties of *distributions* over heterogeneous entities of quantities like revealed productivities, relative input intensities, and their evolution over time. Evolutionary accounting:

$$\Delta\Pi_t = \sum_i s_i(t-1)\Delta\Pi_i(t) + \sum_i \Pi_i(t-1)\Delta s_i(t) +$$
$$\sum_e s_e(t)\Delta\Pi_e(t) + \sum_f s_f(t-1)\Delta\Pi_f(t-1) +$$
(some interaction terms)

(1) within and (2) between term; (3) entry; (4) exit

Decomposition: Italy & France 1991-2004
Bottazzi et al. (2010)

	Within(%) $s_{i,t-1} \cdot \Delta\pi$	**Between(%)** $\pi_{i,t-1} \cdot \Delta s_i$	**Covariance(%)** $\Delta\pi_i \cdot \Delta s_i$
With employment weights			
Italy	103.73	41.39	-45.12
France	121.43	63.38	-84.81
With sales weights			
Italy	152.73	-29.69	-23.04
France	89.23	11.79	-1.02

- Idiosyncratic learning dominates market reallocation
- The puzzle of negative covariances...

Transition probabilities (TP) of the labor productivities

- Labor productivity is stable: AR close to 1 Dosi and Grazzi (2006)
- Similar evidence from transition probabilities matrix both over one or more years (Baily et al. 1992; Bartelsman and Dhrymes, 1998)
- Period 2000-04. The binding requirements of financial statements provides a more balanced panel to estimate TP
- High persistency (main diagonal TP are high) and highest at the top bottom quantile, also on the five year interval.
  - Time t average productivity in 2000-01
  - Time $t+1$ average productivity in 2002-04

$\Rightarrow$ Use TPM to identify groups of firms

Transition Probabilities in Productivity

15	1	2	2.70	4
1	71.54	24.30	21.37	1.35
2	21.37	53.99	20.37	3.37
3	5.17	19.35	58.04	17.55
4	1.80	2.47	18.00	77.62

27	1	2	3	4
1	68.03	25.57	5.31	0.97
2	26.54	45.36	22.20	5.79
3	4.34	26.54	53.56	15.44
4	0.97	2.41	18.82	78.17

17	1	2	3	4
1	70.18	22.71	4.50	2.46
2	21.89	44.47	24.76	5.73
3	6.34	22.92	48.49	22.10
4	1.43	6.75	22.10	70.18

28	1	2	3	4
1	70.29	23.00	5.29	1.37
2	23.00	48.84	23.64	4.56
3	5.48	24.28	51.12	19.17
4	1.19	3.93	19.99	74.85

18	1	2	3	4
1	74.81	22.32	15.99	1.12
2	20.21	61.24	0.60	2.80
3	3.32	15.99	61.84	19.02
4	1.51	0.60	20.81	78.32

29	1	2	3	4
1	64.06	26.51	7.19	2.17
2	23.85	44.74	25.72	5.62
3	8.08	22.37	45.13	24.34
4	3.94	6.31	21.88	68.10

Laggards, Climbers and Leaders

		$t+1$			
		1	2	3	4
	1	A	A		B
t	2	A	A		B
	3				
	4	D	D		C

- Productivity Laggards (A)
- Productivity Climbers (B)
- Productivity Leaders (C)
- Falling Back (D)

Laggards, Climbers and Leaders

- So few climbers!

Characteristics of groups at time t

- Size: Climbers and Leaders bigger on average. Sometimes Climbers even bigger than Leaders
  - recover of size-productivity relation
- Export activities
  - Differences get more evident when considering destination and number of products
- Profitability
  - Laggards have higher profits than Climbers

Laggards, Climbers and Leaders (averages)

Sec 15	Lagg.	Climb.	Lead.
Size	3.83	4.16	4.04
Export	0.66	0.88	0.86
Exp NACE4	2.21	5.19	5.90
Imp NACE4	2.54	4.05	7.17
Exp countr.	6.42	9.67	15.2
Imp countr.	2.76	4.00	6.22
Patent	0.01	0.05	0.03
Prof %	5.48	4.16	14.4
Obs	761	21	345
Trans Prob	85.6	4.72	77.6

Sec 27	Lagg.	Climb.	Lead.
Size	3.93	4.41	4.40
Export	0.74	0.79	0.90
Exp NACE4	3.74	3.54	4.93
Imp NACE4	3.76	7.43	8.71
Exp countr.	8.13	9.93	14.1
Imp countr.	3.00	7.68	9.19
Patent	0.02	0.00	0.05
Prof %	7.35	4.79	13.2
Obs	343	14	162
Trans Prob	82.7	6.76	78.2

Sec 17	Lagg.	Climb.	Lead.
Size	3.81	3.89	4.00
Export	0.70	0.84	0.87
Exp NACE4	3.57	5.90	6.95
Imp NACE4	3.96	6.90	8.84
Exp countr.	8.39	12.5	19.9
Imp countr.	3.81	6.29	8.50
Patent	0.01	0.03	0.03
Prof %	7.11	4.87	15.7
Obs	793	40	343 2
Trans Prob	81.1	8.18	70.2

Sec 28	Lagg.	Climb.	Lead.
Size	3.57	3.76	3.89
Export	0.49	0.63	0.83
Exp NACE4	2.09	3.25	5.83
Imp NACE4	1.51	4.35	5.79
Exp countr.	4.17	6.99	12.9
Imp countr.	1.23	2.69	4.49
Patent	0.01	0.05	0.06
Prof %	7.99	7.51	18.0
Obs	1809	65	820
Trans Prob	82.6	5.93	74.8

Laggards, Climbers and Leaders (averages)

Sec 15	Lagg.	Climb.	Lead.
Size	3.83	4.16	4.04
Export	0.66	0.88	0.86
Exp NACE4	2.21	5.19	5.90
Imp NACE4	2.54	4.05	7.17
Exp countr.	6.42	9.67	15.2
Imp countr.	2.76	4.00	6.22
Patent	0.01	0.05	0.03
Prof %	5.48	4.16	14.4
Obs	761	21	345
Trans Prob	85.6	4.72	77.6

Sec 27	Lagg.	Climb.	Lead.
Size	3.93	4.41	4.40
Export	0.74	0.79	0.90
Exp NACE4	3.74	3.54	4.93
Imp NACE4	3.76	7.43	8.71
Exp countr.	8.13	9.93	14.1
Imp countr.	3.00	7.68	9.19
Patent	0.02	0.00	0.05
Prof %	7.35	4.79	13.2
Obs	343	14	162
Trans Prob	82.7	6.76	78.2

Sec 17	Lagg.	Climb.	Lead.
Size	3.81	3.89	4.00
Export	0.70	0.84	0.87
Exp NACE4	3.57	5.90	6.95
Imp NACE4	3.96	6.90	8.84
Exp countr.	8.39	12.5	19.9
Imp countr.	3.81	6.29	8.50
Patent	0.01	0.03	0.03
Prof %	7.11	4.87	15.7
Obs	793	40	343 2
Trans Prob	81.1	8.18	70.2

Sec 28	Lagg.	Climb.	Lead.
Size	3.57	3.76	3.89
Export	0.49	0.63	0.83
Exp NACE4	2.09	3.25	5.83
Imp NACE4	1.51	4.35	5.79
Exp countr.	4.17	6.99	12.9
Imp countr.	1.23	2.69	4.49
Patent	0.01	0.05	0.06
Prof %	7.99	7.51	18.0
Obs	1809	65	820
Trans Prob	82.6	5.93	74.8

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Regression Framework

- Dependent: Growth rate of productivity
- Run regression on two separate periods pre- post euro

$$\Delta y_{t,t+1} = \alpha + \beta_1 Exp_{i,t} + \beta_2 Pat_{i,t} + \beta_3 Z_{i,t} + \varepsilon_i$$

- $\Delta y_{t,t+1}$ is productivity growth as logarithmic differences between period $t, t+1$.
- to account for euro introduction, split time span in two: pre-euro 1991-95 and post-euro 2000-04
- Z firm level characteristics (size, initial labor prod, sectoral and geographic dummies
- Independent variables measured at time t.

Regression results

- Firms that were already exporting registered higher productivity growth in the following period
  - Supporting hypothesis of learning mechanisms on the export market (Clerides et al.; 1998)
- Positive effects associated to patents (proxy for innovation)
- Negative sign on initial productivity $\Rightarrow$ regression to the mean tendency

Pre- Post Euro comparison

- Firms' characteristics much less relevant after the euro
- Patent dummy significant only in supplier dominated and scale-intensive
- Export is less associated to productivity growth in more recent years

	Prod Growth 1991-1995		Prod Growth 2000-2004	
	(1)	(2)	(1)	(2)
	Whole sample	Whole sample	Whole sample	Whole sample
Exp_t	**0.021**	**0.041**	-0.012	**0.024**
Pat_t	**0.057**	**0.071**	-0.010	**0.022**
LP_t		**-0.218**		**-0.233**
$Size_t$		**0.024**		**0.014**
Sectoral dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	14714	14714	21505	21505
R-squared	0.02	0.10	0.01	0.11

Table : Growth of productivity regression, all observations, OLS estimates. Coefficients significant at the 5% are in bold.

	(1) Suppl Dom	(2) Special. Suppl	(3) Scale Dom	(4) Science Bas
		Productivity Growth 1991-1995		
Exp_t	**0.047**	**0.021**	**0.034**	**0.053**
Pat_t	**0.061**	0.054	**0.112**	**0.077**
LP_t	**-0.174**	**-0.209**	**-0.252**	**-0.168**
$Size_t$	**0.026**	**0.022**	**0.022**	0.000
Observations	8334	3229	2591	560
R-squared	0.09	0.11	0.11	0.12
		Productivity Growth 2000-2004		
Exp_t	-0.004	0.014	**0.047**	**0.069**
Pat_t	**0.039**	0.002	**0.030**	0.044
LP_t	**-0.154**	**-0.226**	**-0.284**	**-0.251**
$Size_t$	**0.010**	0.003	**0.016**	0.004
Observations	11492	4845	4171	997
R-squared	0.06	0.11	0.12	0.14

Investment

- Include investment rate (as normalized by firm value added) at time t among regressors
  - Investment as driver of productvity growth
- Investment available for the whole population up to 1997, after only on a representative sample.
- Use observed investment only (estimated too different from observed)
- Investment is significant in explaining productivity growth, but much smaller in the post-euro
- Other regressions coefficients are stable with respect to previous specification

	1991-95 Whole sample	2000-04 Whole sample
Exp_t	**0.040**	**0.022**
Pat_t	**0.074**	0.011
LP_t	**-0.208**	**-0.217**
$Size_t$	**0.020**	**0.011**
Inv_t	**0.269**	**0.070**
Sectoral dummies	Yes	Yes
Regional dummies	Yes	Yes
Observations	14714	9574
R-squared	0.13	0.11

Table : Growth of productivity regression (II) with observed investments. OLS estimates. Standard errors in brackets. Coefficients significant at the 5% are in bold.

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Difference in Difference

- After euro, firms' characteristics less relevant for productivity growth
- Diff in Diff to account for differences before and after euro.
- Exporters (treatment group) face a higher competition (no more competitive devaluation); Domestic only firms (control group)
- $t = 1$ for the pre-Euro and $t = 2$ for the post-Euro period

$$y_{i,t} = \alpha + \beta_1 post_t + \beta_2 exp_i + \beta_3 exp_i * post_t + \beta_4 Z_{i,t} + a_i + \varepsilon_{i,t} \quad t = 1, 2 \quad (1)$$

- $post_t$ dummy for post-Euro period; $exp_{i,t}$ equal unity for treatment group (exporters in post Euro period) and zero otherwise, $Z_{i,t}$ controls.
- Differencing to remove a_i gives

$$\Delta y_i = \beta_1 + \beta_3 \Delta exp_i * post_t + \beta_4 \Delta Z_i + \Delta \varepsilon_i. \quad (2)$$

- $\hat{\beta}_3$ measures the difference in the effect of being exporter (on Π) before and after the Euro between the treatment and the control groups.

Diff in Diff

	(1) 1996/2004 Level	(2) 1996-97/2003-04 Level	(3) Fixed Effect Level
Post $*$ *Exp*	**-0.062**	**-0.064**	**-0.018**
	(0.016)	(0.020)	(0.008)
Size	**-0.067**	**-0.055**	**-0.149**
	(0.016)	(0.021)	(0.011)
Pat	**0.074**	**0.068**	**0.031**
	(0.023)	(0.026)	(0.012)
Observations	7774	5160	50947
R-squared	0.006	0.006	0.76

Table : Difference in difference regression. Standard errors in brackets. Coefficients significant at the 5% are in bold. Our elaboration on Micro.3

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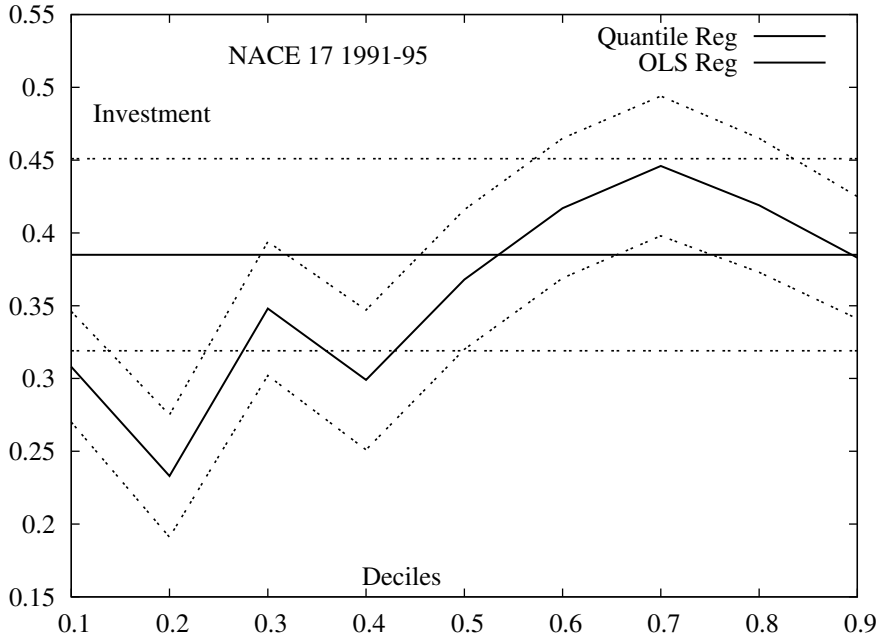
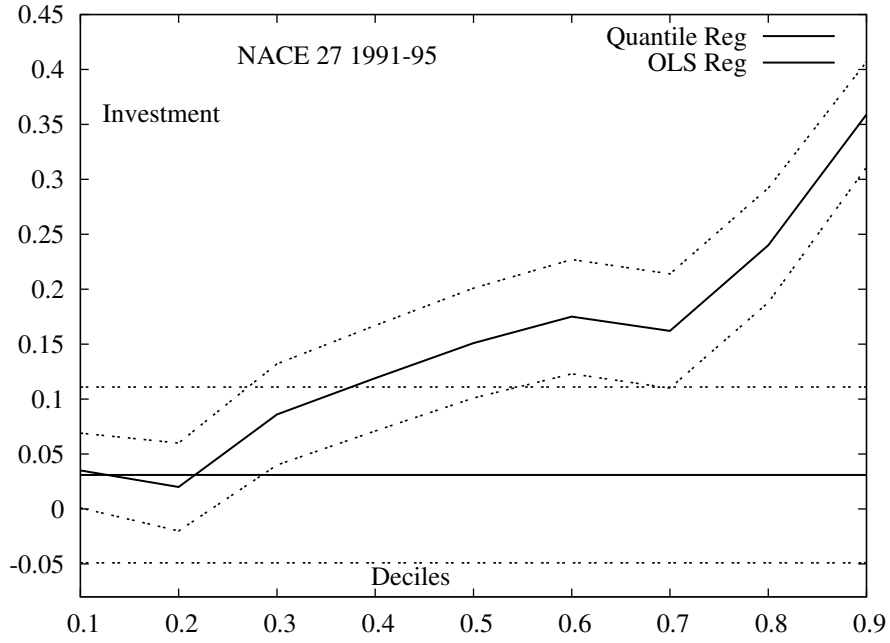
Quantile regressions

- Quantile regression enables to capture the effect of a regressor at the different levels (quantiles) of the conditional distribution of the dependent variable
- Given the high heterogeneity in the distributions, quantile regression provides a method to identify the relations among variables
- One does not get a unique coefficient (as with OLS) but an estimate at every quantile of the conditional distribution of the dependent variable (productivity growth)

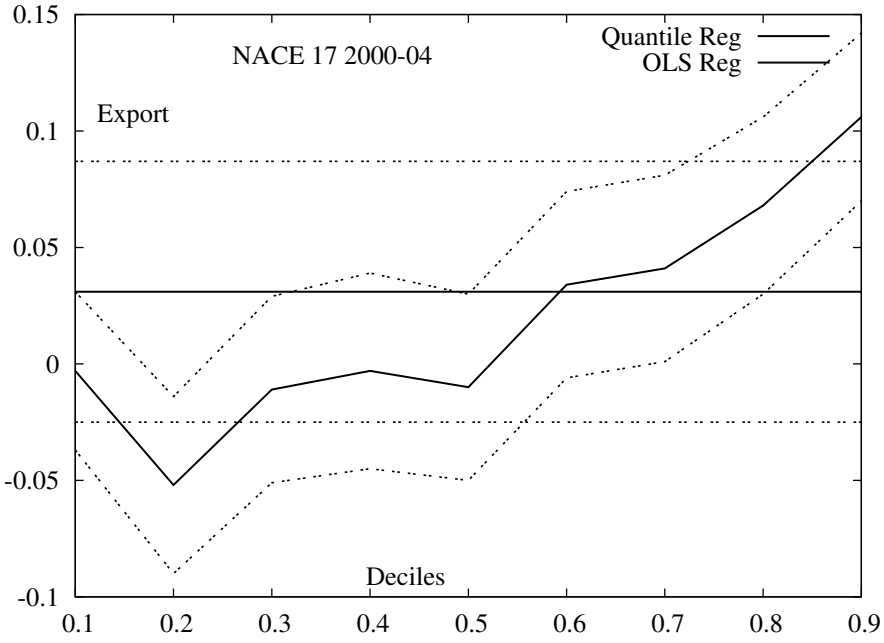
- Matthew effect?
- For some sectors/ variables the impact of regressors is growing in the quantiles.
- A small group of efficient high performance high growth firms

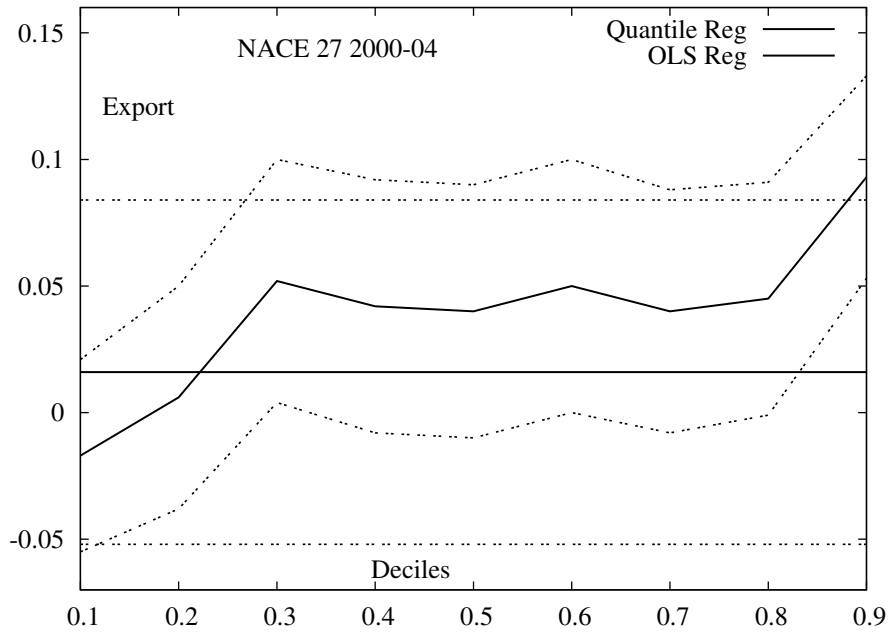
Quantile Regression - Investment





Quantile Regression - Investment





Concluding Remarks

- There remains large differences in performances of firms within same 2 and 3 Digit industries: a sort of "neo-dualism" emerging?
  - Differences have widened not shrinked over time
  - Asymmetries in the distribution of labor productivities
- Market mechanism less effective than firm level learning
- Very few firms climbing up the productivity distribution
- Uneven effects of exporting and investment for low/ high productivity growth firms.
- The "euro shock" has not (yet ?) fully disclosed its selection effects.

Investment and firm dynamics

- The diffused occurence of investment spikes at the micro-level.
- If investment episodes occur with lumps they might well have disrupting effects on the firm's operation. In this respect, several studies have started to investigate the relationship between capital adjustment episodes and other firm variables such as productivity or employment growth.

Little is known about the *timing and conditions* in which a firm decides to invest.

Research questions

$\Rightarrow$ FOCUS ON INVESTMENT EPISODES

- Evolution of investment
- Evolution of corporate performances around a spike

We address sequentially the following questions:

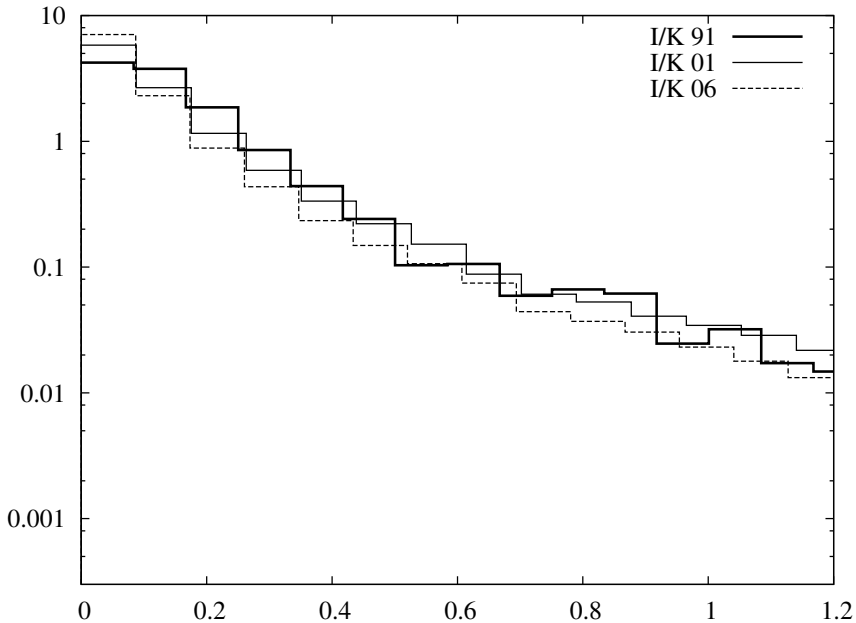
1. How does investment look like? (smooth or lumpy ?)
2. Is investment independent from firm size? (Gibrat like story)
3. What firm characteristics are associated with higher investment?
4. After a spike, how can we characterize the relation between investment episodes and firm performance?
   - Is this relation differentiated across time and indicators of performance?

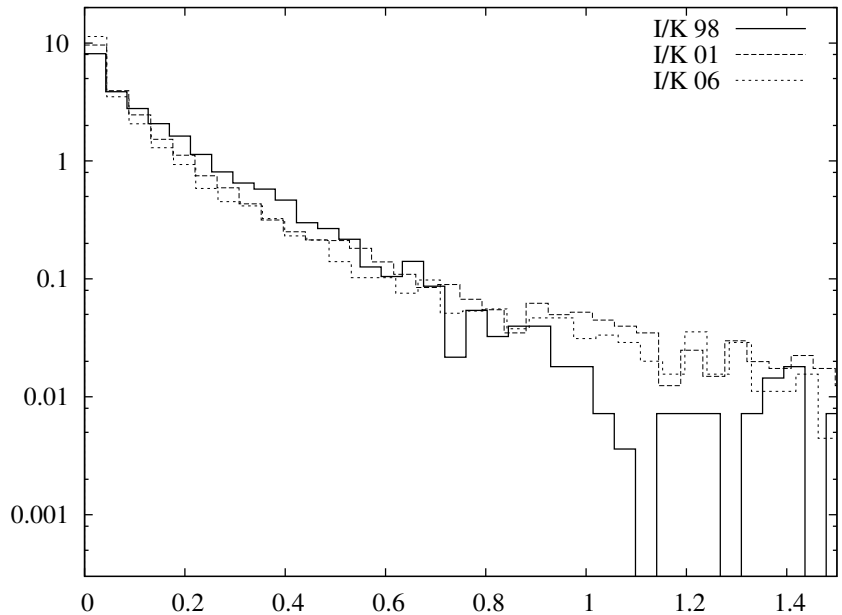
The variables

Investment rate:	I_t/K_{t-1}
Number of employees:	N_t
Growth of employment:	$g_t^N = log(N_t) - log(N_{t-1})$
Labour productivity:	$\Pi_t = VA_t/N_t$
Growth of labour productivity:	$g_t^\Pi = log(\Pi_t) - log(\Pi_{t-1})$
Total sales:	TS_t
Growth of total sales:	$g_t^{TS} = log(TS_t) - log(TS_{t-1})$
Profitability rate:	$P_t = GOM_t/TS_t$

Investment lumpiness I

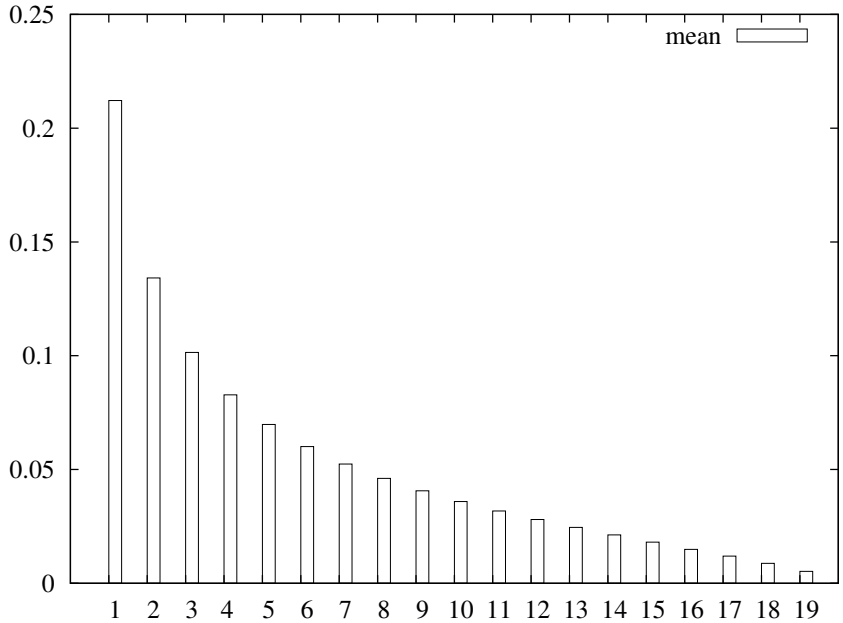
Figure : Investment rate distribution, France (left) and Italy (right)

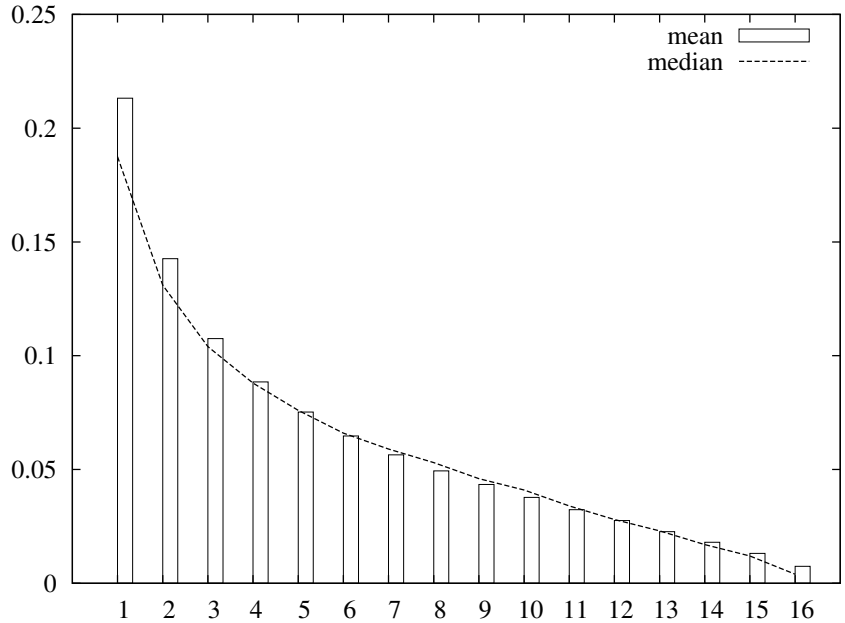




Investment lumpiness II

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





Investment spike

- An investment spike is an unregular investment episode at the firm level
- The firm is not simply "adjusting" its capital stock
- Several ways to define a spike with respect to the history of investment of a firm
  - Absolute threshold: Investment rate higher than 20%, 35%
  - Relative threshold: Investment rate higher than median (times a constant)
  - $\Rightarrow$ corrected measure to account for the size dependency of the investment rate

Alternative definitions of investment spikes

Type	**Absolute**	**Relative**	**Linear**	**Exponent**
Ref.	Cooper et al., 1995	Power, 1998	Nilsen et al., 2003	this pape
Measure	$\frac{I_t}{K_{t-1}} > 0.2$	$\frac{I_t}{K_{t-1}} > \rho \underset{\tau}{\text{median}}(\frac{I_{i\tau}}{K_{i\tau-1}})$		
share nb of spikes	18.27	13.18	11.58	12.22
share total investment	28.04	20.5	26.77	27.2

▸ Nb. spike

The size bias issue I

- Small firms are more likely to display high investment rates
- A definition of spike that would not account for this will be biased in favor of small firms (under-represent big firms)

Table : Share of spikes across size classes, comparing rules, 2003

Observations All sample	Size classes	**Spikes Absolute**	**Spikes Linear**	**Spikes Exponential**
0.20	ln K $<$ 6	0.35	0.29	0.23
0.66	6 $<=$ ln K $<$ 9	0.58	0.58	0.64
0.13	ln K $>=$ 9	0.07	0.13	0.12

The size bias issue II

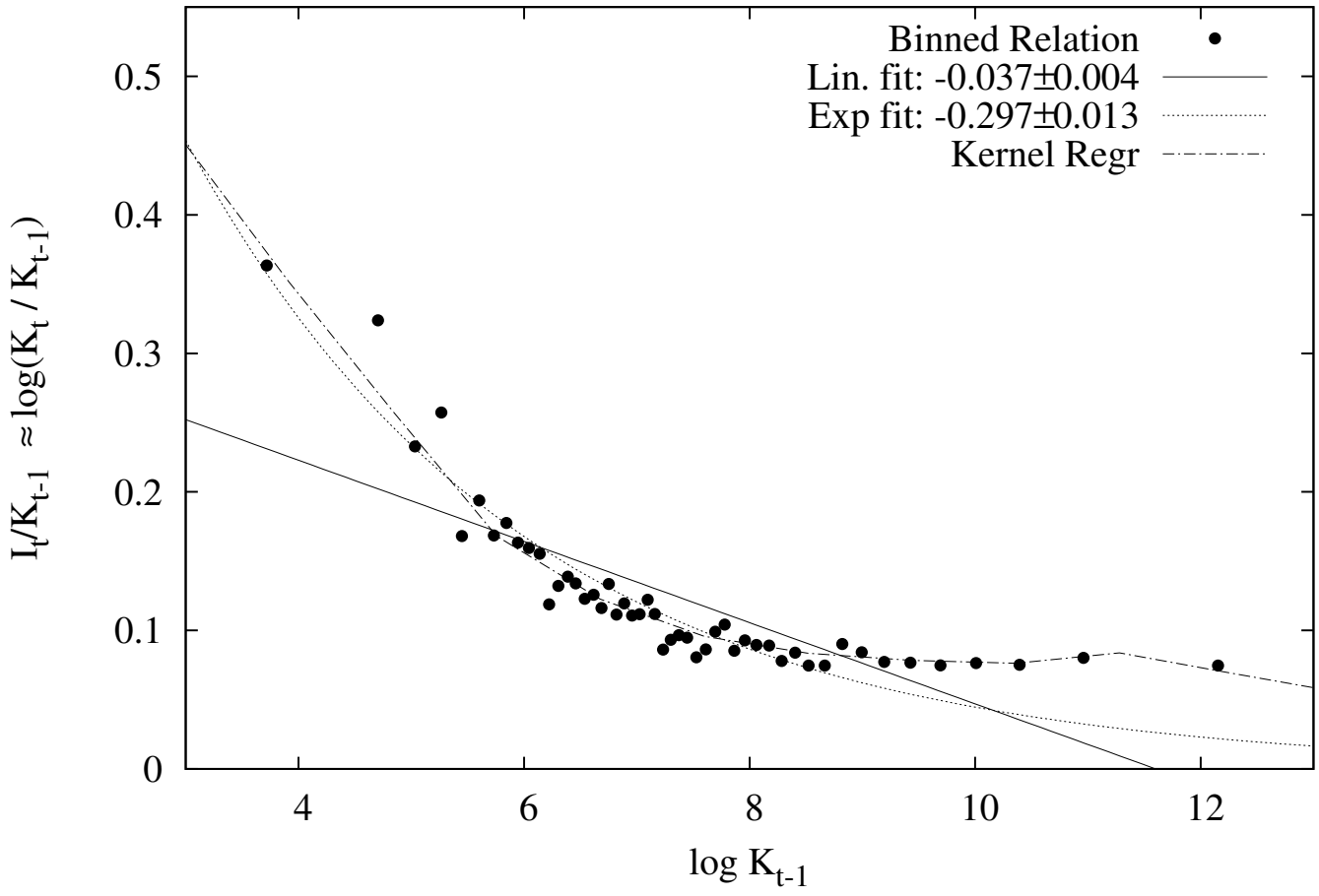
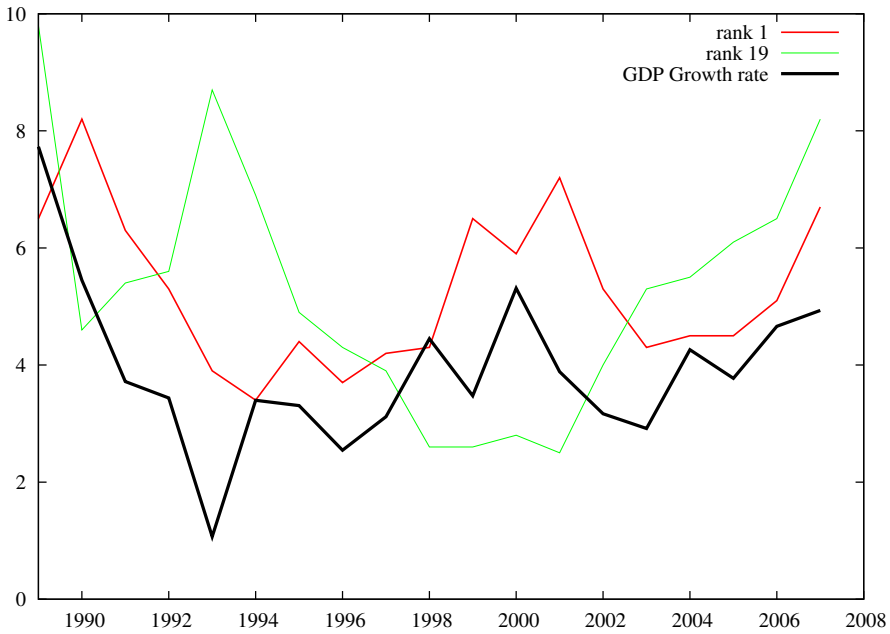


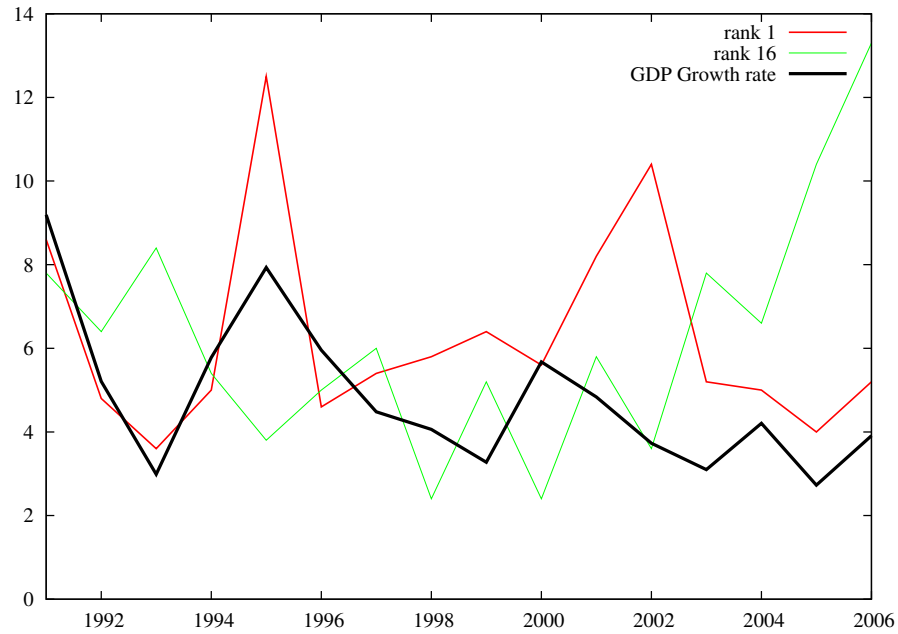
Figure : Linear vs exponential fit and spike threshold, 2003

Investment spikes and the Business Cycle

- Investment spikes have been shown to be highly procyclical (Gourio and Kashyap, 2004)
- Low investment rates are in turn counter-cyclical (see figure below)

Figure : Aggregate investment and frequency of spikes in France (*left*) and Italy (*right*).





Investment and Firm performance

The first part of our analysis has adressed the **dynamics of the investment variable**, and confirmed its lumpy pattern.

In a second step, we consider **the interrelation between the investment spike and firm performance** (sales, size, growth, productivity and profitability).

1. First we test which (and how) variables affect the probability to have a spike
2. Then we focus on the effect of investment spikes on firm performance.

Determinants of the probability to have a spike

Using the *Exponential* and *Linear* measures

Random Effects logistic regression

Binary dep. var : taking $y_{it} = 1$ if there is a spike and 0 if not

$$y_{it} = \beta_1 X_{it} + \sum_{j=1}^{3} \beta_j \times D_{j,it} + v_s + u_{it}$$

where x_{it} is a vector of observed variables, D_1, D_2 and D_3 are duration dummies (time since last spike). v_s are time and sectoral dummies.

Determinants of the probability to have a spike - Results

- Size is positive only when measured as Turnover
- Profitability has a strong positive effect, whether productivity not significant
- Investment opportunities (sales and growth and lagged sales growth) too
- Growing firms invest more
- Exporting does not appear significant in explaining investment
- Spike at $t-1$ increase probability of spike at t

However we observe some difference across size proxies

▸ results

▸ results by Pavitt sector (1)

▸ results by Pavitt sector (2)

Effects of spikes on performance variables

Using the *Exponential* measure

- We regress each performance variable on a group of dummy variables (D_0, D_1 and D_2) that indicate if the firm had its *last* investment spike 0 (contemporaneous relation), 1 or 2 years before t.
- D_{before} controls for spikes before $t-2$
- *SPIKE* indicates that the firm had *at least*one spike in the period

Panel data analysis - Random effect

Taking X_{it} as one of our variables of interest:

$$X_{it} = \sum_{j=0}^{2} \beta_j \times D_{j,it} + \beta_3 D_{before,it} + \beta_4 SPIKE_i + \nu_s + \epsilon_{is}$$

ν_s are time and sectoral dummies.

$\Rightarrow$ We also expand our model with the dummy for having increased the number of plants

▸ results(1) ▸ results(2)

	$I_t/K_{t-1} > 0.20$	$I_t/K_{t-1} > 0.35$	Relative rule	Linear rule	Exponential rule
0	32.31	57.44	36.36	46.35	44.87
1	24.17	24.34	30.26	26.53	26.62
2	18.53	11.01	19.78	15	15.17
3	11.91	4.67	9.44	6.73	7.26
4	6.76	1.73	3.44	3.39	3.64
5	3.50	0.56	0.72	1.19	1.47
6	1.68	0.21	-	0.50	0.56
7	0.65	0.03	-	0.18	0.23
8	0.34	0.01	-	0.10	0.13
9	0.09	0.00	-	0.02	0.04
10	0.03	-	-	0.01	0.01
11	0.02	-	-	-	-

return

Determinants of spike probability

Table : Determinants of investment spikes, EXPONENTIAL rule

	(1)	(2)	(3)	(4)	(5)	(6)
$Sales_{t-1}$	0.005***	-	-	0.004***	-	-
$Employees_{t-1}$	-	-0.005	-	-	-0.001	-
$Plants_{t-1}$	-	-	-0.000	-	-	-0.001
$Profit_{t-1}$	0.211***	0.197***	0.197***	0.171***	0.161***	0.160***
$Prod_{t-1}$	-0.004	0.003**	0.0033	0.001	0.006**	0.006**
$Gr.Prod_{t-1}$	-	-	-	0.011***	0.009**	0.009**
$Gr.Sales_{t-1}$	-	-	-	0.033***	0.034***	0.034***
$Gr.Empl_{t-1}$	-	-	-	0.072***	0.073***	0.073***
Export	-	-	-	-0.002	0.000	-0.001
D_1	0.159***	0.160***	0.160***	0.152***	0.126***	0.0153***
D_2	0.064***	0.064***	0.064***	0.063***	0.052***	0.063***
D_3	0.047***	0.048***	0.048***	0.048***	0.046***	0.048***
time dummies	Yes	Yes	Yes	Yes	Yes	Yes
sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
Nb. observations	122452	122452	122447	122237	122237	122232

Determinants of spike probability by Pavitt sector

	Supplier Dominated			Scale Intensive		
	(4)	(5)	(6)	(4)	(5)	(6)
$Sales_{t-1}$	0.004***	-	-	0.001	-	-
$Employees_{t-1}$	-	-0.002	-	-	-0.003*	-
$Plants_{t-1}$	-	-	0.000	-	-	-0.002
$Profit_{t-1}$	0.150***	0.142***	0.149***	0.196***	0.192***	0.184***
$Prod_{t-1}$	0.014***	0.018***	0.018***	- 0.007	- 0.005	-0.005
$gr.Prod_{t-1}$	0.0122**	0.011*	0.009	0.009	0.008	0.007
$gr.Sales_{t-1}$	0.030***	0.032***	0.041***	0.018**	0.018**	0.024***
$gr.Empl_{t-1}$	0.064***	0.065***	0.069***	0.071***	0.072***	0.076***
$Export$	-0.012***	-0.009***	-0.007***	0.007*	0.008**	0.010***
D_1	0.114***	0.136***	0.150***	0.136***	0.134***	0.157***
D_2	0.048***	0.053***	0.063***	0.053***	0.053***	0.063***
D_3	0.045***	0.040***	0.052***	0.041***	0.041***	0.044***
time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Nb. obs.	64283	64283	69469	26304	26304	28126

***significant at 1% level; ** at 5% level, * at 10% level

return

Determinants of spike probability by Pavitt sector

	Special Suppliers			Science Based		
	(4)	(5)	(6)	(4)	(5)	(6)
$Sales_{t-1}$	-0.002	-	-	0.004	-	-
$Employees_{t-1}$	-0.006***	-	-	-	0.003	-
$Plants_{t-1}$	-	-	-0.003	-	-	-0.004
$Profit_{t-1}$	0.124***	0.128***	0.163***	0.109***	0.098**	0.079**
$Prod_{t-1}$	0.011	0.009	0.004	0.001	0.007	0.008
$gr.Prod_{t-1}$	0.006	0.006	0.017	0.034**	-0.037**	-0.020
$gr.Sales_{t-1}$	0.004	0.003	0.002	0.094***	0.096***	0.098***
$gr.Empl_{t-1}$	0.107***	0.108***	0.110***	0.007	0.006	0.039
Export	-0.010*	-0.009	-0.008	0.000	0.002	0.010
D_1	0.128***	0.128***	0.156***	0.183***	0.183***	0.209***
D_2	0.061***	0.061***	0.073***	0.050***	0.050***	0.078***
D_3	0.048***	0.048**	0.049***	0.039***	0.039***	0.040***
time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Nb. obs.	16947	16947	18079	6025	6025	6558

***significant at 1% level; ** at 5% level, * at 10% level

return

Effects of spikes on firm performance

Table : Effects of investment spikes on firm performance, EXPONENTIAL rule (1)

	Profit		*Empl*		*Gr.Empl*	
	(7)	(8)	(7)	(8)	(7)	(8)
D_0	0.011**	0.012**	0.032***	0.031***	0.051***	0.049***
$*\delta Plant$	-	-0.009	-	0.014**	-	0.026***
D_1	0.008*	0.008	0.041***	0.041***	0.017***	0.016***
$*\delta Plant$	-	0.002	-	0.001	-	0.011
D_2	0.001	0.001	0.035***	0.034***	0.003	0.003
$*\delta Plant$	-	-0.002	-	0.024***	-	0.013*
D_{before}	0.004	0.004	0.033***	0.033***	-0.002	-0.002
SPIKE	0.012*	0.012*	0.023*	0.023*	0.012***	0.012***
time	Yes	Yes	Yes	Yes	Yes	Yes
sector	Yes	Yes	Yes	Yes	Yes	Yes
Nb. obs	134244	134244	134210	134210	134188	134188

***significant at 1% level; ** at 5% level, * at 10% level

return

Effects of spikes on firm performance

Table : Effects of investment spikes on firm performance, EXPONENTIAL rule (2)

	Prod		*Gr.Prod*		*Sales*		*Gr.Sales*	
	(7)	(8)	(7)	(8)	(7)	(8)	(7)	(8)
D_t	0.017⋆	0.018⋆	-0.011**	-0.010**	0.059⋆	0.058⋆	0.053⋆	0.051⋆
$*\delta Plant$	-	-0.010	-	-0.021⋆	-	0.004	-	0.025⋆
D_{t-1}	0.018⋆	0.018⋆	0.007	0.007	0.060⋆	0.061⋆	0.013⋆	0.012⋆
$*\delta Plant$	-	0.017	-	0.007	-	-0.003	-	0.010
D_{t-2}	0.017⋆	0.018⋆	0.003	0.004	0.052⋆	0.052⋆	0.003	0.003
$*\delta Plant$	-	-0.03**	-	-0.035	-	0.000	-	-0.008
D_{before}	0.015⋆	0.015⋆	-0.001	-0.001	0.050⋆	0.049⋆	-0.004	-0.004
SPIKE	0.057⋆	0.057⋆	0.005	0.005	0.122⋆	0.122⋆	0.02⋆	0.017⋆
time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nb. obs	133635	133635	133365	133365	134230	134230	134228	134228

⋆significant at 1% level; ** at 5% level, * at 10% level

return

Thank you!

Baily, M. N., Hulten, C. and Campbell, D. (1992). Productivity dynamics in manufacturing establishments, *Brookings Papers on Economic Activity: Microeconomics* **4**: 187–249.

Baldwin, J. R. and Gu, W. (2006). Plant turnover and productivity growth in canadian manufacturing, *Industrial and Corporate Change* **15**(3): 417–465.

Bartelsman, E. J. and Doms, M. (2000). Understanding productivity: Lessons from longitudinal microdata, *Journal of Economic Literature* **38**(2): 569–594.

Bottazzi, G., Dosi, G., Jacoby, N., Secchi, A. and Tamagni, F. (2010). Corporate performances and market selection. some comparative evidence, *Industrial and Corporate Change* **19**(6): 1953–1996. forthcoming.

Bottazzi, G., Grazzi, M. and Secchi, A. (2005). Characterizing the production process: A disaggregated analysis of Italian manufacturing firms, *Rivista di Politica Economica* **Jan-Feb**(I-II): 243–270.

Bottazzi, G. and Secchi, A. (2011). A new class of asymmetric exponential power densities with applications to economics and finance, *Industrial and Corporate Change* **20**(4): 991–1030.

Bugamelli, M., Schivardi, F. and Zizza, R. (2010). The euro and firm restructuring, *Europe and the Euro*, NBER Chapters, National Bureau of Economic Research, pp. 99–138.

Clerides, S. K., Lach, S. and Tybout, J. R. (1998). Is learning by exporting important? micro-dynamic evidence from Colombia, Mexico, and Morocco, *The Quarterly Journal of Economics* **113**(3): 903–947.

Davis, S. J., Haltiwanger, J. C. and Schuh, S. (1996). *Job Creation and Destruction*, MIT Press: Cambridge, MA.

Dosi, G. and Grazzi, M. (2006). Technologies as problem-solving procedures and technologies as input–output relations: some perspectives on the theory of production, *Industrial and Corporate Change* **15**(1): 173–202.

Dunne, T., Roberts, M. J. and Samuelson, L. (1989). The growth and failure of U.S. manufacturing plants, *The Quarterly Journal of Economics* **104**(4): 671–98.

Ericson, R. and Pakes, A. (1995). Markov-perfect industry dynamics: A framework for empirical work, *Review of Economic Studies* **62**(1): 53–82.

Foster, L., Haltiwanger, J. and Krizan, C. J. (2001). *New Developments in Productivity Analysis*, Chicago: University of Chicago Press, chapter Aggregate Productivity Growth: Lessons from Microeconomic Evidence, pp. 303–372.

Griliches, Z. and Mairesse, J. (1999). Production functions: The search for identification, *in* S. Steiner (ed.), *Econometrics and Economic Theory in the Twentieth Century: the Ragner Frisch Centennial Symposium*, Cambridge University Press: Cambridge.

Haltiwanger, J. C., Lane, J. I. and Spletzer, J. R. (1999). Productivity differences across employers: The roles of employer size, age, and human capital, *American Economic Review* **89**(2): 94–98.

Hopenhayn, H. (1992). Entry, exit and firm dynamics in long run equilibrium, *Econometrica* **60**: 1127–1150.

Jovanovic, B. (1982). Selection and the evolution of industry, *Econometrica* **50**(3): 649–70.

Lilien, D. (1982). Sectoral shifts and cyclical unemployment, *Journal of Political Economy* **90**: 773–793.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity, *Econometrica* **71**(6): 1695–1725.

Melitz, M. J. and Ottaviano, G. I. P. (2008). Market size, trade, and productivity, *Review of Economic Studies* **75**(1): 295–316.

Teece, D. J., Rumelt, R., Dosi, G. and Winter, S. (1994). Understanding corporate coherence: Theory and evidence, *Journal of Economic Behavior & Organization* **23**(1): 1–30.

Winter, S. G. (1987). Knowledge and competences as strategic assets, *in* D. J. Teece (ed.), *The Competitive Challenge: Strategy and Organization for Industrial Innovation and Renewal*, Ballinger: Cambridge, MA.