SIZE, GROWTH AND PRODUCTIVITY DYNAMICS IN ITALIAN MECHANICAL FIRMS[1]

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Summary

This paper provides estimates of labour productivity growth in Italian mechanical sector during the period 1997-2002 analyzing its determinants with particular attention to the role played by turnover (exits and entrants) and company size. Data come from the longitudinal company accounts database of Research Centre of Unioncamere. The analysis put in evidence the global slowdown of productivity and the positive impact on productivity growth given by gross firm turnover. Transition matrices reveal a relevant degree of persistence in the period and a positive relation of this persistence with firm size. We apply the decomposition of Baily et al. (1996) to analyse the role of turnover: survivors account in negative of overall growth, on the contrary, the contribution of entrants and exits is positive and very high. Finally, from the decomposition of productivity growth by different groups of companies emerges the negative impact of unsuccessful upsizers (firms which decrease productivity by increasing employment). Against the conventional view of the strong capacity of permanent small business (above all class 1-9 employees) to spur the growth of the economy, our results indicate that they are likely to decrease productivity.

1 Introduction

Traditional productivity studies have typically used aggregate - and/or industry - level data to study the sources and patterns of productivity growth. However, theoretical studies of industrial organization have suggested that aggregate productivity growth typically stems from behaviour at the firm - or plant - level. In fact, these theories have shown that plant-level dynamics due to plant heterogeneity is one of the most important factors in the evolution of industrial productivity (Jovanovic, 1982; Hopenhayn, 1991; Ericson and Pakes, 1995; Olley and Pakes, 1996).
Economic literature about global productivity is extremely rich and an extensive survey is provided in Hulten (2000). In this paper we will focus on labour productivity (LP from now on), which is only one component of Total Factor Productivity (TFP). The fact that LP varies widely between plants and companies is well-known (Salter, 1966; Bartelsman and Doms, 2000; Foster *et al.*, 2001; Bottazzi *et al*., 2002). This observation give raises to a number of questions. Performance in any

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one year is to some extent a matter of luck, so both the good and bad performer of a particular year will tend to appear averaged in a different one. So how much of the variation is due to purely transitory factors and does it therefore diminish over time? Second, what role does the process of competition play? Does the spur of competition cause laggard firms to improve? Or does it simply cause them to be eliminated by liquidation or take over?

Up to now, it has been difficult to analyse these questions in a rigorous way because of a lack of adequate data covering companies of each size in the whole Italian economy (not just manufacturing).[2] Recent years have seen a relevant increase in studies on productivity. This is partly due to rising availability of longitudinal micro-level data (LMD)[3]. This trend is also motivated, as explained in Bartelsman and Doms (2000), by the development of a rich theoretical microeconomic foundation and to the displeasure with the concept of the aggregate production function. A considerable feature of LMD is that they enable to observe the empirical distribution of productivity measures at firm's and sector level.

This paper is a preliminary attempt, using the large data base of company accounts constructed by Research Center of Unioncamere. The database contains information on many variables appearing in firm's company accounts.

In our study we investigate the distribution of LP in an important Italian manufacturing sector: the sector Dk29. We are interested to assess the degree of variability within the sector and the persistence of these differences in the period 1997-2002.

Available data from the Unioncamere Database (UD) allow to compute only LP measured either by value added per employee, gross output per employee or sales per employee.

Our analysis puts in evidence the positive impact of firm demography in raising the overall efficiency of the mechanical sector. In the period 1997-2002 turnover caused in fact an increase of LP because companies with productivity *above* the mean entered and companies with productivity *below* the mean exited. Notwithstanding the impact of the incumbent companies on productivity growth was not positive as well, but on the contrary their average productivity made worse. This is an unexpected result because it seems sensible to think that competition could raise productivity in incumbent firms encouraging firms to innovate to reduce costs and to improve the organisation of production.

Transition matrices computed over the examined period show that companies enter with different intrinsic productivity and maintain more or less the same position in the distribution of the sector: the diagonal cells of the transition matrices show that a large fraction of companies in a productivity size class remaining in the same class six years later. This means that the mechanical sector evidences a permanent heterogeneity among companies.

A decomposition of productivity growth shows a negative reallocation effect between companies. This can be interpreted as reflecting the creative destruction processes: for the companies of the mechanical sector the destruction has been creative, the turnover has contributed to the productivity growth even if partly smoothed because of a negative reallocation effect growth.

The remainder of this paper is organised as follow: Section 2 provide some definitions, describe the data, and reports summary measures of firms dynamics. Section 3 describes the variables used to compute the LP, how to deflate them, the labour productivity dynamics and finally we compare results obtained from UD with findings obtained from ISTAT. In section 4 some descriptive statistics are reported and the productivity distribution is studied by means of nonparametric density estimation. In section 5 we analyze the dynamics of LP during the period 1997-2002 using transition matrices. Section 6 reports the decomposition of LP with respect to different groups of companies defined firstly according productivity and employment growth and then according firm size. The final section contains some comments on results and final remarks.

[2] For an investigation on industrial dynamics base on a decade of micro-longitudinal data from four Italian industry see. Bottazzi *et al.* (2002).

[3] Empirical studies based on micro-level longitudinal data have rapidly increased in number over the recent past (see Ahn, 2001 for a survey).

2 Data and measurement procedure

2.1 Description of the data and definition

Data for our research is taken from the administrative file of company accounts of Cerved, which is the largest and most accurate database of company accounts in Italy[4], suitably processed from the statistical point of view by Unioncamere. The data contained in the Cerved file has been integrated with the data of REA information system file by Research Centre Unioncamere[5]. It is worth noting that Research Centre of Unioncamere faced the problem of not reliable data, particularly relevant in the case of administrative data (Gagliardi and Vernaci, 2004), checking for the presence of outliers and removing evidently unreliable observations.

The source of data in our research is the universe of companies of the Italian mechanical sector (Branch Dk29, Construction of machines and mechanical devices) in operation in the period 1997-2002[6]. As it is known, the Italian mechanical sector represents - both for Added Value and Exports - one of the strategic sectors of the Country[7].

The UD can be considered an "open" database because it contains firms which enter the set after transformation of their juridical type (individual firms or partner-ship becoming companies) companies which follows an opposite procedure and consequently exit from the set, and firms which enter and exit in the same period (mergers, wind-up, bankruptcy proceedings). The turnover (entries/exits) are usually considered representative of the sector and economic system trend.

There are a couple of issues worth noting about the nature of entries and the extent to which entries and exits reflect mergers and acquisitions. For entry, the registration date is when the first hiring occurs. Thus, for example, the 'entries' may reflect cases where (usually small) enterprises decide to employ individuals on an official basis. Mergers and acquisitions cannot be identified across the data as whole, but there has been some estimation of their importance in certain regions and sectors. According to some studies using social security data (INPS data) for particular regions and periods, between 10 and 15 per cent of entry regards a change of legal status, 20 per cent involves a substantial change of pre-existing firms, and 65-70 per cent is 'pure' entry (equivalent figures are likely to hold for exiting firms). For further details, see Bartelsman *et al*. (2003).

Each company has a unique identification number. We identify entry and exit by linking successive years together. If a unit has a new identification number, it has entered. If a previous number has disappeared, then it has exited and if the number is the same, the unit is a survivor. Of course, entry/exit would be biased if companies changed their reference numbers owing to data error. We therefore dropped any company that disappeared for one or more periods and then reappeared with the same reference number (which under the sampling rules would be a mistake).[8]

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[4] We refer to the file obtained from the Cerved with the reclassification of the official company accounts deposited at the National Business Register managed by Chambers of Commerce.

[5] In particular, REA, the Repertory of Economic and Administrative Data about enterprises enrolled in the National Business Register, represent a major step for the Italian economic-statistical system as a whole. In particular, REA, which contains the simplified version of economic and statistical data stored in other administrative archives, provides full and trust worthy information for each enquiry. For an overview of the administrative archives provided by the Italian Chambers of Commerce, see Gagliardi and Vernaci (2004).

[6] It is worth stressing that employees of entrants companies in the last year (2002) are not still completely validated. Consequently the estimate of total employment for entrants in 2002 might be lightly biased.

[7] In terms of Added Value (at factors cost) branch Dk29 in 2002 covered 10.5% of the total of industry (in the strict sense) and 2,6% of the total of the entire national economy. In terms of exports, the branch covered about 19,7%f total exports (authors from ISTAT).

[8] The total number of disappearing/reappering companies, and thus dropped, is 1198.

The calculation of entrants, exitors and stayers is complicated by the forward and backward looking nature of the calculation. In order to limit the possible impact of measurement problems, it was decided to use definitions of continuing, entering and exiting firms on the basis of three (rather than the usual two) time periods. Consider an establishment observed in *t*. If it is present in *t*-1 but absent in *t*+1 it is an exitor. Likewise, if it was absent in *t*-1 but present in *t*+1 it is an entrant. However, it is also possible to be absent in *t*-1 and *t*+1, i.e. an entrant that exits after one year. This latter category is thus both an entrant and an exitor[9]. Consequently, the number of establishments in *t* consist of stayers plus entrants plus exitors less one year establishments. This scheme is set out in Table 1.

Table 1. Definition of different types of companies in the database

Company	Type definition
Entrant (entry)	Present in *t* not present in *t*-1.
Exitor (exit)	Present in *t* will not be present in *t*+1.
One-year-only	Present in *t* not present in *t*-1, will not be present in *t*+1.
Stayer	Neither an entrant, exitor nor one-year only, so that present in *t*-1, *t*, *t*+1.

In practice, a number of complications arise in constructing and interpreting data that conform to the definitions of stayers, entrants and exitors described above. In particular, the "one-year" category, in principle, represents short-lived firms that are observed in time *t* but not in adjacent time periods and could therefore be treated as an additional piece of information in evaluating firm demography[10]. Thus, the total number of firms in the analysis excludes these "one-year" firms[11].

Table 2. Number of all, stayers, entrants, exitors and one-year-only companies

Year	all	stayers	entrants	exitors	One-year	stayers	entrants	exitors	one-year
	Number					*Fraction of all (%)*			
1997	12137			629				5.02	
1998	12553	10909	1045	670	71	86.90	8.32	5.34	-0.57
1999	13072	11134	1189	847	98	85.17	9.10	6.48	-0.75
2000	13504	10954	1279	1458	187	81.12	9.47	10.80	-1.38
2001	13719	10015	1673	2427	396	73.00	12.19	17.69	-2.89
2002	12883		1591				12.35		
Total 1998-2001	52848	43012	5186	5402	752	81.39	9.81	10.22	-1.42

Following the definitions given in Table 1, we report in Table 2 the number of companies in each group[12]. The left panel of the table contains the number of all, stayers, entrants, exitors and one-year-only companies in each year. The right panel reports the fraction of each category with respect to all companies in each year. For example, in 1998 (second row), there were a total number of 12553 companies, 10909 (86,9%) stayers, 1045 (8,3%) entrants and 670 (5,3%) exitors. Finally, 71 companies stayed for one-year-only. Hence stayers plus entrants plus exitors less one-year-only add up to the total.

[9] If we defined entrants as those present in *t*, not present in *t*-1 but will be present in *t*+1 this would allocate the one-year-only among exitors which would understate the number of entries.
[10] However, in some databases this category also includes measurement errors and possibly ill-defined data.
[11] Note that one-year-only companies are included in both entrant and exit companies.
[12] Available data does not allow to detect entries in 1997, exits in 2002 and stayers in 1997 and 2002.

The table therefore suggests the following. On average roughly eight out of 10 companies will survive to the following year. Roughly one out of 10 establishments have entered, and one of 10 establishments will exit, 0.1 of whom is a one-year-only. Furthermore, it is interesting to note that the fraction of entrants and exitors (gross firm turnover) constantly increases in the considered period so that the role of stayers shrinks from 87% to 73%.
Besides demographic data we defined a set of companies which are present in each year and represent the core of the period 1997-2002. This set formed by 7765 companies can be considered a fixed panel of 1997-2002 and will be called "survivors" from now on.
Table 3 shows the average company size (number of employees) of all, stayers, entrants, exitors and survivors.

Table 3. Average number of employees in the period 1997-2002 for differents groups of companies

	Average company size				
Year	All	Stayers	Entrants	Exitors	Survivors
1997	32.9	36.6		24.9	36.6
1998	34.1	36.3	16.6	21.5	39.5
1999	32.4	35.5	10.0	20.0	39.3
2000	33.1	36.3	12.7	23.4	41.3
2001	31.8	36.4	10.1	24.2	41.6
2002	31.6		5.6		43.2
Mean	32.6	36.1	10.5	23.2	33.1

In the observed period, the average size of companies is around 32 employees with a small year-by-year variation. Stayers are rather bigger with an average size of 36. Entrants and exitors are on average smaller, with exitors being larger than entrants. Overall, although there are a large number of entrants and exitors, they are clearly smaller than the remaining companies[13].

3 Labour productivity

3.1 How to measure productivity

As stated in section 1 we are interested in analyzing the dynamics of LP in the mechanical sector Dk29 for the period 1997-2002 using the UD. Thus, we do not face the problem linked to the computation of Total Factor Productivity (TFP).
We recognize as well that our focus on LP rather than TFP affects the interpretation of our results. The role of capital deepening and biases in technical change cannot be well understood by the behaviour of LP alone: for example, investments in labour saving equipment which increase LP may not successful from a TFP point of view[14].
LP estimates are derived as the ratio of a measure of output and inputs. Output can be measured in different ways and this can lead to different estimates of productivity growth. Two basic measures of output are added value and gross output. The former excludes intermediate inputs (materials, energy and services used up in the process of production) while the latter includes those inputs (shipments adjusted for inventories). In several papers regarding U.K. companies (Oulton, 1998) output is measured by sales.

[13] The very low average number of employees for 2002 entrants is linked to what was pointed out in note 6 (p. 3).
[14] Caution needs to be applied when using partial productivity measures as changes in input proportions can influences these measure. A simple substitution of capital for labour within the input mix of a firm or industry can also raise average labour productivity. This means that movements in the average labour productivity statistics don not always represent true changes in the underlying productivity of labour.

Company account data allow us to measure LP either by value added per employee (LPAV), by gross production (output) (LPGO) per employee, or by sales per employee (LPSA).
In other words, the labour measure is just a head count with no allowance for hours worked, nor any distinction between full time and part time employee is made. The mathematical expressions of LP are as follows.

1) value added of *i*-th company at time *t* ($VADD_{it}$) per employee (E_{it}),

$$LPAV_{it} = \frac{VADD_{it}}{E_{it}} \tag{1}$$

2) gross output (GO_{it}) per employee

$$LPGO_{it} = \frac{GO_{it}}{E_{it}} \tag{2}$$

where gross output is measured as the sum of sales, other revenues and change in goods inventories.

3) ($SALES_{it}$) per employee:

$$LPSA_{it} = \frac{SALES_{it}}{E_{it}} \tag{3}$$

The choice between output measures is not so clear-cut for LP measurement. Increasing or decreasing LP estimates based on gross output may not reflect a change in technology or efficiency but, rather, substitution between labour and intermediate inputs. For example, outsourcing activities previously conducted in-house will cause gross output per unit of labour input to increase even though the total amount of labour used to produce the output may not have changed, or only changed a little. In such a case, direct labour input is reduced and replaced by intermediate purchases and gross output may not necessarily increase, yet the substitution of inputs will result in an increase in measured LP. In practice, of course, some gain in efficiency is the goal of the outsourcing but, while it may be realised, it is not reflected as the measured change in LP.
Consequently, sectors experiencing significant increases in outsourcing or in-house production may appear to have rates of productivity growth higher than other sectors if LP was measured on a value-added output basis. The growth of added value LP is less dependent on changes in the ratio of intermediate inputs to labour or the degree of vertical integration. As outsourcing increases, value added is reduced, as well as labour input, and LP is not artificially boosted by the outsourcing. Both the numerator and the denominator change in the same direction when outsourcing or in-house production increase. Any change in LP is dependent on the efficiencies achieved within the industry by the outsourcing. Gross output-based LP measures are more sensitive to the degree of vertical integration and outsourcing than added value based LP measures (OECD, 2001).
As patterns of outsourcing and in-house production are constantly changing on an industry basis, these considerations constitute a case to adopt LP estimates based on a value-added concept of output. However, Dean *et al*. (1966, p. 192) state some of the reasons for adopting a gross output-based estimate of MultiFactor Productivity (MFP) also apply to LP. “The use of value-added output for measurement of LP — as distinct from its use in MFP measures — has not been closely examined in the theoretical literature and value-added is in fact frequently used in studies of LP. A persuasive case can be made for the use of gross output in LP series also. Some of the considerations that underlie the choice of gross output for multifactor productivity measurement carry over to the area of LP.”
LP estimates provide an alternative, although partial, measure of productivity. Here value-added based estimates have greater validity. Increasing or decreasing LP estimates based on gross output

may not reflect a change in technology or efficiency but, rather, substitution between labour and intermediate inputs. The growth of value-added LP is less dependent on changes in the ratio of intermediate inputs to labour or the degree of vertical integration. As patterns of outsourcing and in-house production are constantly changing on an industry basis, these considerations constitute a case to adopt LP estimates based on a value-added concept of output.
Value added is commonly regarded as superior to sales as a measure of output, though the opposite view has been forcefully espoused by Jorgenson *et al.* (1987). Sales may well differ between firms or between sectors because of differences in the extent to which goods and services are bought in. All LP estimates provide an alternative, although partial, measure of productivity. In reality, the three indexes of LP, may vary for reasons which have nothing to do with efficiency, e.g. differing human or physical capital intensity.
We prefer to compute the LP with three measure of output in order to evaluate the robustness of our results.

3.2 Productivity in real terms: deflating the aggregates

To take the inflationary dynamics[15] into account, it is necessary deflating the three nominal variables at the industry level (all companies in an industry use the same deflators).
Deflation of gross output and sales is conceptually straightforward. A nominal value of output is divided by an output price index to derive a quantity index of gross output. In this paper we have employed the implicit deflator for sector Dk29.
The process is more complicated in the case of added value. It involves double deflation because the volume change of added value combines the volume change of gross output and intermediate inputs. We deflated the added value with an industry implicit price deflator of double deflation.[16]
Numerators of productivity indexes are added value, gross output and sales at factor cost measured at 1995 prices.
For each company group we computed the above cited deflated productivity indexes called LPAV95, LPGO95 e LPSA95. Weighted means and robust dispersion indexes (computed as ratio between 90^{th} and 10^{th} percentiles) for each year are reported in Table 4 - Table 8. In the whole period (1997-2002) the LP of all companies is increased of 4.37% in terms of LPGO, of 3.34 in terms of LPAV and 5.10% in terms of LPSA. These findings are much lower to those given in previous OECD studies (Barnes *et al.*, 2001) where, for the Italian manufacturing sector, the growth rate of LP was 27.8% in the period 1985-1990 and 20.9% in the period 1987-1992. Thus, the growth of LP in Italian mechanical companies showed a strong slowdown.

[15] From 1997 to 2002 prices in Italy are increased about 12%.

[16] The wedge between double-deflated and single-deflated value-added increases, the less stable is the share of intermediate inputs in gross output (OECD 2001, p. 33). In general, researchers rely on deflating nominal variables at the sectoral level (all companies in an industry use the same deflators. Still, "using deflated production to measure productivity has one drawback, which is the same whether applied at the micro level or at the sectoral or aggregate level. Any quality improvement in output that is not reflected in the deflator will result in a downward bias in productivity" (see Bartelsman, Doms, 2000). Furthmore, if large firms have lower (higher) output prices than small firm, then the use of a common industry price deflator will (underestimate) (overestimate) the real output of large producers and overestimate (underestimate) the output of small firms, leading to a systematic bias in firm LP across the firm size distribution (see Aw *et al*.,1997)

Table 4. LP for all companies (eurolire 1995 per employee)

	average LP			quantile Dispersion		
Year	LPAV95	LPGO95	LPSA95	LPAV95	LPGO95	LPSA95
1997	44626	170264	163932	114.39	98.81	99.26
1998	44497	166664	160776	101.22	91.05	91.22
1999	45131	171193	180143	101.13	91.41	94.41
2000	46289	175527	173874	101.43	89.85	92.58
2001	47274	182288	177150	107.42	98.74	101.36
2002	46116	177697	172286	88.18	74.78	76.85
Weighted Mean	45684	173994	171458			
Δ%97-02	3.34	4.37	5.10			

Table 5. LP in the survivors (eurolire 1995 per employee)

	average LP			quantile Dispersion		
Year	LPAV95	LPGO95	LPSA95	LPAV95	LPGO95	LPSA95
1997	45120	174067	167347	84.55	63.76	65.27
1998	45742	172210	164735	66.00	51.24	50.38
1999	45965	174166	186033	61.83	50.48	51.1
2000	47033	178402	177971	59.67	54.66	53.54
2001	46849	178717	174836	60.62	56.98	58.07
2002	44600	171542	166027	60.29	58.83	58.8
Weighted Mean	45897	175596	172908			
Δ%97-02	-1.15	-1.45	-0.79			

Table 6. LP for stayers (eurolire 1995 per employee)

	average LP			quantile Dispersion		
Year	LPAV95	LPGO95	LPSA95	LPAV95	LPGO95	LPSA95
1998	44943	168518	162074	74.87	58.13	59.89
1999	45439	172086	181461	72.35	59.15	60.48
2000	46958	177812	176678	74.98	63.94	63.37
2001	47522	182667	178513	79.39	66.41	66.13
Weighted Mean	46248	175125	174775			

Table 7. LP for entrants (eurolire 1995 per employee)

	average LP			quantile Dispersion		
Year	LPAV95	LPGO95	LPSA95	LPAV95	LPGO95	LPSA95
1998	38283	142152	146455	196.93	330.70	353.03
1999	41401	169467	179021	201.74	259.93	339.20
2000	39458	162674	149177	173.52	249.39	329.77
2001	50590	243800	210001	227.79	273.59	330.06
2002	63250	232207	229831	68.20	94.26	85.25
Weighted Mean	48298	186741	189136			

Table 8. LP for exitors (eurolire 1995 per employee)

	average LP			quantile Dispersion		
Year	LPAV95	LPGO95	LPSA95	LPGO95	LPAV95	LPSA95
1997	40402	146434	133540	1810.37	523.73	1845.31
1998	39201	144146	141147	1101.04	352.34	1148.66
1999	39592	149731	147657	535.38	219.08	551.46
2000	41446	154444	152077	190.23	132.48	174.80
2001	44478	162162	159263	149.99	124.27	158.32
Weighted Mean	42145	151150	151349			

3.3 Comparison with ISTAT data

Before to elaborate more sophisticated models it is necessary to check the reliability of the database comparing the output estimated in the previous sections with those obtained from ISTAT in the annual survey on "structure and competitiveness of the system of industrial and services firms"[17]. The output of this analysis is reported in Table 9.

Table 9. Comparison of UD database and ISTAT survey (sector DK29)

year	Employees UD	Employees ISTAT	col(1)/col(2) %	LPAV UD Eurolire 1995	LPAV ISTAT Eurolire 1995	Col(4)/col(5) %	LPSA UD Eurolire 1995	LPSA ISTAT Eurolire 1995	Col(7)/col(8) %
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1997	398907	568564	70.2	44626	39710	112.4	163932	133139	123.1
1998	427688	573474	74.6	44497	41134	108.2	160776	138269	116.3
1999	423157	564478	75.0	45131	40463	111.5	180143	139972	128.7
2000	446805	580472	77.0	46289	42766	108.2	173874	143934	120.8
2001	435774	596949	73.0	47274	43218	109.4	177150	145409	121.8
2002	407427	593227	68.7	46116	42190	109.3	172286	145099	118.7
Weighted mean 1997-2002				**45684**	**41603**	**109.8**	**171458**	**141044**	**121.6**

Source: author's calculation from ISTAT and UD.

As can be noted, the total employment of companies collected in the UD database represents more than 70 % of that collected by ISTAT which contains also non companies firms in all years but 2002. Both productivity indicators (LPAV and LPSA) at constant prices (1995=100) show a substantial accordance of the temporal evolution with respect to the different sources of data. The productivity levels obtained from the UD are always larger than those obtained from ISTAT, on average +9.8% for LPAV and +21.6% for LPSA. It is interesting to note that the reduction of productivity in 2002 denoted by the UD database is confirmed by official ISTAT data.
The positive results of the comparison – good coverage, similar levels of average productivity and trend in the considered period – give us sufficient insights to retain that the UD database contains highly reliable data.

[17] This survey is performed by ISTAT since 1997. The last available data regards year 2002. For further details see ISTAT (2004).

3.4 Descriptive statistics of LP

The level of productivity

Table 10 sets out the (employment-weighted) levels of LP measured with each of the three variables for entrants, exitors, stayers and survivors for sector Dk29, with survivors normalised to 100. These data are weighted annual averages along the period 1997-2002. A consistent picture emerges. Entrants are more productive than stayers, stayers are more productive than exitors and, hence entrants are more productive than exitors. Survivors and stayers are rather similar.

This immediately suggests that external restructuring, i.e. the process of entry and exit, tends to raise productivity growth. Nevertheless, there are several possible reasons for this finding. For example, it could be a compositional effect, whereby exit is concentrated in low productivity companies and entry in high productivity companies.

Table 10. Levels of LP for Entrants, Exitors, Stayers and Survivors (Stayers =100)

	entrants	stayers	exitors	survivors	entrants	stayers	exitors	survivors
LPAV95	48298	46248	41099	45897	104.4	100.0	88.9	99.2
LPGO95	186741	175125	155150	175596	106.6	100.0	88.6	100.3
LPSA95	189136	174775	147042	172908	108.2	100.0	84.1	98.9

Note: annual means.

Analysis of the productivity dynamics

Productivity trend has been analyzed with respect to the groups called “survivors” and “all” on which we will focus the attention in the next sections.

As can be noted from Figure 1 - Figure 3 and Table 4-Table 8 LP of sector DK29, independently of the used indicator, in 2002 with respect to 1997 is decreased for “survivors” and increased for “all”. This means that the turnover (exit/entry) improved the overall productivity. In the next section we will try to understand the reason of such evidence.

Figure 1. LP (LPAV95) trend for survivors and all companies (1997=100)

Figure 2. LP (LPGO95) trend for survivors and all companies (1997=100)

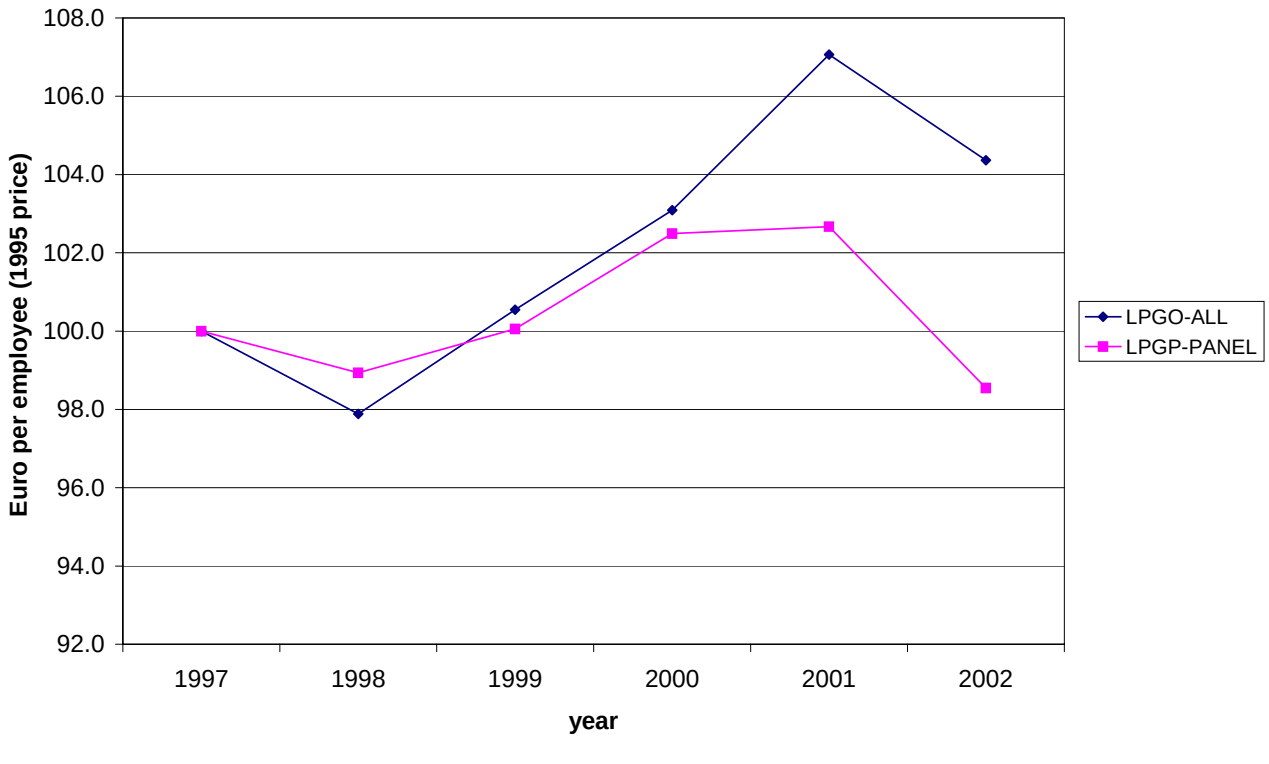


Figure 3. LP (LPSA95) trend for survivors and all companies (1997=100)

The variance of productivity.

In the last three columns of Table 4 - Table 8 we report a robust dispersion measure. That is the ratio of 90^{th} and 10^{th} quantile which suggests a large variation in productivity, with companies at the top quantile much more productive than those at the 10^{th} quantile (we choose a quantile comparison to reduce the impact of outliers).

It is worth noting that the quantile dispersion differs significantly amongst different group. In particular:

- The lowest values are those for survivors and stayers;
- Exitors evidence the largest variability;
- Entrants have large variability but lower than exitors;
- *Ceteris paribus*, variability is largest when productivity is measured using LPAV95 for stayers and survivors, while for LPSA95 the largest variability regards entrants and exitors.

4 Distribution of Labour productivity

Descriptive statistics of the LP Distribution (LPD) in the 1997 and 2002 give a snapshot of the characteristics of the LP of the Italian mechanical sector.

In the first place, with reference to the LP size, from the analysis of the data reported in Table 11 we can point out that the median from 1997 to 2002 is increased with respect to the three LP indicators; furthermore, the median is always lower than the arithmetic mean (see Table 4) so that the distribution of LP is positively skewed.

In the second place, it seems to be very important to analyse the variability of the LP in the two years. As the dataset contains extreme observations (see the distance between maximum and third quartile), it can be useful to compute variability indexes which are resistant to the presence of

outliers. In the table we report an index defined as a ratio between the median of the distance (in absolute value) of each observation from the median (*MAD = Median Absolute Deviation*) and the median (*MAD*/Median).
Again from Table 11 we can observe that this index increases in the two years for all three productivity indexes. Over 1997-2002, the dispersion of productivity across establishments actually increased. Furthermore:

- the variability is lower for LPAV95 in both years, followed by LPGO95 and LPSA95;
- LPAV95 presents the larger temporal increase of the relative variability of LPD.

Table 11. Descriptive statistics LPAV95, LPGO95 and LPSA95 (Eurolire95 per employee) in 1997 and 2002: all companies

	LPAV95		LPGO95		LPSA95	
	1997	2002	1997	2002	1997	2002
median	30649	32146	108071	115828	106056	114930
mad	10674	12305	50490	56914	49853	56591
mad/median	0.348	0.383	0.467	0.491	0.470	0.492
minimum	0.023	0.583	0.001	0.175	0.001	0.175
maximum	41280206	97384519	192069998	284420163	182368927	287234433
1st quartile	20782	21156	65345	68416	63823	67363
3rd quartile	42296	46448	175007	193978	171517	192805
n. obs.	11476	11632	12129	12179	12109	12175

Figure 4. Non parametric density estimation for log LP level (left panels) and LP % growth (right panels)

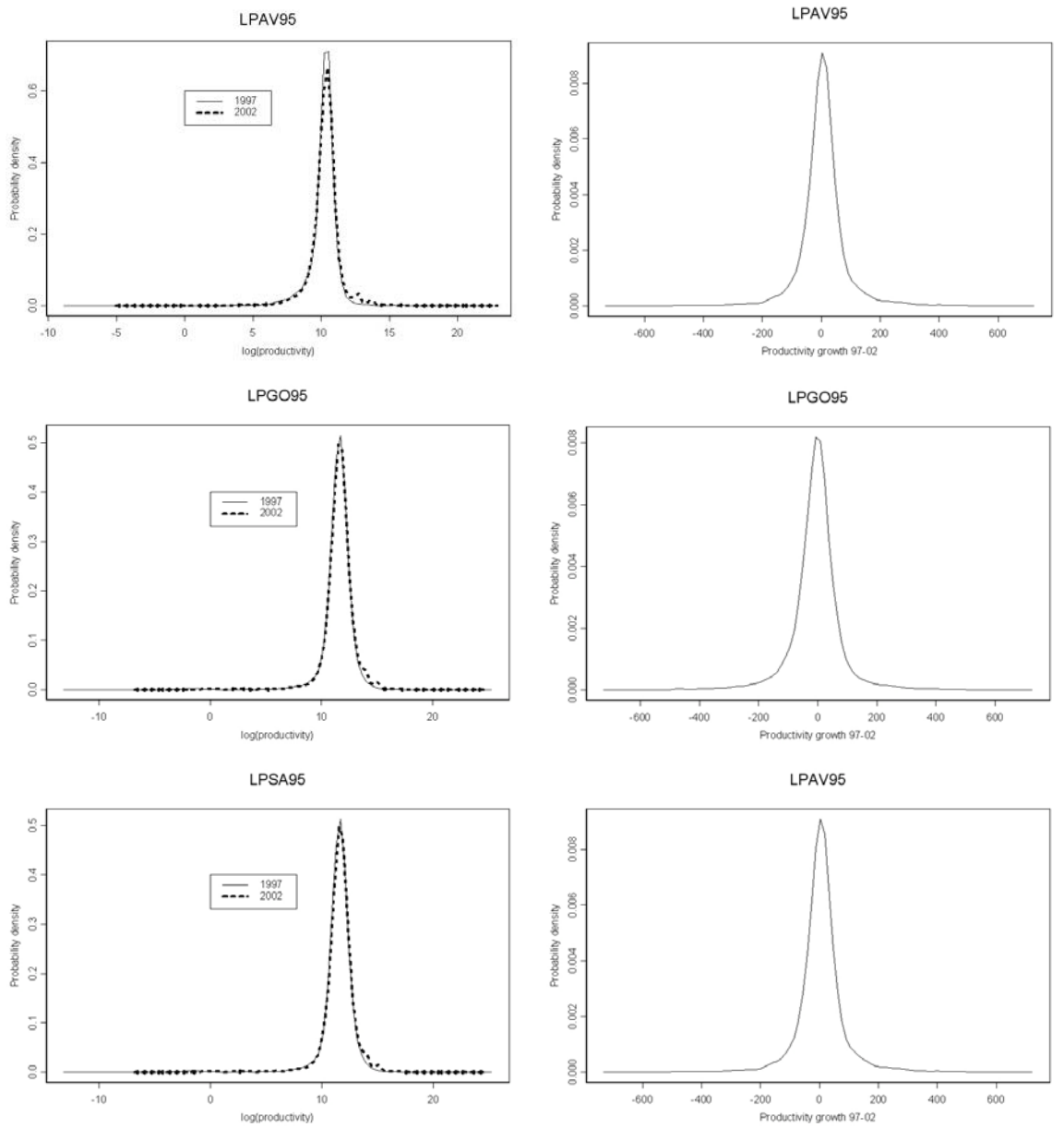


Figure 4 shows the cross-section non parametric kernel densities estimated according Pagan and Ullah (1999) for log-transformed productivity indexes[18] (left panels) and percentage productivity growth (right panels) computed as $\log(LP_T / LP_0)\times 100$. In the first case we considered all companies, while productivity growth, to make the graph more readable, has been computed amongst survivors removing companies with LP growth exceeding 500% (right panels). Density distributions of LP confirm the very wide dispersion which exists at any time and they show the existence of very long tail of low productivity companies in both years. The dominant impression gained observing left panels is that the distributions in the two years could be superimposed with a very little overall change in shape between the two dates as confirmed by the median levels in Table 11.

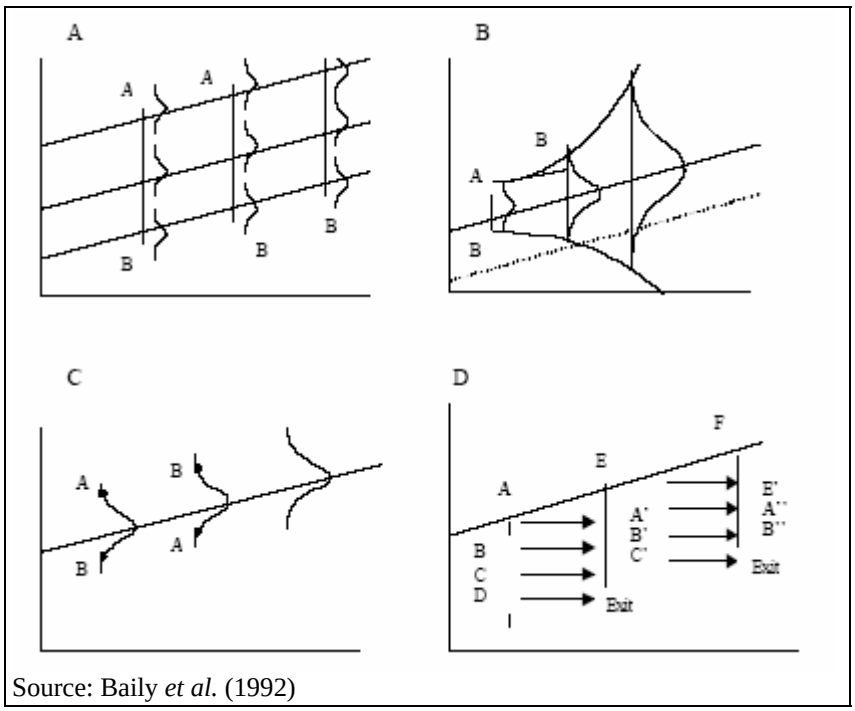
[18] This methodology does not make any *a priori* hypothesis on the probability density function. According to such approach the density function is directly estimated from the data.

A remarkable feature revealed by Figure 4 (right panel) is the substantial number of survivors with negative LP growth. In fact, about 50% fell into this category.

5 Productivity growth (1997-2002) analysis through transition matrices

The time series behaviour of firms underlying these static spreads is potentially very different. Figure 5 following Baily, *et al*. (1992) sets out a number of potential scenarios.
In Figure 5A the spread is real. Firms A and B enter with different intrinsic productivity (quality of management for example) but stay more or less where they are in the distribution. This case is expression of permanent heterogeneity.
In Figure 5B the spread is spurious. All firms are fundamentally the same, but each period some firms get positive shocks and some negative. A firm that starts with relative productivity shown at point A will have an expected relative productivity at B in a following time. Thus there is a spread at any one time between firms A and B. The prediction of this model however is that at any other time, firm A is as likely to be back to the top of the distribution as firm B is back to the bottom.
In Figure 5C firms enter with fairly equal productivity initially, but some firms grow and others decline, with the latter presumably exiting below some productivity level.
Finally, Figure 5D illustrates the case of vintage capital. It shows that case where firms enter with different capabilities, but such capabilities fade as the firm ages (they enter with new capital which then depreciates for example). In this case, firm A has just entered with the most modern capital stock whilst firm D is the most out of date. In the following period firm A is superseded by firm E and moves down the distribution. Firm D exits. As the periods continue, firms move down the distribution and then exit.

Figure 5. Alternative views of the distribution of productivity



Source: Baily *et al.* (1992)

To examine which of these pictures is the most accurate we examine transition matrices to see how readily firms move from different parts of the distribution.
Table 12 - Table 14 show 6 year transition matrices for LPAV95, LPGO95 and LPSA95, respectively. Each diagonal cell shows the fraction of companies in the quintile remaining in the

same quintile 6 years later. The figures in the top row and first column show the 20th, 40th etc. productivity quintiles, with the 20th being the bottom productivity quintile and the 100th being the top. The quintile positions of entrants and exitors are also shown.

Table 12. LP transition matrix, all companies (LPAV95)

		quintiles of LPAV95 (constant prices = 1995) in 2002						
		First (20%)	Second (40%)	Third (60%)	Fourth (80%)	Fifth (100%)	Exitors	Total units in each row
quintiles of LPSA (constant prices = 1995) in 1997	First (20%)	23.0%	13.4%	6.4%	5.0%	4.0%	48.3%	100%
	Second (40%)	13.4%	22.7%	17.5%	8.9%	4.2%	33.4%	100%
	Third (60%)	6.5%	17.6%	22.2%	15.5%	5.8%	32.3%	100%
	Fourth (80%)	4.4%	8.8%	17.9%	27.1%	12.5%	29.3%	100%
	Fifth (100%)	3.6%	5.5%	8.3%	18.9%	32.0%	31.7%	100%
	Entrants	27.8%	18.4%	16.1%	14.3%	23.5%		100%

Table 13. LP transition matrix, all companies (LPGO95)

		quintiles of LPGO (constant prices = 1995) in 2002						
		First (20%)	Second (40%)	Third (60%)	Fourth (80%)	Fifth (100%)	Exitors	Total units in each row
quintiles of LPSA (constant prices = 1995) in 1997	First (20%)	26.7%	10.6%	4.2%	3.0%	3.5%	52.1%	100%
	Second (40%)	16.0%	27.5%	13.1%	5.7%	2.1%	35.6%	100%
	Third (60%)	7.3%	19.4%	25.3%	13.9%	3.3%	30.7%	100%
	Fourth (80%)	4.4%	7.8%	20.0%	29.2%	9.9%	28.7%	100%
	Fifth (100%)	3.3%	4.2%	9.3%	18.6%	31.4%	33.1%	100%
	Entrants	23.5%	16.9%	15.6%	16.5%	27.5%		100%

Table 14. LP transition matrix, all companies (LPSA95)

		quintiles of LPSA (constant prices = 1995) in 2002						
		First (20%)	Second (40%)	Third (60%)	Fourth (80%)	Fifth (100%)	Exitors	Total units in each row
quintiles of LPSA (constant prices = 1995) in 1997	First (20%)	26.4%	10.9%	4.2%	3.2%	3.7%	51.6%	100%
	Second (40%)	15.7%	26.4%	13.3%	5.6%	2.4%	36.6%	100%
	Third (60%)	7.0%	19.5%	25.5%	13.4%	3.8%	30.9%	100%
	Fourth (80%)	4.0%	8.2%	19.7%	30.5%	9.4%	28.2%	100%
	Fifth (100%)	3.5%	4.4%	9.1%	18.4%	31.6%	33.0%	100%
	Entrants	24.0%	17.1%	15.7%	16.0%	27.2%		100%

Consider the top left cell of the LPSA95 matrix (Table 14). This shows that 26,4% of companies in the lowest productivity quintile were still in the lowest quintile after 6 years. Working along the row, the next cell shows that 10,9% of companies in the lowest quintile (20th percentile) in *t* moved up into the second quintile (40th percentile) in *t*+1. Note (column entitled 100%) that only 3,7% of companies move into the top quintile. The column headed Exitors shows that 51,6% of companies from bottom quintile exited. Table 12 and Table 13 show the same figures for LPAV95 and LPGO95.

A number of interesting features emerge from this analysis. First, in all three tables the diagonal elements are the highest elements, indicating that between 25,5% and 31,6% of companies stay in the same quintile for these six year gaps.

Second, much fewer establishments move quintiles; the off diagonal elements are all smaller than the diagonal elements. It is also interesting to note that, excluding Exitors and Entrants, the upper triangular part of the three matrices contains always lower values of the corresponding cells of the lower triangular part. This means that, in the considered period, survivors reduces on average the productivity as it is pointed out in Table 5.

Third, the majority of companies who exit are from the lowest quintile (48,3% in terms of LPAV95, 52,1% in terms of LPGO95 and 51,6% in terms of LPSA95).

Figure 5A therefore gets the most support from the data. The picture is clearest for companies at the bottom of the distribution. They either stay low productivity, or they exit. Very few of these companies grow to be high productivity; 50% of them exit. At the top of the distribution there is a fair amount of persistence. Equally, a consistent number of firms (1/3) at the top do seem to exit six years later.

Finally the last row considers the entry rates. The first column show the fraction of companies in the first quintile, who entered at some point over the period (about 25%). The fractions are rather evenly spread between 1997 and 2002, which companies that enter spread over many parts of the distribution. The distribution present a bimodal u-shaped distribution: the majority enter in the first and the last quintile. In reality between 1997 and 2002 the mean and the median of LP distribution increase if we consider the group “all companies” and decrease regarding “survivors”.

6 Decomposing productivity growth

6.1 Theory of decomposition

Suppose we divide manufacturing establishments up into a number of groups. We wish to know what is the contribution of each group to overall productivity growth over a given period. A decomposition close to the one used by Baily *et al.* (1996) will be employed[19].

Let Y_{jt} be total generic output (added value, gross output or sales) and E_{jt} be employment in group *j* at time *t*. Then LP in group *j* is defined as

$$LP_{jt} = \frac{Y_{jt}}{E_{jt}} \qquad j = 1,2,...,k \quad t = 0,...,T$$

LP in the sector is:

$$LP_t = \sum_j Y_{jt} / \sum_j E_{jt} = \sum_j w_{jt} LP_{jt}$$

where $w_{jt} = E_{jt} / \sum_j E_{jt}$ is the employment share and $\sum_j w_{jt} = 1$. The proportional growth of sectorial LP between time 0 and *T* is

$$\left(LP_T - LP_0\right) / LP_0 = \sum_j \left(w_{jT} LP_{jT} - w_{j0} LP_{j0}\right) / LP_0$$

which can be decomposed as follows:

$$\left(LP_T - LP_0\right) / LP_0 = \frac{\sum_j w_{j0}\left(LP_{jT} - LP_{j0}\right)}{LP_0} + \frac{\sum_j \left(w_{jT} - w_{j0}\right)\left(LP_{j0} - LP_0\right)}{LP_0} + \frac{\sum_j \left(w_{jT} - w_{j0}\right)\left[\left(LP_{jT} - LP_{j0}\right) - \left(LP_T - LP_0\right)\right]}{LP_0} \tag{4}$$

The first summation on the right hand side is the "within group" effect, the growth of productivity in each group weighted by its base period employment share. The second and third summations are reallocation effects.

Aggregate productivity growth is raised if there is a rise in the labour share of groups with a higher than average productivity *level* in the base period (the second term). It is also raised if there is a rise in the share of groups with higher than average productivity *growth* (the third term)[20].

In words

Aggregate productivity growth = Within group effect + Reallocation levels effect + Reallocation growth effect.

[19] This is the approach developed in Oulton (1998). A good discussion of different methods is presented in Baldwin and Gu (2002) and in Balk and Hoogenboom-Spijker (2003).

[20] The third term differs from the corresponding one in Baily *et al* (1996) by the inclusion of aggregate productivity growth, $(q_t\text{-}q_0)/q_0$. This changes the individual reallocation growth effects but not the total of such effects.

The contribution of the *j*-th group to aggregate productivity growth is therefore measured as:

$$\left\{w_{j0}\left(LP_{jT}-LP_{j0}\right)+\left(w_{jT}-w_{j0}\right)\left(LP_{j0}-LP_{0}\right)+\left(w_{jT}-w_{j0}\right)\left[\left(LP_{jT}-LP_{j0}\right)-\left(LP_{T}-LP_{0}\right)\right]\right\}/LP_{0} \quad (5)$$

The *within effect* capture the gain in aggregate productivity coming from within companies productivity growth weighted by initial output share. The *reallocation level effect* captures the gain in aggregate LP coming from the expanding market of high productivity companies, or from low-productivity companies' shrinking share weighted by initial shares while the reallocation growth effect captures the gain in aggregate LP coming from high productivity growth companies' expanding shares or from low-productivity growth companies' shrinking shares.

6.2 Decomposition in practice

6.2.1 The role of turnover

With reference to the companies time series of all companies in the period 1997-2002 for sector DK29 (see Table 4), the real output (1995 prices) is increased, yearly on average over the six years, by 1.11% in terms of added value, by 1.32% in terms of gross output and 1.47% in terms of sales[21]. In the same period employment rose respectively of 0.42%, 0.43% and 0.43%[22]; productivity rose by 0.67%, 0.87% and 1.02% (see Table 15 - Table 17).
Exits accounted for 28% of employment in 1997 and productivity in these companies was respectively 3.9%, 7.7% and 7.1% lower than those of the survivors. So, the disappearance of these companies would certainly have raised productivity. Apart from exits, several other changes were going on at the same time. First, productivity is decreased in survivors by (-0,23%, -0,29% and -0,16%). Exitors were replaced by new entrants which accounted for 17,5% in 2002 employment. These new companies had higher productivity than the survivors as attained by 2002, and the percentage gap is very larger than that between exits and survivors in 1997. Such increase covers the reduction of productivity of the survivors: globally, companies operating in 2002 (survivors plus entrants) present a positive growth of productivity with respect to the total companies operating in 1997 (survivors plus exitors)[23].
Concluding, in the period 1997-2002 turnover caused an increase of LP because companies with productivity *above* the mean are entered and companies with productivity *below* the mean are exit.
Unfortunately the impact of the incumbent companies on productivity growth was not positive as well, but on the contrary their average productivity made worse. This is against any sensible expectation because, one would expect competition to raise productivity in incumbent firms. It encourages firms to innovate by reducing slack, putting downward pressure on costs and providing incentives for the efficient organisation of production. Nickell (1996) finds that various measures of competitive pressures in a sector have a positive impact on productivity levels and growth rates.

[21] There are significant differences in growth rate of LPGO with respect to the results obtained by Scarpetta *et al.* (2002) in two previous periods:1987-1992 and 1992-1997. For the same sector the average annual growth rates were, respectively, +3.5% and +4.7%.
[22] The difference of employment growth in the table of Added Value with respect to the tables of Gross output and Sales is due to the omission of companies with negative Added Value.
[23] It should be noted that the results of productivity decomposition are influenced by the length of the time interval over which growth is calculated. Firstly, by construction, the contribution of entering firms is greater the longer the time interval considered. Second, if new entrants undergo a significant process of learning and selection, the time horizon is likely to affect the comparison between entering and other firms. Evidence for the United States suggest that these two factors significantly affect the decomposition of productivity growth (see Baily *et al*. 1996; Haltiwanger, 1997).

Table 15. Productivity (LPAV95) and employment, 1997-2002: survivors versus exits and entrants

	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPAV95)	Productivity 2002 (LPAV95)	Annualized growth of Value added	Employment	Productivity
	%	%	Euro 1995	Euro 1995	%	%	%
Exits/entrants	28.3	17.5	43376	53277	-4.53	-7.40	4.56
Survivors	71.7	82.5	45122	44600	3.25	3.52	-0.23
Total	100.0	100.0	44627	46116	1.11	0.42	0.67

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5).

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Table 16. Productivity (LPGO95) and employment, 1997-2002: survivors versus exits and entrants

	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPGO95)	Productivity 2002 (LPGO95)	Annualized growth of Gross output	Employment	Productivity
	%	%	Euro 1995	Euro 1995	%	%	%
Exits/entrants	28.67	17.60	160798	206507	-3.89	-7.46	5.69
Survivors	71.33	82.40	174074	171542	3.25	3.59	-0.29
Total	100.00	100.00	170269	177697	1.32	0.43	0.87

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5).

Table 17. Productivity (LPSA95) and employment 1997-2002: survivors versus exits and entrants

	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPSA95)	Productivity 2002 (LPSA95)	Annualized growth of Sales	Employment	Productivity
	%	%	Euro 1995	Euro 1995	%	%	%
Exits/entrants	28.67	17.60	155435	201582	-3.73	-7.46	5.94
Survivors	71.33	82.40	167355	166028	3.41	3.60	-0.16
Total	100.00	100.00	163937	172286	1.47	0.43	1.02

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5).

We apply the decomposition of Baily *et al.* (1996) to analyse the role of turnover. Table 18 - Table 20 show the decomposition of productivity growth between survivors on the hand and exits/entrants on the other. From the last column of Table 18 - Table 20, we can see that survivors account in negative of overall growth. On the contrary, the contribution of entrants and exits is positive and very high. These findings are very lower than those reported for LPGO in Italy by Scarpetta *et al.*

(2002) in previous periods for the same sector using OECD data: +3.5 in 1987-92, +4.7% in 1992-97.

The *within* effect gives a positive contribution between 60% and 70% (68% for LPAV95, 62% for LPGO95 and 65% for LPSA95).

The *reallocation* effects (level plus growth) in the period 1997-2002 show a contribution to the LP growth larger than one third. Globally, the total reallocation effect has a negative contribution which comes from a mix of a positive and fair level effect and a consistent negative growth effect (see Figure 6).

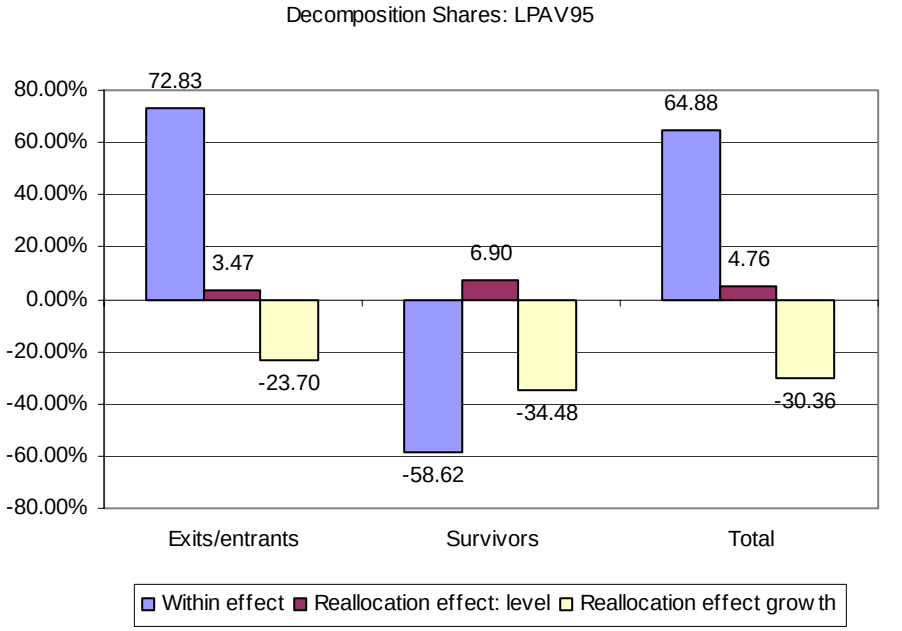
What does a negative reallocation contribution to LP growth suggest?

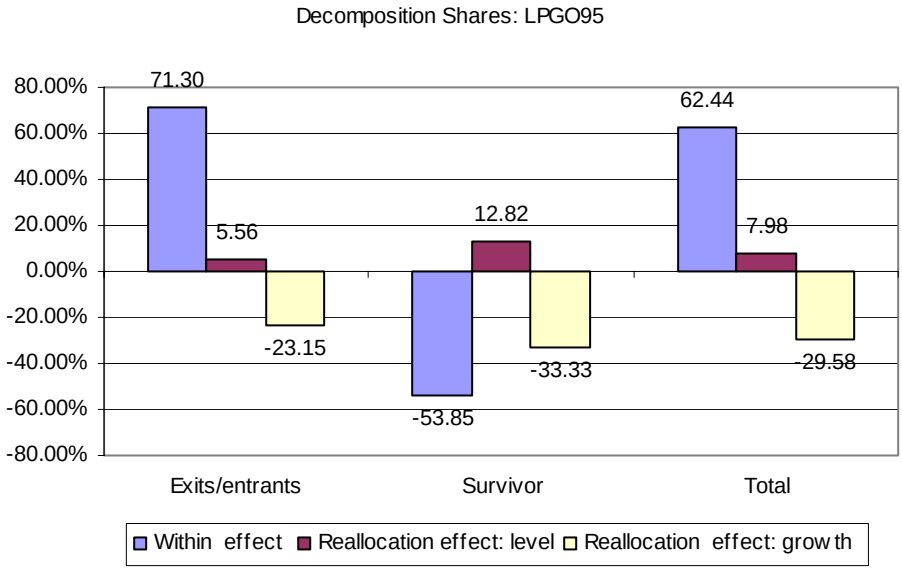
Negative reallocation contributions are often interpreted in the literature as reflecting the creative destruction processes[24] while the within firm are interpreted as reflecting more traditional sources of productivity growth (the average firms become more productive with advancing technology). However, rather than being alternatives, these effects (within vs. reallocation) may be closely related. "That is, the pace of the creative destruction process might be interpreted as a measure of the *contestability or competitive of markets.* As such, greater competitive pressures may induce incumbents to perform more efficiently. Therefore, for the companies of the mechanical sector the destruction has been creative, the turnover has contributed to the productivity growth even if partly smoothed because of a negative reallocation effect growth" (see, Bartelsman *et al*, 2004).[25]

[24] «La notion de destruction créatrice (usuellement attribuée à Joseph Schumpeter) est primordiale pour la compréhension de la croissance économique. La théorie de Schumpeter développe l'idée que l'hétérogénéité la composition de la population des entreprises résultant des créations et des disparitions, de la croissance et de la récession peuvent être importants pour la création et le développement de nouveaux procédés, de nouveaux produits ou de nouveaux marchés. Différents modèles de destruction créatrice ont été développés (Jovanovic, 1982; Aghion and Howitt ,1992; Ericson and Pakes, 1995).» See Crépon and Duhautois (2004).

[25] A negative value of the reallocation growth effect may be referable to a potential problem of this method of decomposition. In reality, in presence of measurement errors in assessing market shares and relative productivity levels in the base year, the correlation between changes in productivity and changes in market share could be spurious, affecting the within and the reallocation level effects. An upward bias in employment estimates generates a downward bias in LP estimates. So, the negative reallocation growth effect may reflect the spurious correlation between change in productivity and changes in market share (see Disney *et al*, 2000, pp. 13).

Figure 6. Decomposition of LP growth in all companies: percentage of share of total annual productivity growth of each component





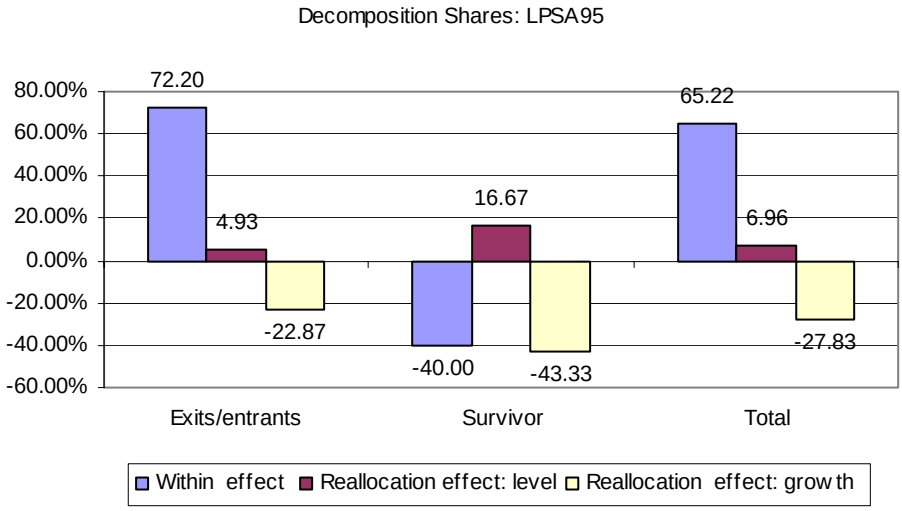


Table 18. Decomposition of productivity (LPAV95) growth, 1997-2002: survivors versus exits and entrants

1997-2002	*Within effect*	*Reallocation effect: level*	*Reallocation effect: growth*	*Total contribution*
	%	*%*	*%*	*%*
Exits/entrants	1.26	0.06	-0.41	0.91
Survivors	-0.17	0.02	-0.10	-0.24
Total	1.09	0.08	-0.51	0.67

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5).

Table 19. Decomposition of productivity (LPGO95) growth, 1997-2002: survivors versus exits and entrants

1997-2002	*Within effect*	*Reallocation effect: level*	*Reallocation effect: growth*	*Total contribution*
	%	*%*	*%*	*%*
Exits/entrants	1.54	0.12	-0.50	1.16
Survivors	-0.21	0.05	-0.13	-0.29
Total	1.33	0.17	-0.63	0.87

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text

Table 20. Decomposition of productivity (LPSA95) growth 1997-2002: survivors versus exits and entrants

1997-2002	*Within effect*	*Reallocation effect: level*	*Reallocation effect: growth*	*Total contribution*
	%	*%*	*%*	*%*
Exits/entrants	1.61	0.11	-0.51	1.22
Survivors	-0.12	0.05	-0.13	-0.20
Total	1.50	0.16	-0.64	1.02

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

6.2.2 Productivity growth in the survivors: downsizing versus upsizing

To develop policies to raise productivity growth we have to understand the causes of productivity growth of survivors. To support this phase of the analysis, companies in the sector were assigned to four categories or quadrants devised by Baily *et al.* (1996), as illustrated in Table 4. Quadrant 1 consists of the "successful upsizers", companies that were able to increase both LP and employment. Quadrant 2 are the "successful downsizers", companies that raised productivity but did so by reducing employment. Quadrant 3 are the "unsuccessful downsizers", companies that faced reductions in both productivity and employment. Finally, quadrant 4 includes companies called "successful upsizers, firms that raised employment but at the expense of productivity. This scheme is illustrated in Table 21, where LP is productivity and E is the number of employees.

Table 21. Groups of companies detected with respect to LP and employment change

Quadrant	Categories	Description
1	Successful upsizers	LP>0, E>0
2	Successful downsizers	LP>0, E<0
3	Unsuccessful downsizers	LP<0, E<0
4	Unsuccessful upsizers	LP<0, E>0

Table 22. Productivity and employment change for the survivors: 1997-2002

	LPAV95	LPGO95	LPSA95
% of companies downsizing	**27.43**	**27.60**	**27.64**
productivity rising	18.17	17.88	17.97
productivity falling	9.27	9.73	9.67
% of companies upsizing	**72.57**	**72.40**	**72.36**
productivity rising	36.02	29.87	30.95
productivity falling	36.55	42.53	41.41

Note: Figures show % of companies in the base year.

Table 22 shows the fraction of companies falling into each category. Between 1997 and 2002 28% of companies downsized and 72% upsized. It also shows that 18% of companies downsized and *raised* productivity growth, whilst about 10% downsized and decreased productivity.
It is therefore true that in the considered period fewer companies downsized. But as the table shows, when companies downsize not necessarily their productivity grows. Looking at Table 23, for example, less than 30% of companies downsize (quadrants 2 and 3) but only 18.2% raised their productivity (quadrant 2). Hence the productivity slowdown in 2002 might be ascribed to upsizing companies which increased their productivity roughly in half of the cases. More detailed research is needed to unravel the complex, dynamics forces that determined the LP slowdown in 2002. This will require further analysis of this rich panel of survivors. Barnes and Haskel (2000b) contains more analysis and data but the point is that productivity growth and employment size are two endogenous variables and hence the ultimate causes of slow productivity growth depend on what drives these two variables.

Table 23. Productivity (LPAV95) and employment amongst survivors, 1997-2002: by quadrant[26]

Quadrant	Share of companies (%)	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPAV95)	Productivity 2002 (LPAV95)	Annualized growth of Value added	Annualized growth of Employment	Annualized growth of productivity
	%	%	%	Euro 1995	Euro 1995	%	%	%
1 (ΔLP>0, ΔE>0)	36.0	29.2	33.0	42277	52700	13.42	6.81	4.93
2 (ΔLP>0, ΔE<0)	18.2	25.6	15.4	34995	51970	1.14	-5.76	9.70
3 (ΔLP<0, ΔE<0)	9.3	13.4	8.7	48221	33625	-9.26	-4.60	-6.05
4 (ΔLP<0, ΔE>0)	36.6	31.8	43.0	54840	37793	2.09	12.06	-6.22
Total	100.0	100.0	100.0	45202	44526	3.38	3.73	-0.30

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

Table 24. Productivity (LPGO95) and employment amongst survivors, 1997-2002 : by quadrant

Quadrant	Share of companies (%)	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPAV95)	Productivity 2002 (LPAV95)	Annualized growth of Value added	Annualized growth of Employment	Annualized growth of productivity
	%	%	%	Euro 1995	Euro 1995	%	%	%
1 (ΔLP>0, ΔE>0)	29.9	29.5	32.4	163911	202703	12.01	5.88	4.73
2 (ΔLP>0, ΔE<0)	17.9	27.8	16.4	139575	203545	0.30	-6.08	9.17
3 (ΔLP<0, ΔE<0)	9.7	11.8	7.5	173620	130633	-8.69	-4.96	-4.95
4 (ΔLP<0, ΔE>0)	42.5	30.9	43.7	215048	143526	2.29	13.40	-6.65
Total	100.0	100.0	100.0	174093	171547	3.25	3.60	-0.29

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

Table 25. Productivity (LPSA95) and employment amongst survivors, 1997-2002 : by quadrant

Quadrant	Share of companies (%)	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPAV95)	Productivity 2002 (LPAV95)	Annualized growth of Value added	Annualized growth of Employment	Annualized growth of productivity
	%	%	%	Euro 1995	Euro 1995	%	%	%
1 (ΔLP>0, ΔE>0)	30.9	30.8	33.7	157008	193209	11.80	5.84	4.61
2 (ΔLP>0, ΔE<0)	18.0	27.9	16.5	133812	197942	0.63	-6.05	9.59
3 (ΔLP<0, ΔE<0)	9.7	11.7	7.4	169528	127838	-8.72	-5.04	-4.92
4 (ΔLP<0, ΔE>0)	41.4	29.7	42.4	208752	138767	2.43	13.74	-6.71
Total	100.0	100.0	100.0	167357	166042	3.41	3.59	-0.16

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

[26] Note that annualized growth rate of LP for the "raw" total companies (-0.30%) is different from that indicated in Table 15 (-0.23). This difference is due to the different number of missing values which are greater in Table 23 because considering tha variation of employees deflate the number of companies with missing values.

Table 26. Decomposition of productivity (LPAV95) growth amongst survivors, 1997-2002: by quadrant

Quadrant	Within effect	Reallocation effect: level	Reallocation effect: growth	Total contribution
	%	%	%	%
1 (ΔLP>0, ΔE>0)	1.35	-0.05	0.19	1.48
2 (ΔLP>0, ΔE<0)	1.93	0.46	-0.80	1.59
3 (ΔLP<0, ΔE<0)	-0.86	-0.06	0.29	-0.64
4 (ΔLP<0, ΔE>0)	-2.40	0.48	-0.81	-2.73
Total	0.01	0.83	-1.13	-0.30

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

Table 27. Decomposition of productivity (LPGO95) growth amongst survivors, 1997-2002: by quadrant

Quadrant	Within effect	Reallocation effect: level	Reallocation effect: growth	Total contribution
	%	%	%	%
1 (ΔLP>0, ΔE>0)	1.31	-0.03	0.14	1.42
2 (ΔLP>0, ΔE<0)	2.04	0.45	-0.87	1.62
3 (ΔLP<0, ΔE<0)	-0.58	0.00	0.20	-0.38
4 (ΔLP<0, ΔE>0)	-2.54	0.60	-1.02	-2.95
Total	0.24	1.03	-1.55	-0.29

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

Table 28. Decomposition of productivity (LPSA95) growth amongst survivors, 1997-2002: by quadrant

Quadrant	Within effect	Reallocation effect: level	Reallocation effect: growth	Total contribution
	%	%	%	%
1 (ΔLP>0, ΔE>0)	1.33	-0.04	0.13	1.43
2 (ΔLP>0, ΔE<0)	2.14	0.46	-0.89	1.70
3 (ΔLP<0, ΔE<0)	-0.58	-0.01	0.21	-0.39
4 (ΔLP<0, ΔE>0)	-2.48	0.63	-1.05	-2.90
Total	0.40	1.04	-1.60	-0.16

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

Table 26 - Table 28 report results obtained applying the decomposition of Baily *et al*. (1996). The decomposition for all companies and for each quadrant separately indicate how much of the productivity growth reflects increases within individual companies (column labelled "within effect"), and how much comes from mix reallocation effects (columns labelled "reallocation levels effect" and "reallocation growth effect").

This first mix term (labelled "reallocation level effect") arises because of shifts in employment share between companies. This term is positive or negative depending upon whether the companies that are above average in productivity are increasing or decreasing their shares of employment.

The tables show that for all companies the term is positive (0.83 for LPAV95, 1.03 for LPGO95 and 1.04 for LPSA95). Within quadrants, this cross term is always negative and very small for the companies in quadrant 1 e 3, but positive for those in quadrant 2 e 4. The larger value is always in quadrant 4.

The second mix effect (labelled "reallocation growth effect") is positive or negative depending upon whether companies that have positive productivity growth have increasing or decreasing employment share, respectively, or vice-versa. This term is negative overall (-1.13% for LPAV95, -1.55% for LPGO95 and -1.60% for LPSA95) indicating that companies that have negative productivity growth do on average have increasing employment.

The analysis shows that there is a trivial within effect. It seems that a fair general characterization of the results is that most of overall decrease in productivity should be attributed to the reallocation effect with a predominance of the growth effect on the level effect.

How is this finding determined? The figures in the last column of Table 26 - Table 28 explain how much every group contributes to overall productivity growth. Quadrant 4 account (in negative) for the lion's share of overall productivity growth. Its share (-2,73 for LPAV95, -2,95 for LPGO95 and -2,90 for LPSA95) is about equal to the positive contribution of quadrants 1 and 2.
Thus, the decreasing of LP in the period 1997-2002 is strongly due to the negative impact of unsuccessful upsizers. This negative effect to the development of productivity is due for more than 60% to the within effect. Large part of this comes from the decrease in productivity combined with an increase in employment share (from 30% to 43%).

6.2.3 Productivity growth in the survivors: the role of company size

In the present section we analyze the productivity growth amongst survivors splitting the sample according to different employment classes and quadrant producing many findings for each productivity indicator. In this framework, we report the output only with regard to LPGO which presents the lowest fraction of missing values (only 12 out of 7765), but results on the remaining indicators are roughly the same.
Table 29 reports the break downs of the survivors by company size in terms of employees.
The extreme skewness of the distribution is evident. Companies with 99 or more employees in 1997 accounted for 6% of the total number of companies. Between 1997 and 2002 employment rose in absolute terms in companies which had less than 100 employees in 1997. In relative terms, establishments employing more than 99 people in 1997 decreased their share of total employment (from 56 % to 47%).
In 2002 the maximum level of LP is reached in the top class (>99 employee). We find the maximum growth in the top size class. However, this size class was also the fastest shedder of labour.
Table 30 shows the contribution of each size class to productivity growth. The following situation appears: the top size class, (share of companies 6.05%), accounts positively for almost a third of aggregate productivity growth, while classes 1-9 and 50-99 account negatively for almost 50%.
Companies belonging to the latter classes prevail on those with more than 99 employees determining the productivity slowdown in the period.
Reallocation effects turn out to be very important when the decomposition is by size (70%). Overall, they reduce the growth. Most of this effect is due to the fact that companies which show the largest negative productivity changes (classes 1-9 and 50-99) are also the biggest unsuccessful upsizers on average.[27]
These findings are striking in light of the conventional wisdom of the importance of small business in the growth of the economy. Small business (above all class 1-9) that did add employment disproportionately were likely to decrease productivity. In contrast, companies in class >99 that lightly decreased employment (on average) were likely to increase productivity.[28] To better understand the role played by employment size we decomposed the productivity growth by quadrant (see Table 31). The Baily *et al.* (1996) taxonomic model offers revealing insights into the varieties of downsizing productivity linkages that may be found in Italian mechanical manufacturing. The main conclusions gained from the table regard the weight of different quadrant inside each dimensional class. For example class 1-9 and 50-99 which are on average the main unsuccessful upsizers contains respectively only a fraction of 48.3% and 39.7% of actually

[27] There may be a lot of factors underlying this results which deserve further investigation. For example, small companies may be making unique products whose prices are not well captured by the deflator. See Baily *et al.* (1996).
[28] It is evident that downsizing has played an important role in the productivity growth story. But what form has this downsizing taken? Since an establishment may consist of more than one local unit, a company could downsize by closing local units or by slimming down employment within each local unit.

unsuccessful upsizer and a consistent fraction of successful upsizers (32% and 27.2%, respectively). Furthermore, 20% companies in class 50-99 are successful downsizers. On the contrary, in class >99 which on average is composed by successful upsizers (see Table 29) we find about 30% of unsuccessful upsizers. Finally this latter class contains the largest fraction of successful downsizers (27.3%).

Table 29. Productivity (LPGO95) and employment amongst survivors, 1997-2002 by 1997 employment size group

Employment in 1997 (range)	Share of companies (%)	Share employment 1997 (%)	Share employment 2002 (%)	Productivity 1997 (LPGO95)	Productivity 2002 (LPGO95)	Annualized growth of Added Value	Employment	Productivity
	%	%	%	Euro 1995	Euro 1995	%	%	%
1-9	42.80	4.82	8.98	204365	155943	13.50	23.91	-4.74
10 - 19	22.83	8.63	9.68	138355	134090	5.67	6.49	-0.62
20 - 49	21.83	18.11	19.18	141321	140779	4.89	4.98	-0.08
50 - 99	6.50	12.46	14.77	194387	156227	2.48	7.97	-3.93
>99	6.05	55.98	47.39	183045	199374	1.76	-0.02	1.78
TOTAL	100.00	100.00	100.00	174074	171542	3.25	3.59	-0.29

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

Table 30. Decomposition of productivity (LPGO95) growth amongst survivors, 1997-2002: by 1997 employment size group

Quadrant	*Within effect*	*Reallocation effect: level*	*Reallocation effect: growth*	*Total contribution*
	%	%	%	%
1-9	-0.27	0.14	-0.22	-0.34
10 - 19	-0.04	-0.04	0.00	-0.09
20 - 49	-0.01	-0.04	0.00	-0.05
50 - 99	-0.55	0.05	-0.09	-0.59
>99	1.05	-0.09	-0.19	0.78
TOTAL	0.18	0.03	-0.50	-0.29

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. *Note* Each group's contribution is given by equation (5). For further explanation see text.

Table 31. Labour productivity growth (LPGO95) by employment classes and quadrant amongst survivors (1997-2002)

employment classes (1997)		(ΔLP>0, ΔE>0)	(ΔLP>0, ΔE<0)	(ΔLP<0, ΔE<0)	(ΔLP<0, ΔE>0)	Total
1-9	annualized ΔLP	2.31	1.24	-0.02	-8.27	-4.74
	number of comp. (%)	32.0%	13.2%	6.6%	48.3%	100.0%
10 – 19	annualized ΔLP	2.17	1.60	-0.68	-3.71	-0.63
	number of comp. (%)	28.8%	21.6%	11.1%	38.5%	100.0%
20 – 49	annualized ΔLP	1.83	1.17	-0.33	-2.75	-0.08
	number of comp. (%)	27.6%	19.9%	12.5%	40.0%	100.0%
50 – 99	annualized ΔLP	1.02	0.84	-0.44	-5.34	-3.93
	number of comp. (%)	27.2%	20.2%	12.9%	39.7%	100.0%
>99	annualized ΔLP	1.30	2.28	-0.40	-1.39	1.78
	number of comp. (%)	30.1%	27.3%	13.4%	29.2%	100.0%
TOTAL	annualized ΔLP	1.42	1.62	-0.38	-2.95	-0.29
	number of comp. (%)	29.9%	17.9%	9.7%	42.5%	100.0%

Growth rates are annualised, e.g. growth of X from 0 to T is $(100/T)*(X_T-X_0)/X_0$. Note that this is *not* the same as the average annual rate of growth. Each group's contribution is given by equation (5). For further explanation see text.

7 Final comments and concluding remarks

In this paper productivity growth in Italian mechanical sector (Dk29) since 1997 to 2002 has been analyzed. The data base is represented by the UD which includes the universe of companies of Italy for the same period.

The choice has been to construct 3 measures of LP - LPAV95, LPGO95, LPSA95 - which have been analysed in 4 different groups of companies: the total number of companies in each year of the period 1997-2002, the entrants, the survivors, the exitors for the same span of years.

The results obtained through our analysis are rich and put in evidence different aspects of this sector of Italian economy.

1) The survivors have the considerable loss of LP (-1.15% for LPAV95, -1.45% for LAGO95 and – 0.79 for LPSA95) which can be explained by a conjoint effect operating intensely in a relevant group of unsuccessful upsizers companies (about 40%): the improvement of employment and the impossibility to improve proportionally the levels of Added Value, Gross output and Sales have produced the worst negative rates of productivity growth. How much this can be considered a cyclical or structural aspect of Italian economy it can not be decided in this paper. What can be surely affirmed is the increasing relevance of this phenomenon in 2002 respect to 1997.
2) The entrants are characterized by relevant higher LP than the survivors. Perhaps it is in consequence of their better performance that allowed them to enter. At the opposite exitors have lower LP than survivors. An high degree of turbulence within the sector can then be considered efficient because it involves respectively the exit and the entrance of low and high productivity units. From a policy perspective, this result is in favour of the necessity to curb the costs of entrance and exit of firms in the sector.
3) Transition matrices reveal a considerable persistence in the level of LP. A percentage of firms which goes from 23% to 33% maintains the same level of productivity in 2002 with respect to 1997. Furthermore, the degree of persistence increases considerably with the LP level.
4) The performance of companies is related to the firm size. The worst is proper of the first dimensional class (1-9) and the class with 50-99 employees (respectively -4.74% and -

3.93%). The best is that of the last class which includes companies with at least 99 employees (+1.78). Because in 1997 the lowest - size companies had the highest level of productivity, we can explain this result with a slowing down of innovation and investment or/and with the adoption of more labour intensive techniques by the units of this class.

5) Following Baily *et al.* (1996) the LP growth of the universe ("all companies") is decomposed in 3 components. The important role of turnover emerges very clearly, net entry give a strong positive contribute to the productivity growth in the period 1997-2002.
6) A further general observation is linked to the necessity to take into account the business cycle which, in 2000-2002, was definitely negative. In this period, incumbent companies (which in the paper were called "survivors", see Table 5) could have been the major looser in terms of productivity during a negative phase of the business cycle, because, being more structured, have a larger fraction of unused plants and employees. On the contrary smaller companies are more labour-intensive, flexible and adaptive. This could be one possible interpretation of larger productivity of new entry companies. Some results obtained splitting the period 1997-2002 in two sub-periods (1997-2000: expansive phase, 2000-2002: recovery phase) can support this conclusions. In 1997-2000 the annualized LP growth of incumbents was as follows: LPAV95 +2.07, LPGO95 +1.24, LPSA95 +3.27. In 2000-2002 LP of incumbents decreased yearly on average much more than in the entire period 1997-2002 (LPAV95 -1.68%, LPGO95 -0.76%, LPSA95 -5.38%)
7) Against the conventional view of the strong capacity of permanent small business (above all class 1-9 employees) to spur the growth of the economy, our results indicate that they are likely to decrease productivity. In class 1-9 about 55% of the companies give a negative contribution to LP growth.
8) All the above results are confirmed in spite of the 3 different measures of LP.
9) We conclude, that more detailed research is needed to unravel the complex dynamic forces that determined LP growth. This will require further analysis of this rich data base and remains the topics for further research.

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