Turbulence underneath the big calm? Exploring the micro-evidence behind the flat trend of manufacturing productivity in Italy

Giovanni Dosi[1] Marco Grazzi[1] Chiara Tomasi[1] Alessandro Zeli[2]

[1]LEM, Scuola Superiore Sant'Anna, Pisa

[2]Istituto Nazionale di Statistica, ISTAT, Roma

ITSG - Università Bocconi
Globalization and International Competitiveness

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Outline

Motivation

- Flat trend in aggregate manufacturing productivity in the last 15 years in Italy.
- Does micro data replicate such trend? (not to be taken for granted)
- If yes then...
- What is the dynamics - if any - behind the flat aggregate trend?
- What was the shock on the distribution of productivity that followed the euro introduction?

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

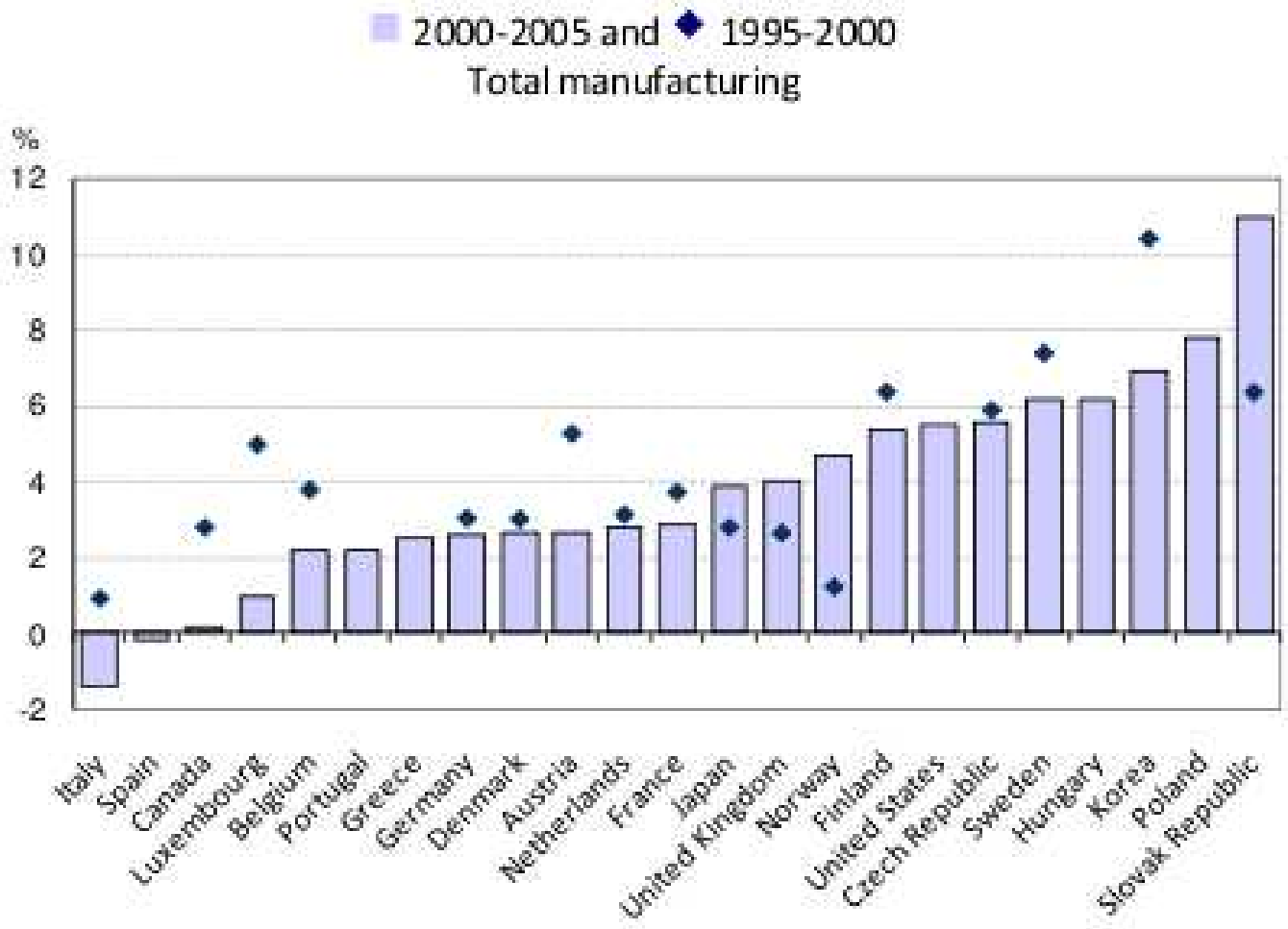
The Database Micro.3 1989-2004

- 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, CSI, 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.

Growth of manufacturing labor productivity (OECD, 2008)



Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

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

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

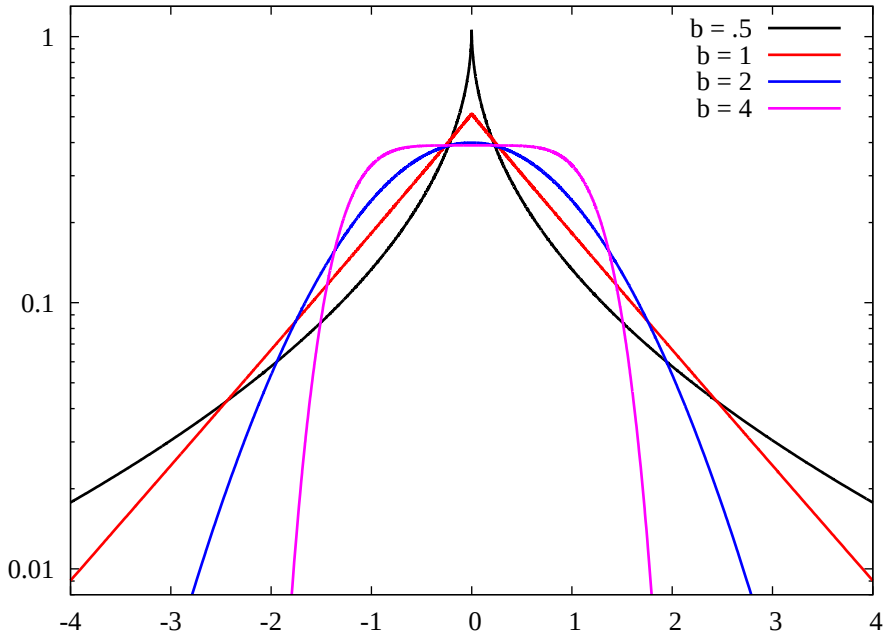
Distributional Analysis I

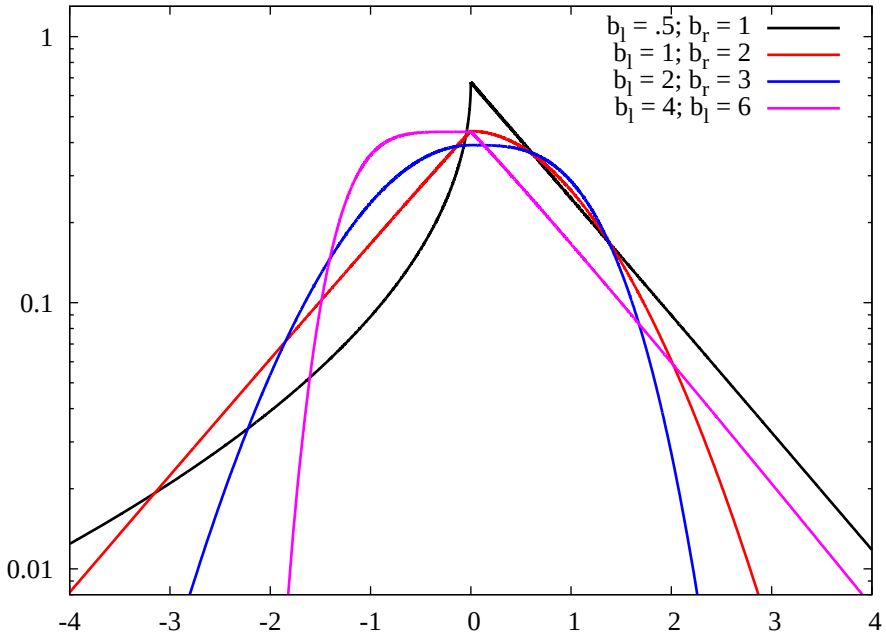
- Heterogeneities in the distribution of labor productivity
- Heterogeneity is not a property of the the level of aggregation 2 Vs. 3 digit sectors (see Griliches and Mairesse, 1999).
- No apparent shock after euro introduction.
  - nor in the central tendency
  - neither in the width of the support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

The Asymmetric Exponential Power

- Asymmetric Exponential Power distributions - AEP (Bottazzi and Secchi 2006) 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

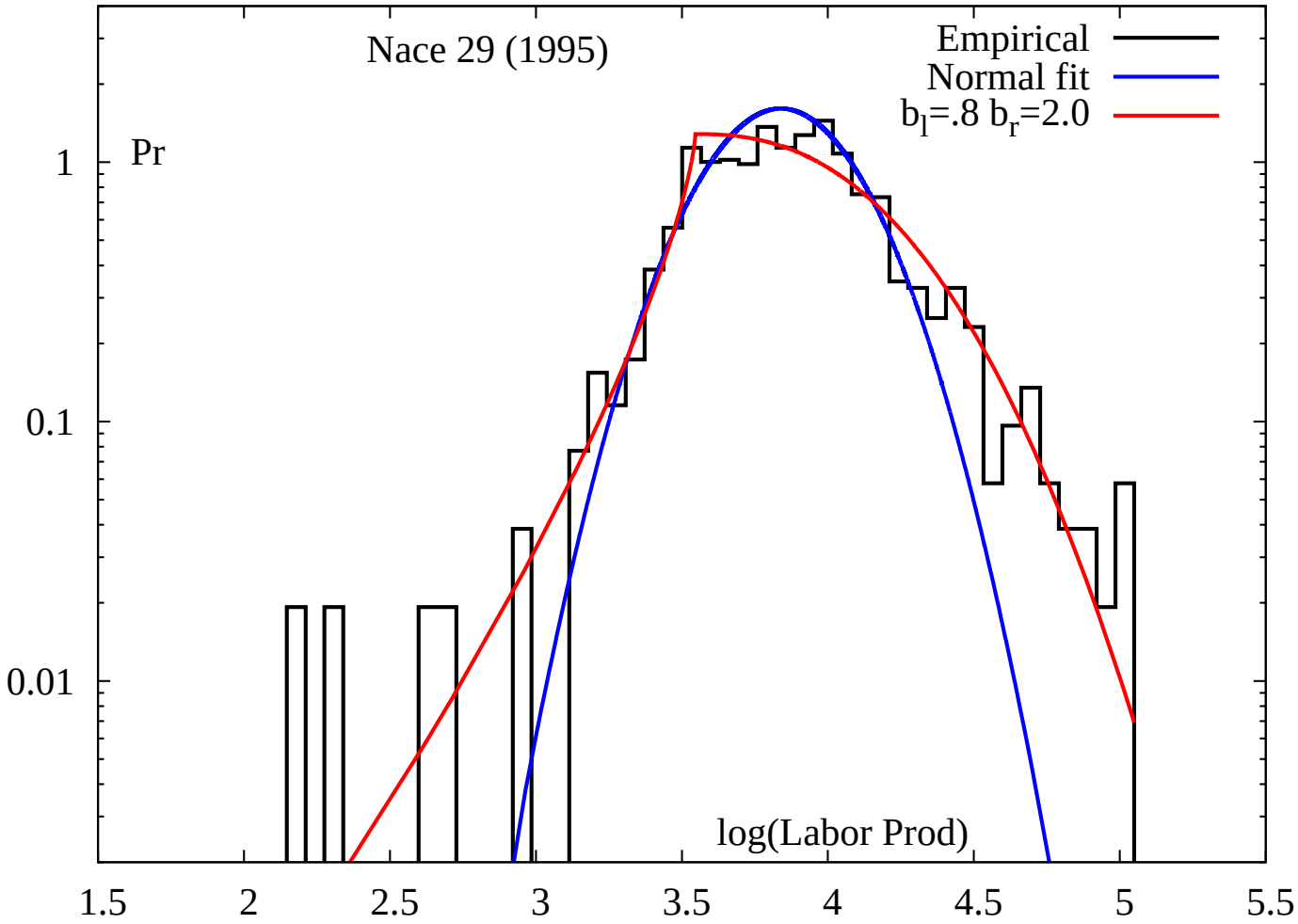
Exponential Power and Asymmetric EP





Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

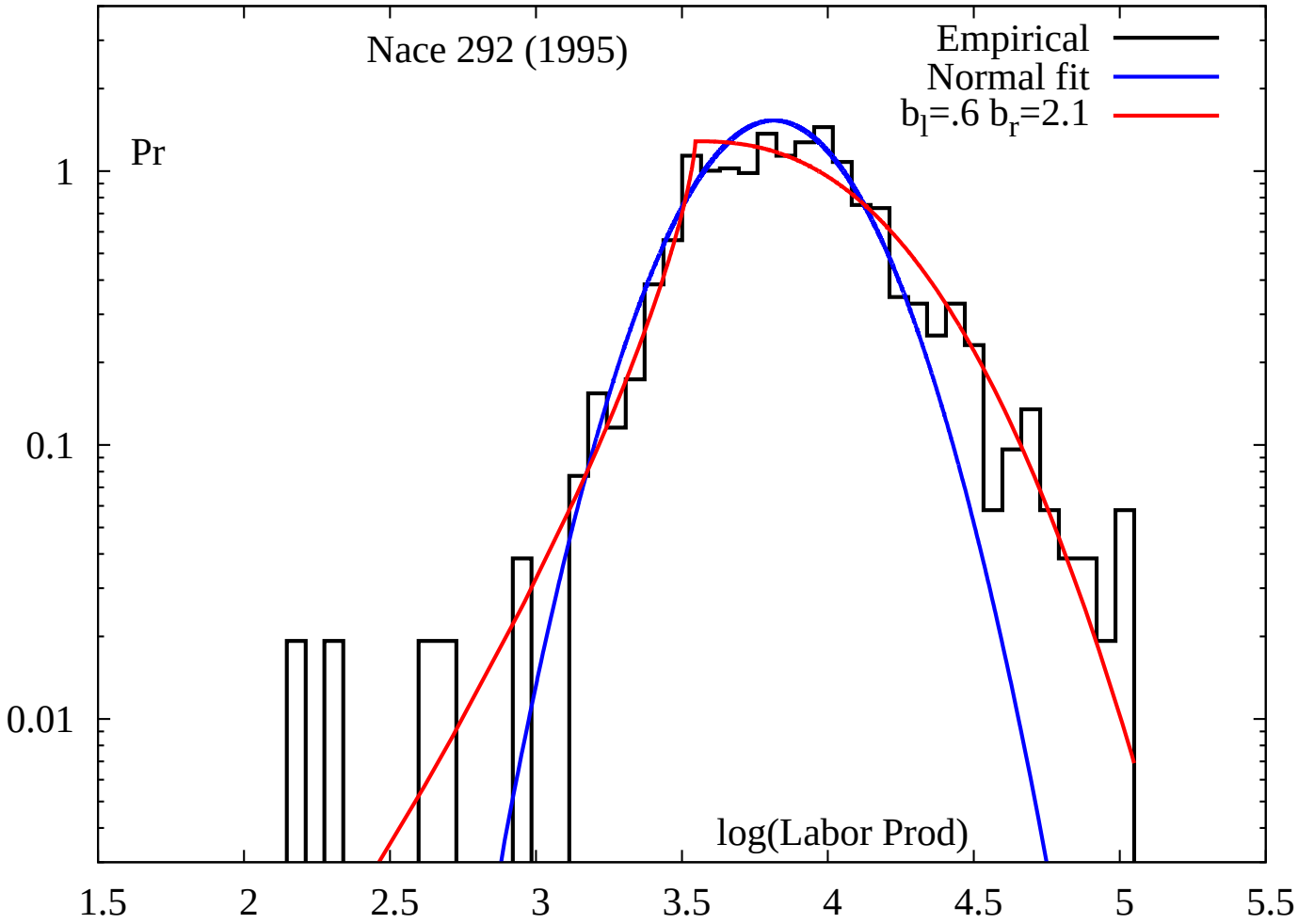
2 Digit NACE 29



Width of the support and asymmetries

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

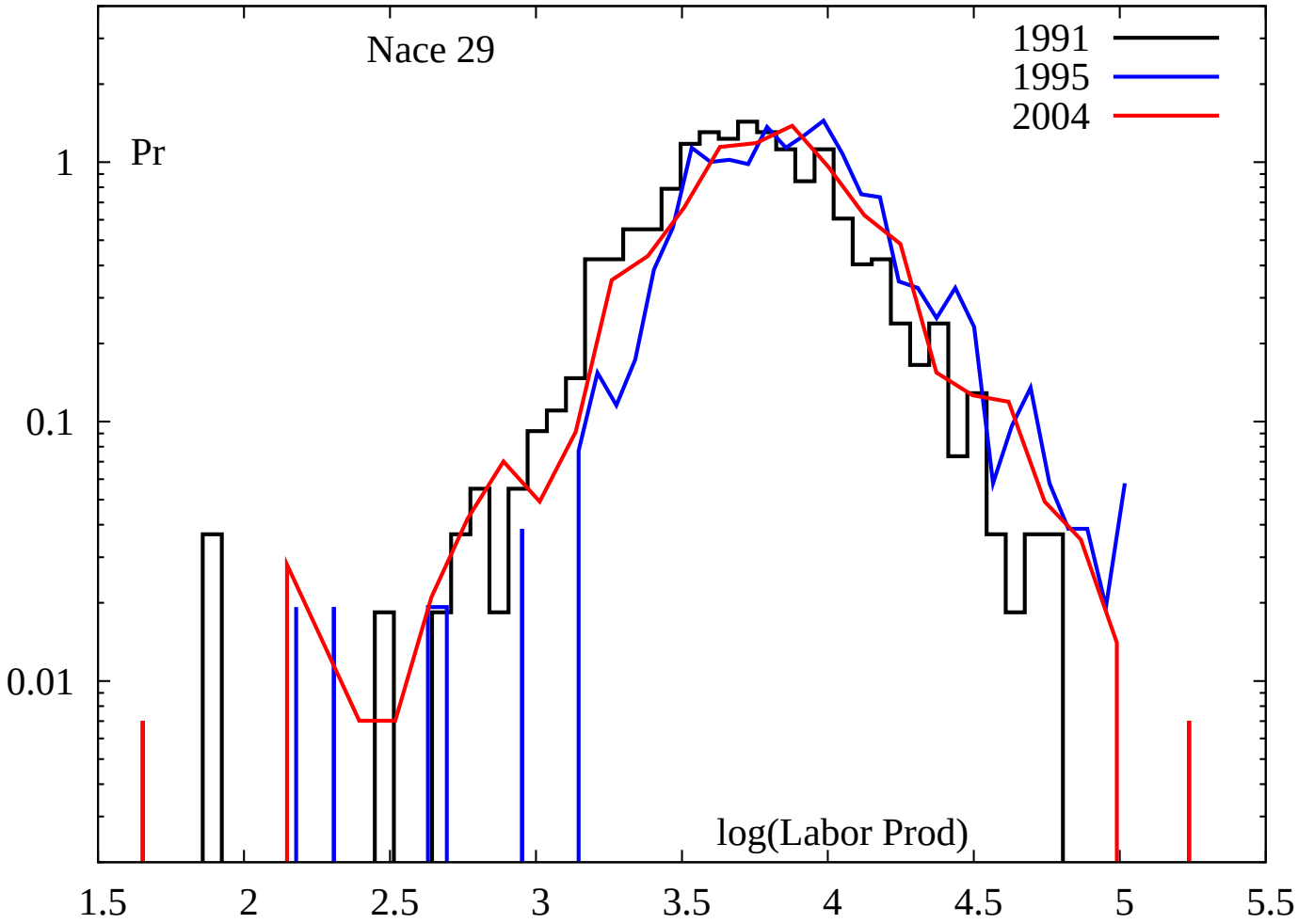
3 Digit nested NACE 292



Width of the support and asymmetries

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

2 Digit NACE 29



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

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

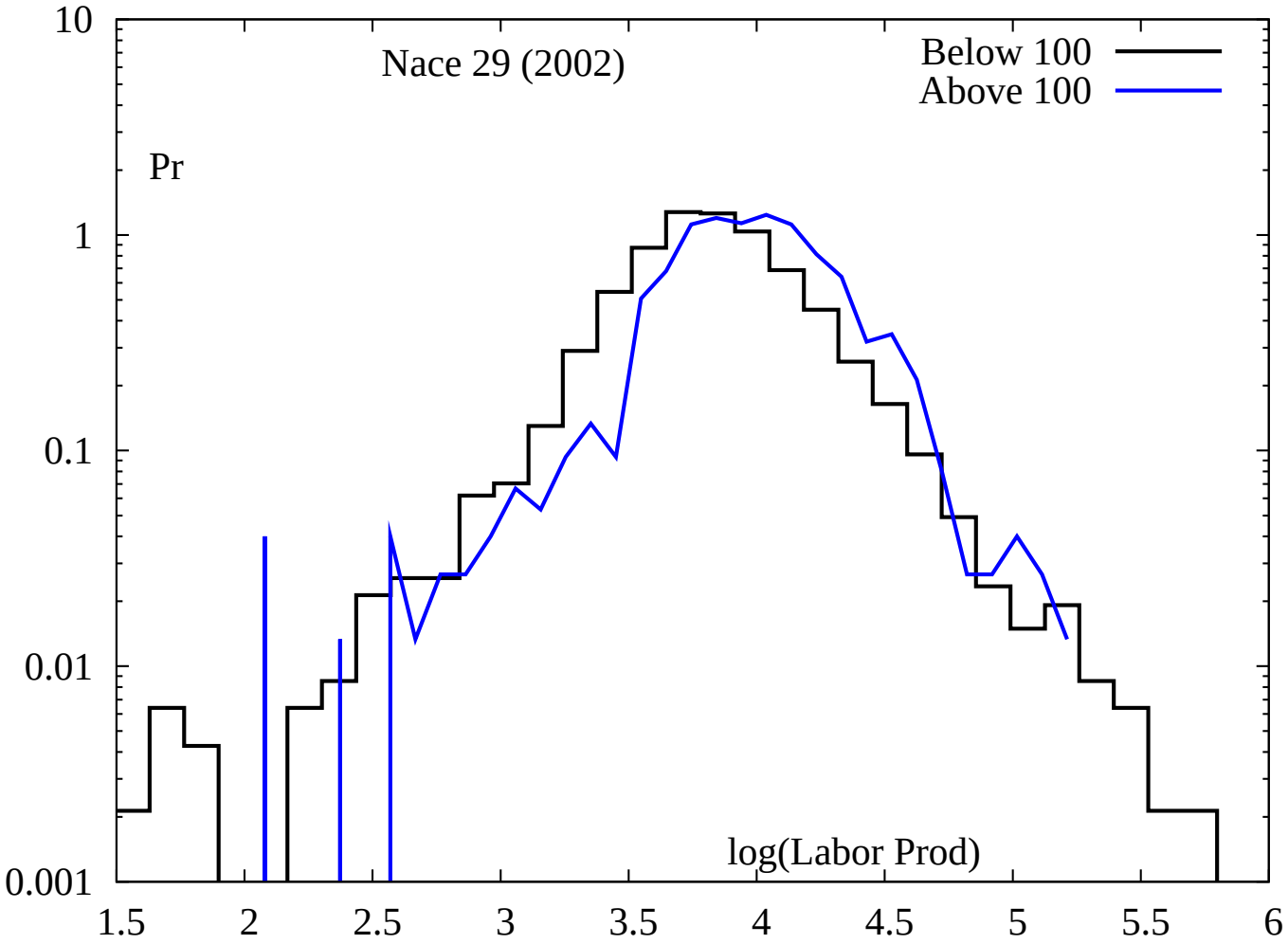
Top to Bottom productivity ratio

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

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Below and above 100 employees



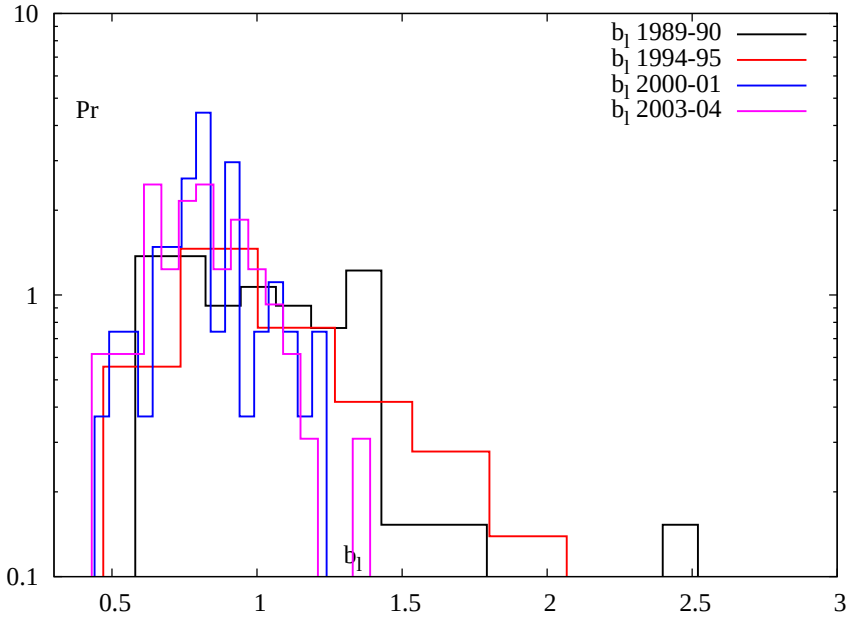
Higher productivity due to shift and reduced support

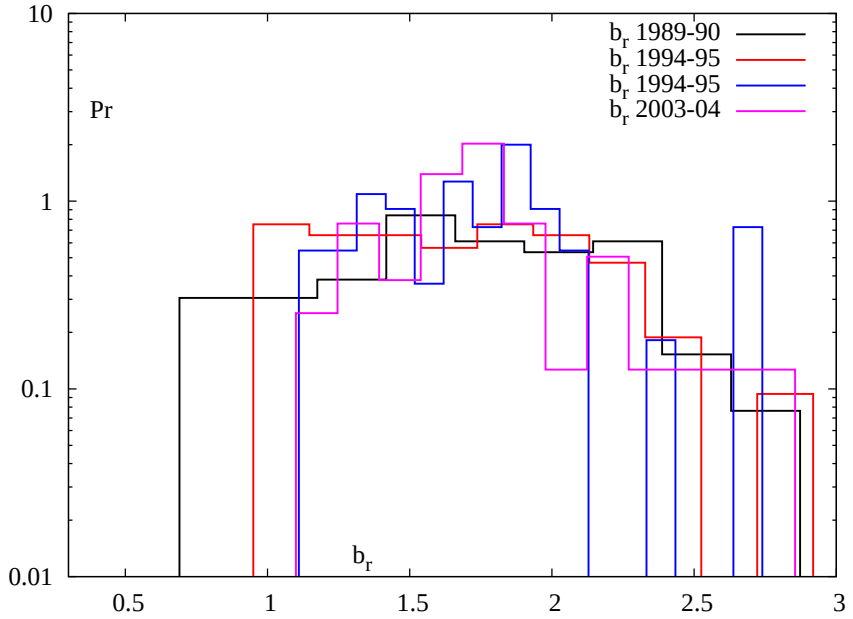
Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Distributional Analysis II - 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.

b_l and b_r parameters in 55 3-Digit sectors

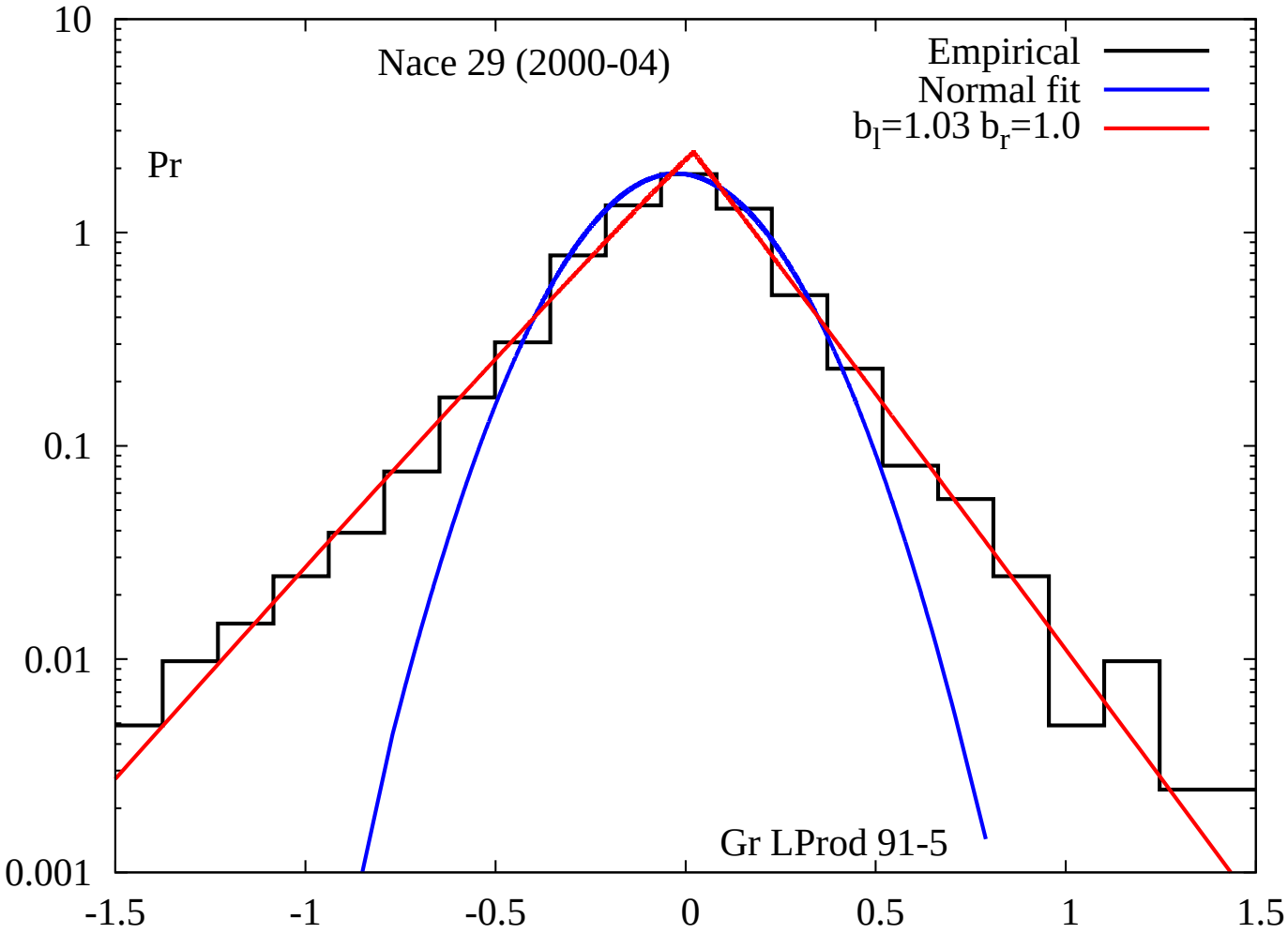




Distributional Analysis III - Growth rates

- Laplace distribution of yearly growth rates of productivity (Bottazzi et al. 2005)
- What about longer time intervals
- Five years intervals 1991-95; 2000-2004.
- No evidence of conversion towards Normal

Growth rates of productivity



Tent-shape distribution of productivity growth rates

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

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

FP statistics

NACE	91-2 Vs 94-95	91-2 Vs 03-2004	94-5 Vs 03-2004	99-00 Vs 03-04	NACE	91-2 Vs 94-95	91-2 Vs 03-04	94-5 Vs 03-04	99-00 Vs 03-04
15	**2.426**	**5.986**	**5.614**	**2.308**	27	**9.172**	**9.188**	1.893	**-3.179**
	0.015	0.000	0.000	0.021		0.000	0.000	0.058	0.001
17	**11.172**	**12.384**	0.692	-0.260	28	**10.956**	**11.847**	**6.782**	**5.768**
	0.000	0.000	0.489	0.795		0.000	0.000	0.000	0.000
18	**8.694**	**14.351**	**7.012**	**3.148**	29	**14.279**	**8.509**	-0.952	-0.271
	0.000	0.000	0.000	0.002		0.000	0.000	0.341	0.787
19	**8.561**	**12.696**	**6.235**	1.390	30	-1.223	0.793	1.477	1.302
	0.000	0.000	0.000	0.165		0.221	0.428	0.140	0.193
20	**2.308**	**5.691**	**3.562**	1.327	31	**5.892**	**8.745**	**5.378**	**2.201**
	0.021	0.000	0.000	0.184		0.000	0.000	0.000	0.028
21	**6.169**	**4.579**	0.062	1.707	32	**2.663**	**2.158**	1.926	**4.034**
	0.000	0.000	0.950	0.088		0.008	0.031	0.054	0.000
22	0.068	-1.791	1.533	-0.376	33	**4.063**	**3.056**	-0.184	**3.218**
	0.946	0.073	0.125	0.707		0.000	0.002	0.854	0.001
23	0.117	1.656	1.310	0.176	34	**5.920**	**4.651**	0.107	1.425
	0.907	0.098	0.190	0.860		0.000	0.000	0.915	0.154
24	**5.334**	**3.994**	0.466	-1.125	35	**2.453**	**2.909**	0.704	0.968
	0.000	0.000	0.641	0.261		0.014	0.004	0.482	0.333
25	**4.021**	0.423	1.932	-0.242	36	**5.732**	**4.746**	0.531	**-3.477**
	0.000	0.672	0.053	0.809		0.000	0.000	0.596	0.001

Rejection of the null means distributions stochasticly differ

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

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. Use the binding requirements of financial statements 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 TP to characterize groups of firms in the TPM

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Transition Probabilities in Productivity

15	1	2	3	4
1	73.12	22.37	3.34	1.00
2	21.37	53.42	20.37	5.01
3	3.34	21.04	53.76	22.04
4	2.00	3.34	22.70	71.79

27	1	2	3	4
1	67.01	25.98	6.84	0.00
2	26.67	41.71	25.98	5.47
3	6.15	28.03	47.86	17.78
4	0.00	4.10	19.15	77.26

17	1	2	3	4
1	68.83	22.64	6.04	2.42
2	23.25	46.79	23.85	6.04
3	6.64	22.64	48.00	22.64
4	1.21	7.85	22.04	69.13

28	1	2	3	4
1	70.92	22.42	5.19	1.40
2	22.42	48.91	24.53	4.20
3	5.05	24.53	48.35	22.14
4	1.54	4.20	22.00	72.18

18	1	2	3	4
1	75.52	20.70	2.24	1.12
2	20.14	57.06	19.58	2.80
3	2.24	20.14	58.18	19.02
4	1.68	1.68	19.58	78.32

29	1	2	3	4
1	63.70	26.08	8.27	1.85
2	24.08	43.46	26.93	5.42
3	8.41	22.66	45.32	23.51
4	3.71	7.70	19.24	69.68

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Laggards, Climbers and Leaders

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

- Productivity Laggards (A)
- Productivity Climbers (B)
- Productivity Leaders (C)

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

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	3.910	4.172	4.241
Export	0.696	0.889	0.879
Exp NACE4	2.469	2.667	6.811
Imp NACE4	2.891	3.722	8.201
Exp countr.	6.871	9.917	17.157
Imp countr.	3.080	4.028	6.923
Patent	0.008	0.056	0.042
GOM	6.043	6.499	13.696
Obs	505	18	214
Trans Prob	84.945	6.055	72.993

Sec 27	Lagg.	Climb.	Lead.
Size	3.963	4.059	4.600
Export	0.751	1	0.942
Exp NACE4	3.781	2.928	5.159
Imp NACE4	3.603	3.357	9.849
Exp countr.	8.671	9.071	14.982
Imp countr.	3.006	6.857	10.287
Patent	0.030	0	0.044
GOM	8.442	6.125	12.716
Obs	237	7	113
Trans Prob	81.164	4.794	77.397

Sec 17	Lagg.	Climb.	Lead.
Size	3.900	4.113	4.157
Export	0.757	0.942	0.873
Exp NACE4	4.174	6.673	7.563
Imp NACE4	4.493	8.481	9.976
Exp countr.	9.882	19.077	20.845
Imp countr.	4.332	8.039	8.976
Patent	0.008	0.039	0.052
GOM	7.698	7.227	15.756
Obs	534	26	229
Trans Prob	80.726	7.860	69.236

Sec 28	Lagg.	Climb.	Lead.
Size	3.641	4.097	4.039
Export	0.566	0.700	0.874
Exp NACE4	2.552	3.962	6.772
Imp NACE4	1.786	5.150	6.831
Exp countr.	5.359	5.962	14.444
Imp countr.	1.452	3.262	5.147
Patent	0.017	0.075	0.091
GOM	8.874	8.259	17.775
Obs	1174	40	516
Trans Prob	82.328	5.610	72.370

Regression Framework

- Dependent: Growth rate of productivity
- Independent: Productivity (Π), Size (employees), export & patent dummy, controls. All at time t
- Run regression on two separate periods pre- post euro

$$\Delta_{t,t+1}\Pi_i = \alpha + \beta_1\,\Pi_{i,t} + \beta_2\,\text{Size}_{i,t} + \beta_3\,\text{exp}_{i,t} + \beta_4\,\text{pat}_{i,t} + \gamma\,\text{controls}_{i,t} + \varepsilon_i$$

- Results
- $\Pi_{i,t} \Rightarrow$ negative and significant in both periods
- Size $\Rightarrow$ Not relevant
- Export $\Rightarrow$ more important in the pre euro
- Patents $\Rightarrow$ only in few sector

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Productivity growth regression (I)

	1991-95					2000-2004				
	const	lprod t	size	exp	pat	const	lprod t	size	exp	pat
15	0.837	-0.202	-0.000	0.026	0.024	0.697	-0.191	0.007	0.017	-0.021
	0.078	0.019	0.008	0.017	0.097	0.070	0.016	0.009	0.018	0.061
17	0.577	-0.159	0.009	0.075	0.178	0.866	-0.254	0.001	0.026	-0.001
	0.071	0.017	0.009	0.015	0.073	0.071	0.017	0.009	0.016	0.047
24	1.099	-0.318	0.029	0.086	0.019	1.149	-0.271	0.002	0.010	0.003
	0.131	0.029	0.011	0.032	0.042	0.099	0.021	0.011	0.042	0.032
27	0.590	-0.207	0.054	-0.008	-0.089	0.469	-0.136	0.015	0.003	0.065
	0.141	0.033	0.012	0.027	0.095	0.092	0.023	0.010	0.023	0.044
28	0.734	-0.207	0.000	0.063	0.013	0.669	-0.206	0.024	0.006	0.019
	0.073	0.019	0.009	0.012	0.036	0.041	0.010	0.006	0.008	0.016
29	0.684	-0.205	0.022	0.051	0.057	0.912	-0.254	0.009	0.019	0.012
	0.069	0.018	0.006	0.015	0.019	0.049	0.012	0.005	0.014	0.011
36	0.431	-0.164	0.032	0.048	0.078	0.767	-0.260	0.014	0.043	0.072
	0.075	0.020	0.010	0.016	0.041	0.067	0.017	0.010	0.022	0.029

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Investment - Regression Framework II

- Add investment rate (as normalized by firm value added) at time t among regressors
- Investment available for the whole population up to 1997, after on a representative sample.
- Use observed investment only (estimated too different from observed)

- Investment turns out to be significant for productivity growth, especially in the pre euro
- Other regressions coefficients are stable (both in sign and significance)

Productivity growth regression II

	1991-1995					2000-2004				
	lprod t	size	inv	exp	pat	lprod t	size	inv	exp	pat
15	-0.198	0.001	0.295	0.027	0.023	-0.195	0.011	0.109	0.011	-0.040
	0.019	0.008	0.056	0.016	0.095	0.022	0.011	0.042	0.026	0.070
17	-0.142	0.001	0.385	0.080	0.172	-0.267	-0.002	0.088	0.031	-0.016
	0.016	0.008	0.032	0.014	0.068	0.028	0.013	0.051	0.028	0.059
24	-0.209	0.028	0.209	0.071	0.011	-0.215	-0.012	0.036	-0.005	0.013
	0.029	0.010	0.023	0.029	0.038	0.029	0.014	0.019	0.053	0.036
27	-0.200	0.052	0.031	-0.009	-0.085	-0.129	0.016	0.023	0.016	0.079
	0.034	0.013	0.037	0.027	0.095	0.030	0.012	0.048	0.034	0.053
28	-0.216	-0.003	0.298	0.060	0.008	-0.225	0.025	0.003	0.001	0.001
	0.019	0.009	0.058	0.012	0.035	0.021	0.009	0.028	0.017	0.023
29	-0.206	0.020	0.371	0.051	0.059	-0.264	0.009	0.023	-0.010	0.006
	0.018	0.006	0.079	0.015	0.019	0.020	0.007	0.062	0.030	0.015
36	-0.182	0.028	0.452	0.051	0.078	-0.212	0.005	0.107	0.030	0.040
	0.020	0.010	0.082	0.016	0.040	0.029	0.013	0.075	0.043	0.036

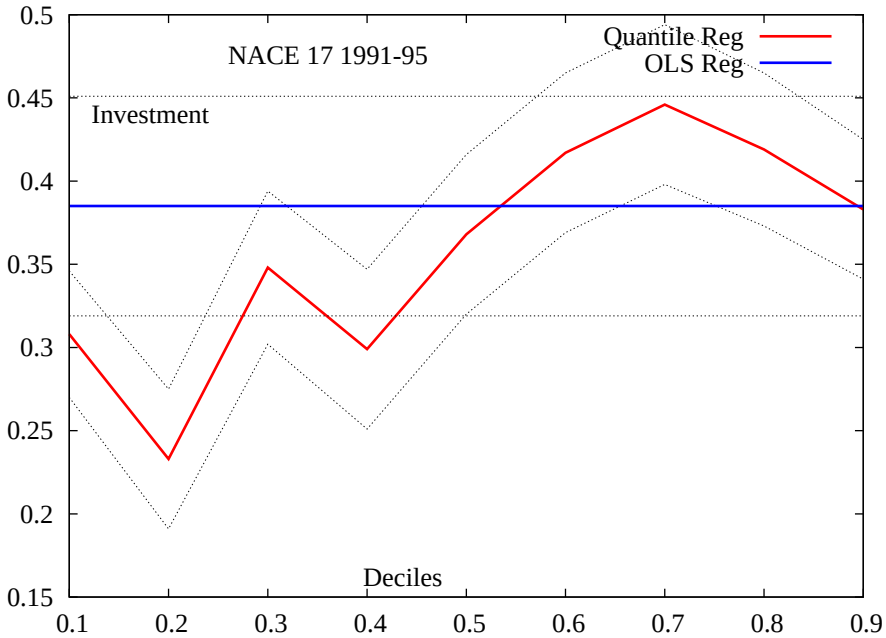
Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

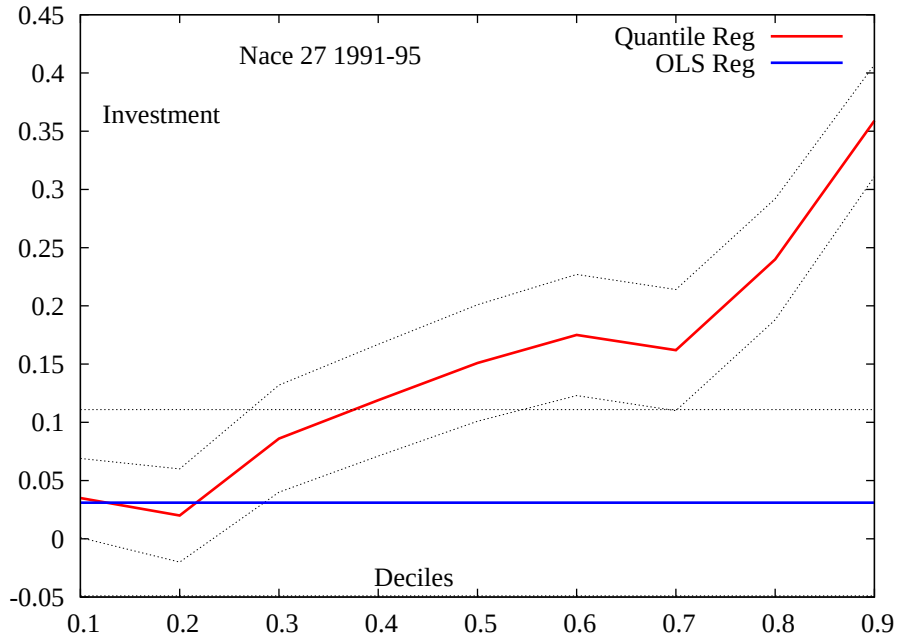
Quantile regressions

- 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 in growing in the quantiles.
- A small group of efficient high performance high growth firms

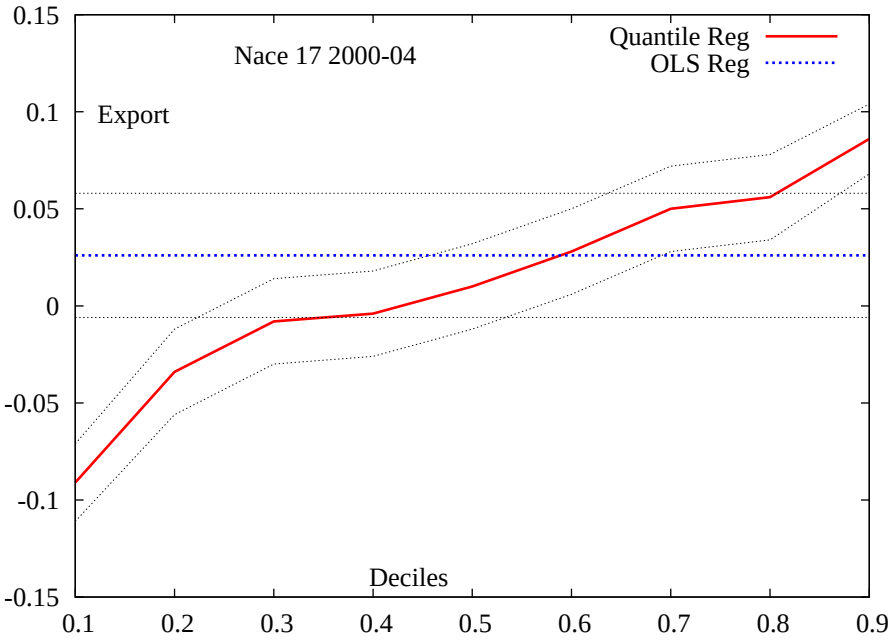
Quantile Regression - Investment

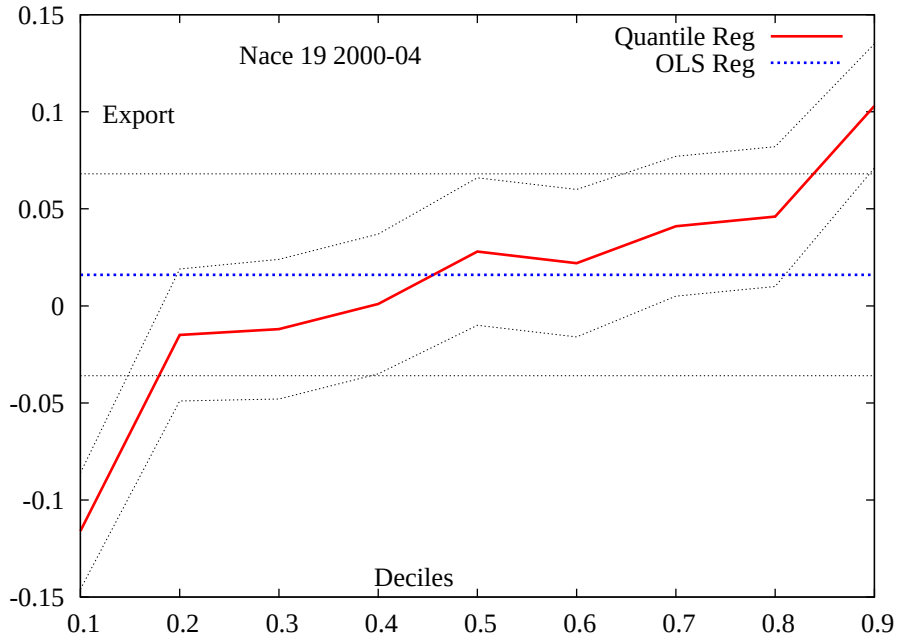




Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

Quantile Regression - Investment





Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento

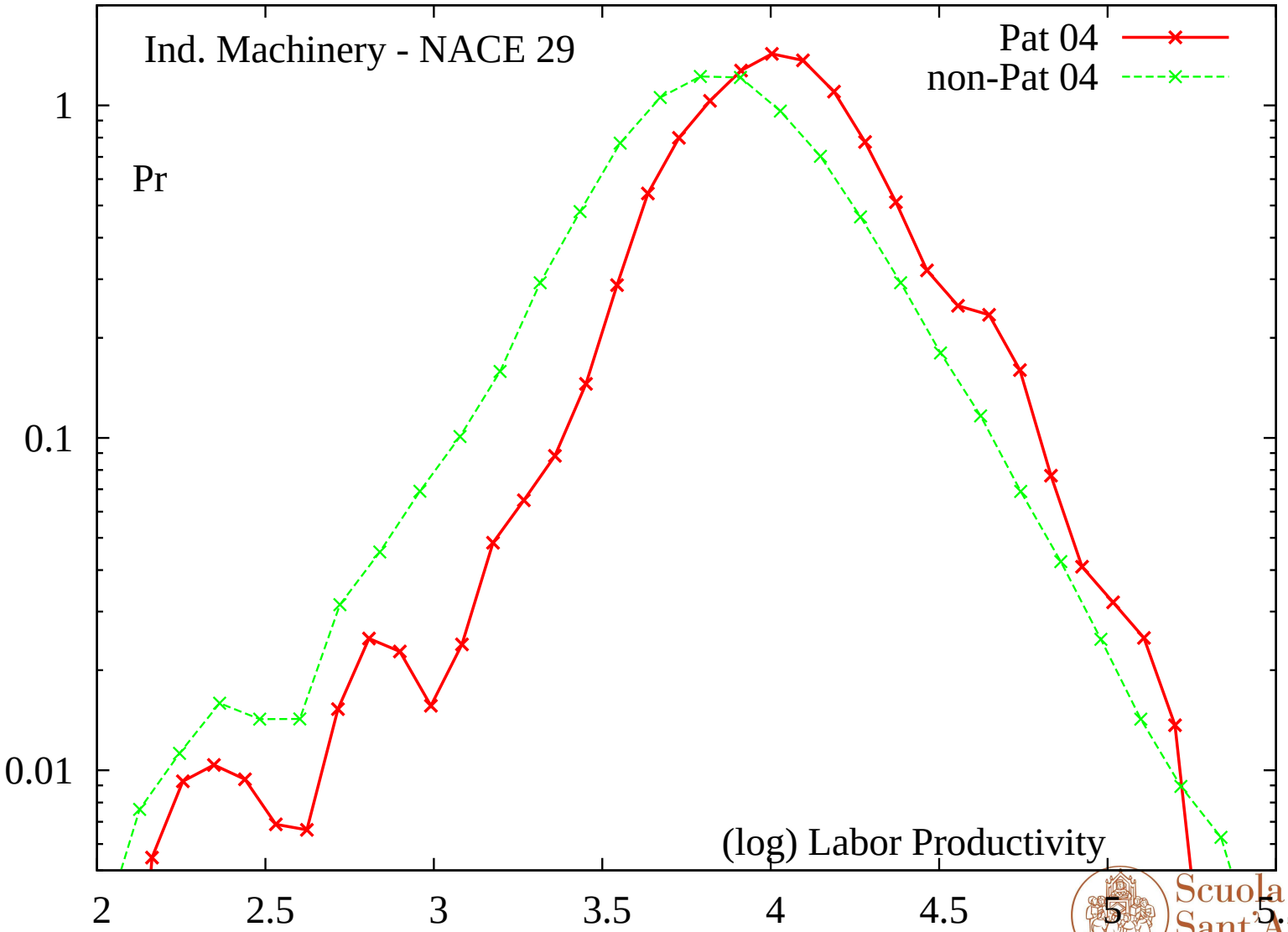
Concluding Remarks

- The flat trend of manufacturing productivity holds also for firms bigger than 20 employees.
- The "euro shock" has not (yet ?) fully disclosed its selection effects.
- 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
- Also uneven effects of exporting and investment for low/ high productivity growth firms.
- Together with very few firms climbing up the productivity distribution

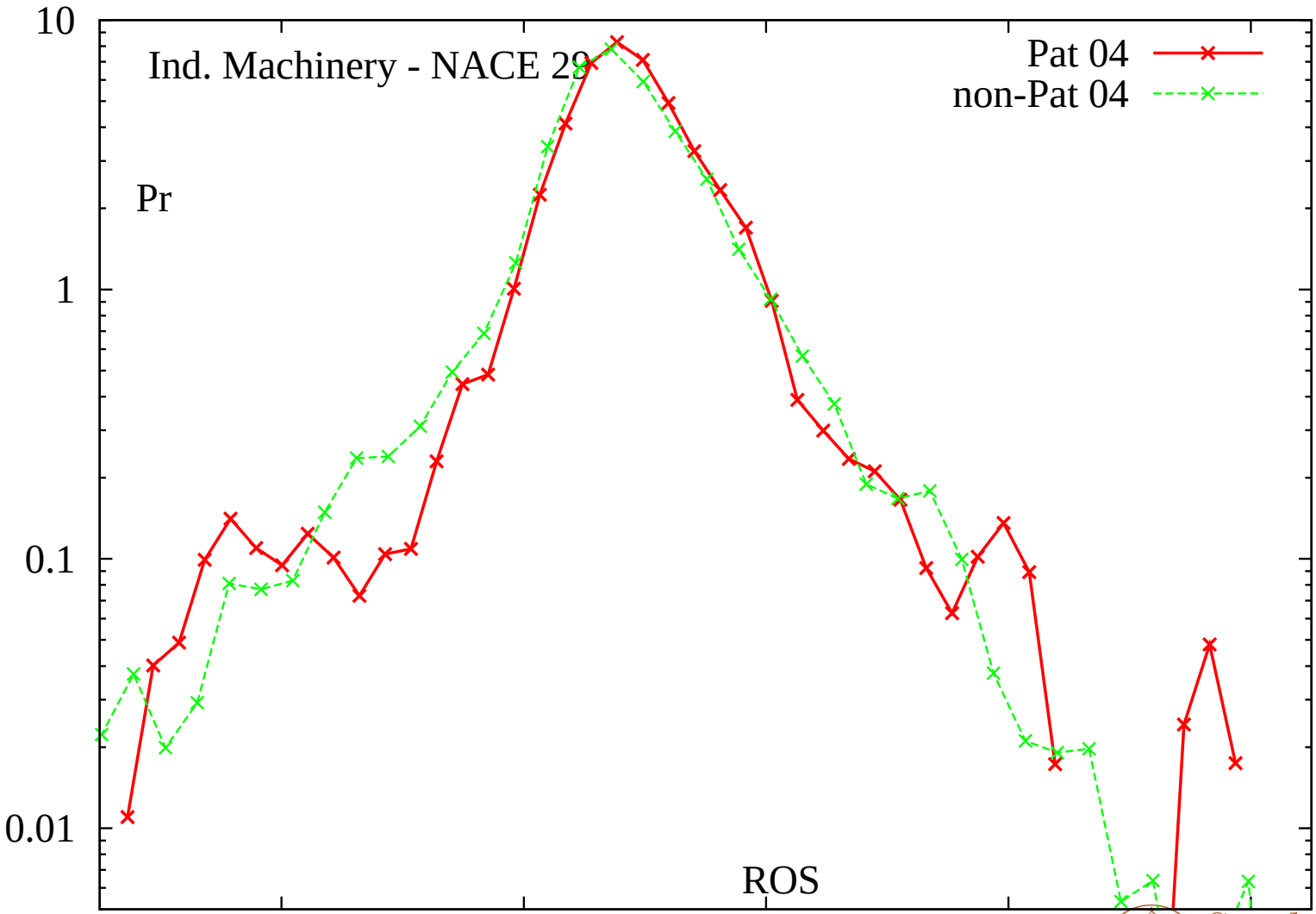
Thank you!

Scuola Superiore
Sant'Anna
di Studi Universitari e di Perfezionamento

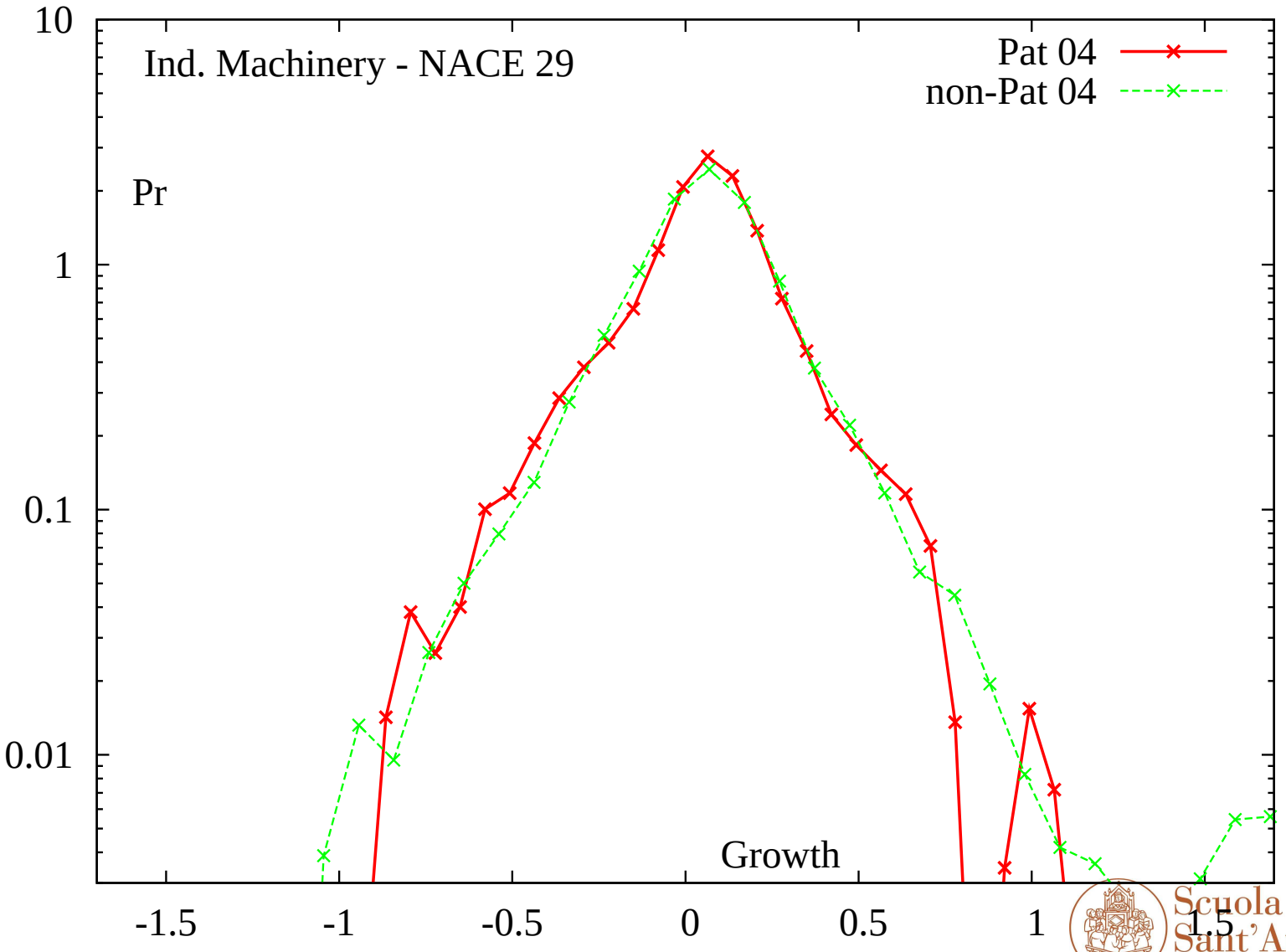
Productivity for Patenters and non Patenters, NACE 29



ROS for Patenters and non Patenters, NACE 29



Growth for Patenters and non Patenters, NACE 29



	91	93	95	99	00	01	03	04
20	43.2	55.1	68.6	48.9	60.3	63.9	59.9	46.4
20	32.7	35.1	36.0	35.2	35.7	37.0	36.4	36.5
21	45.9	79.9	61.4	93.8	79.7	66.6	82.4	80.4
21	44.6	49.3	53.7	53.7	49.5	51.6	51.0	52.9
24	66.8	71.6	84.2	95.2	95.0	96.4	87.4	89.0
24	58.3	64.7	70.3	73.1	69.7	70.4	70.1	71.1
25	52.8	60.7	60.8	60.9	59.0	56.6	58.2	55.3
25	44.0	46.0	46.7	45.7	45.1	43.9	44.2	44.6
32	36.6	39.8	43.8	41.5	43.5	45.5	47.6	49.3
35	60.2	54.4	56.6	45.7	52.3	50.2	49.2	59.3
35	37.3	38.8	44.6	42.5	44.0	44.4	43.5	44.3

Table: Labor Productivity of Patenters (first row) and non patenters (second row).

Scuola Superiore Sant'Anna
di Studi Universitari e di Perfezionamento