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Corporate performances and market selection: some comparative evidence

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Diverse theories of industry dynamics predict heterogeneity in production efficiency to be the driver of firms' growth, survival, and industrial change, either through a direct link between efficiency and growth, or through an indirect effect via profitabilities, as more productive firms can enjoy higher profit margins which, under imperfect capital markets, allow them to invest and grow more. Does the empirical evidence bear out such predictions? This article explores the dynamics of selection and reallocation through an investigation of the relations linking productivity, profitability and growth at the firm level. Exploiting large panels of Italian and French industrial firms, we find that heterogeneity in efficiencies primarily yields persistent profitability differentials, whereas the relationships of corporate growth with either productivity or profitability appear much weaker, if at all existent. This suggests that selection forces are much less strong than usually assumed. The results robustly apply across different industrial sectors and across the two countries.

1. Introduction

One of the most general and robust stylized facts in industrial economics, revealed by recent micro evidence on plants and firms, cross-sectionally and over time, is an

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impressive heterogeneity, in every dimension one is able to observe. The heterogeneity in the 'identity cards' of individual entities concerns sizes, degrees of efficiency (however measured), innovativeness, organizational setups, and financial structures. This equally applies to the dynamics of all these corporate features, and it also concerns seemingly behavioral characteristics, including the propensity to expand and to invest. And, finally, it concerns revealed micro performances, e.g. profitability, growth rates, and survival probabilities.[1] Heterogeneity is ubiquitous across sectors and applies irrespectively of the degrees of statistical disaggregation of industries. It is very persistent over time in the levels of whatever micro variable one looks at, while often it is less so in the rates of change of the same variables.

Granted all that, are there some regularities that one can identify concerning the relations between the 'identities' of individual entities, plants or firms, and their revealed performances? And, more specifically, are there systematic links between some micro characteristics which are plausible candidates for the determinants of differential competitiveness, on the one hand, and revealed performances, on the other?

In fact, several models, grounded in diverse theoretical traditions, do predict heterogeneity in production efficiency and/or innovativeness to be the driver of firms' growth, survival, and industrial change. This applies, first, to the perspectives that we could call "equilibrium dynamics" including the models of Jovanovic (1982), Hopenhayn (1992), and Ericson and Pakes (1995) (see also the extensions to trade in Melitz, 2003). In Jovanovic (1982), new, entrant firms are characterized by heterogeneous efficiency. Selection results from a (passive) process of postentry Bayesian learning: those firms which discover to be efficient enough to ensure nonnegative profitability rationally choose to continue their operations and grow, while the others quit the market. The selection process is similar in Ericson and Pakes (1995), but here firms are able to undertake active learning in that they can influence their own efficiencies and profitabilities by investing in technological search whose intensity is determined via their rational technological expectations on the stochastic outcomes of search itself. Even more so, heterogeneity is the driver of differential firm growth and industrial dynamics in the models sharing an evolutionary perspective—whose formalizations include Nelson and Winter (1982), Winter (1984), Silverberg *et al.* (1988), Silverberg and Verspagen (1994), Dosi *et al.* (1995), Metcalfe (1998), Winter *et al.* (2000, 2003), and Bottazzi *et al.* (2001). In such a perspective a continuous process of out-of-equilibrium creative destruction is driven by the twin processes of idiosyncratic learning—involving changes in production techniques, output characteristics, and organizational practices—and competitive selection among persistently different firms. Such differences, in interactive market environments, influence the degrees of competitiveness and, ultimately, the degrees of 'fitness'

[1]Reviews, covering parts of this broad area, are in Nelson (1981), Dosi (1988, 2007), Caves (1998), Geroski (1998, 2002), Bartelsman and Doms (2000), Ahn (2001), and Dosi and Nelson (2010).

within the population of firms, determining differential growth, and survival opportunities.

One of the predictions of theory is that productivity—proxying production efficiency—ought to be positively related to profitability and firm growth, at least on average. Depending on the models, this occurs either through a direct link between efficiency and growth—as relatively more efficient firms gain market shares by setting lower prices—or through an indirect effect via profitabilities—as more productive firms can enjoy higher profit margins which in turn allow them to invest more (in presence of endemically imperfect capital markets) and eventually grow more.

The increasing availability of longitudinal micro-data allows us to address empirically how efficiency, profitability, and corporate growth relate to market selection and survival.

In this respect, a good deal of effort has gone into the decomposition of aggregate (sectoral or economy-wide) productivity growth, separating (i) idiosyncratic changes in firm/plant productivity levels—the so-called *within component*; (ii) changes in average productivity due to reallocation of output or employment shares across firms—the *between component*; and (iii) the contribution thereof due to entry into and exit from the market. Most studies, to a large extent based on plant-level data from North American countries (cf. Foster *et al.*, 2001, Baldwin and Gu, 2006, and the critical surveys in Bartelsman and Doms, 2000 and Ahn, 2001), do find evidence of a steady process of creative destruction involving significant rates of input and output reallocation even within 4-Digit industries. Moreover, the process is accompanied by a good deal of 'churning' with relatively high flows of entry and exit. Approximately a half of the new firms in all countries for which there is evidence die within the first 5 years of life (Bartelsman *et al.*, 2005). However, some of those which survive grow in their industry shares and provide a significant contribution to overall productivity growth (Baldwin, and Gu, 2006).

Within such a turbulent dynamics in industrial populations and structures, what is the role played, *stricto sensu*, by selection among the incumbents? That is, how effective are competitive interactions in reallocating resources and output shares in favor of the more efficient firms? Here the evidence is mixed. Start by noting that the between component in the decomposition of productivity changes provides only an indirect account of the relation between relative productivity levels and firms' growth. Indeed, it just measures the total sum of the changes in firms' shares weighted by their initial productivity levels. Granted that, if we take this component as a measure of the presence of selection dynamics, everything seems to suggest that the reallocation pressure due to differential productivities is at best weak or, according to some studies, even 'perverse' in that reallocation can go in favor of *less* productive plants or firms. Indeed, when the between component has the expected positive sign, idiosyncratic learning (the within term) generally offers a comparatively larger contribution to productivity growth. However, the sign is *not* always unequivocally positive. Baily *et al.* (1996) find that the contribution to productivity growth is equally split between growing and shrinking firms. In a similar vein, Baldwin and Gu (2006) conclude, on Canadian data, that "... the component that measures the effect of compositional changes arising from shifts in employment shares among continuing plants plays a negligible to moderate role in aggregate productivity growth after 1979" (pp. 438–439), such shifts appearing to be more relevant over the period 1973–1979. The evidence in Disney *et al.* (2003), on UK data, shows a *negative* between effect.[2]

The possibility for selection to be mediated via profitabilities (and differential investment rates) has been much less studied.[3] One of the few such attempts (Coad, 2007) does not find any robust association between profitabilities and subsequent growth.

In any case, beyond broad decompositions of changes in industry aggregates—as revealing as they are—the natural way forward is to explicitly analyze the statistical relations between the characteristics of individual firms (for the time being in terms of productivities) and their growth, both directly and indirectly via the relationships between productivity and profitability, and between the latter and growth. Some preliminary evidence on Italian data is presented in Bottazzi *et al.* (2002, 2008) and Dosi (2007), hinting at a quite weak power of selection forces. In the following we go much deeper into this type of analysis. In addition to contemporaneous relations, we explore longer term structures and we study their dynamics.[4] Moreover, we offer comparative analysis on Italian and French data, trying to illuminate the degrees to which the properties of the productivity–profitability–growth relationships depend on country-specific institutional characteristics or, conversely, are relatively generic features of contemporary industrial dynamics. The characteristics of available data on the two countries, covering long time spans and allowing for a fine level of sectoral aggregation, provide robustness to the results.

The article is organized as follows. In Section 2, we describe the datasets of Italian and French industrial firms. Next, in Section 3, we present intertemporal patterns of sectoral productivities, and perform nonparametric analyses of the pairwise relationships between productivity, profitability, and corporate growth, yielding an initial

[2]The size and even the sign of the various effects depend a good deal also on the method used. So, for example, Baldwin and Gu (2006) find, too, a negative between term in most sectors, when using the Griliches and Regev (1995) decomposition formula.

[3]An important caveat here is that one should explicitly disentangle the relation between physical productivities and the ability/willingness to charge higher margins per unit of output. One study that does it (Foster *et al.*, 2008) shows that in fact the two variables seem to move in opposite directions.

[4]Similar issues are considered through a VAR analysis in Coad *et al.* (2010) and in Coad (2010), respectively, Italian and French manufacturing data. Those works however focus on *growth rates* of productivity and profitability, providing a complementary exercise to the one we perform here.

descriptive picture about the strength of the different associations. We then turn to panel data regressions (Section 4) allowing for unobserved heterogeneity, and we estimate both short run effects and longer time relations.

2. Data and variables

This article draws upon two similar datasets, Micro.3 and EAE, reporting firm-level information for Italy and France, respectively. The Micro.3 database has been developed through a collaboration between the Italian Statistical Office (ISTAT) and members of the Laboratory of Economics and Management of Scuola Superiore Sant'Anna, Pisa. The EAE French databank is collected by the statistical department of French Ministry of Industry (SESSI) and provided by the French Statistical Office (INSEE).[5] The two databanks are open panels combining information from census and corporate annual reports about all the firms with 20 or more employees operating in any sector of activity on the national territory. We consider the period 1989–2004 for the EAE database and the period 1991–2004 for Micro.3.[6]

The study addresses manufacturing firms. As one of our major goals is to understand the strength of selection and reallocation forces operating in each market, we perform the analysis at the finest level of sectoral aggregation allowed by the data. This increases the likelihood that we compare firms which are actually competing with each other. Given the number of observations, we undertake an analysis at the level of 3-Digit industries and, among them, we restrict the attention to those sectors recording at least 100 firms in each year. Since this selection removes the transport equipment industries, where few producers are involved despite their relevance in manufacturing structure of both countries, we also report 2-Digit-level analyses for the sector 'Motor vehicles, trailers & semi-trailers'.[7]

The variables we are focusing on are productive efficiency, profitability, and growth. First, concerning the proxy for growth of the firm (labeled G in the following), our choice is consistent with the general aim of relating such dynamics with the selection and reallocation mechanisms nested in market competition. Thus, we

[5]Both databanks have been made available to authors under the mandatory condition of censorship of any individual information.

[6]The EAE dataset also indicates if the firms underwent any kind of structure modification such as merger, acquisition, etc. The analysis of French firms only includes firms which do not experience any such restructuring.

[7]In both datasets, firms are classified according to their sector of principal activity, on the basis of the French NAF 700 classification standards for the French data, and on the Italian ATECO 2002 ones for the Italian data. In the following, national industrial classifications are converted to the European NACE (Nomenclatures statistique des activités économiques dans la Communauté européenne) classes – Rev 1.1, with which both ATECO and NAF standards perfectly match. In turn, this substantially matches with ISIC Rev 3.1 classification.

measure firm size in terms of sales, rather than in terms of employees or assets, and *G* is the log difference of total sales at constant prices, in two consecutive years. Second, our proxy for profitability (henceforth *P*) is the ratio of gross operating margins (GOM, defined as value added minus cost of labour), divided by total sales. Third, our proxy for efficiency will be a simple labor productivity index, computed as the ratio between value added and number of employees (henceforth Π). We prefer to use this measure, instead of alternative multi-factor proxies of efficiency, to assure direct comparability of our micro productivity measures with those more aggregated ones available from national accounts. Moreover, estimates of multi-factor productivity are highly sensitive to the assumptions concerning the underlying production function (more on this point Dosi and Grazzi, 2006; Bottazzi *et al.*, 2008). In any case, the finding in Foster *et al.* (2001), that TFP and labor productivity tend to be highly correlated, supports the idea that these two measures point in the same direction.[8]

The current values of the variables are deflated with output deflators at the highest level of disaggregation. Consistent 3-Digit production price indexes are available for Italy starting in 1991, hence our choice to consider only the period 1991–2004. In the case of France, 3-Digit deflators are available only for the most recent years: thus, we opted for 2-Digit ones, covering the whole 1989–2004 panel.

3. Productivity, profitability, and corporate growth: broad picture and nonparametric analysis

Tables 1 and 2 offer an introductory picture of the sectoral tendencies followed by labor productivity in the 3-Digit industries selected for the analysis, for Italy and France, respectively (the measures are computed aggregating all the firms present in each sector in a given year).

The bird's-eye view of the data confirms the poor performance of Italian labor productivity when compared with France. In our database, the aggregate productivity of the Italian manufacturing sector grows in 4 years, from 2000 to 2004, by a mere 2%. In the same period, France sees the productivity of its manufacturing industry growing by more than 8%. Moreover, in Italy average productivity in 16 out of 41 3-Digit sectors tends to stop growing or even fall in the new millennium, while the same happens in France only in 5 out of 33 sectors. The interpretation of the sector-wide or even economy-wide factors influencing such average patterns is beyond the scope of this work. Conversely, the focus here is on the dispersion in firm-specific efficiency underlying the sectoral productivity averages and its relation with firm growth together with dispersion in profitabilities. Heterogeneity is indeed

[8]Also, since we focus on relatively narrowly defined industries, we do not expect large differences in capital intensity across firms.

Table 1 Italy—sectoral productivities at constant prices in selected 3-Digit industries, index numbers (2000 = 100)

NACE	SECTOR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
151	Production, process, and preserv. of meat	114.22	125.40	116.68	110.55	101.77	108.94	105.93	115.06	105.99	100.00	99.64	111.02	112.04	108.99
155	Dairy products	100.64	105.95	99.06	97.42	96.50	91.49	95.84	97.27	104.36	100.00	101.18	110.16	110.61	108.37
158	Prod. of other food (bread, sugar, etc.)	93.14	99.59	98.36	91.08	89.12	91.49	92.28	94.34	99.48	100.00	104.52	110.38	100.02	107.35
159	Beverages (alcoholic and not)	85.51	91.41	90.85	92.73	89.84	82.47	89.06	98.52	97.67	100.00	91.34	94.89	88.91	84.81
171	Preparation and spinning of textiles	74.28	86.71	91.70	101.43	97.21	93.32	95.08	93.81	94.09	100.00	94.86	91.10	86.16	85.46
172	Textiles weaving	76.69	79.99	85.46	94.05	101.06	94.04	95.80	92.94	95.98	100.00	97.37	96.63	90.95	95.09
175	Carpets, rugs, and other textiles	76.69	80.22	86.17	91.18	95.19	92.58	95.81	96.43	94.40	100.00	96.34	94.99	93.22	91.45
177	Knitted and crocheted articles	80.89	87.93	91.82	94.71	105.37	96.91	95.87	96.00	87.89	100.00	99.26	99.01	94.84	103.11
182	Wearing apparel	75.55	81.21	85.32	89.59	99.94	99.38	95.33	98.02	93.00	100.00	105.65	107.82	103.94	110.16
193	Footwear	83.63	81.23	90.64	95.65	103.23	98.78	81.37	90.75	95.73	100.00	107.08	106.07	102.14	107.02
203	Wood products for construction	96.91	106.62	107.38	103.54	106.24	103.13	103.58	98.57	99.38	100.00	102.94	107.51	103.71	104.78
212	Articles of paper and paperboard	80.16	79.71	88.43	94.48	92.15	100.88	101.61	101.00	104.38	100.00	92.80	97.07	98.02	102.13
221	Publishing	66.43	72.22	71.10	71.71	69.03	68.51	78.84	77.81	86.32	100.00	84.59	91.46	94.91	111.72
222	Printing	109.75	113.40	110.62	108.36	99.14	99.80	92.89	98.80	98.56	100.00	104.65	100.22	101.37	103.01
241	Production of basic chemicals	65.34	74.71	75.32	96.07	125.51	99.43	99.54	106.53	97.61	100.00	85.26	88.09	83.40	89.36
243	Paints, varnishes, inks, and mastics	94.23	97.19	96.50	100.14	99.92	104.40	95.67	100.48	105.55	100.00	95.25	102.04	110.30	111.79
244	Pharma., med. chemicals, botanical prod	78.84	85.92	87.64	91.09	95.60	99.54	93.18	97.46	99.13	100.00	99.45	104.40	97.67	99.69
246	Other chemical products	80.21	89.17	96.32	102.42	105.93	122.61	112.12	113.55	112.66	100.00	96.88	99.69	90.45	100.62
251	Rubber products	102.06	106.44	113.11	119.20	110.58	99.28	102.71	100.96	103.04	100.00	97.14	102.63	97.41	103.10
252	Plastic products	90.49	95.68	100.66	103.22	102.22	105.02	99.42	99.10	103.42	100.00	97.64	103.18	100.03	98.42
263	Ceramic goods for construction	90.34	95.54	110.77	110.03	111.02	97.19	100.26	100.22	104.50	100.00	91.44	95.13	96.82	101.53
266	Concrete, plaster, and cement	84.55	86.82	78.44	79.04	85.24	89.10	87.91	90.45	94.03	100.00	103.17	110.35	107.02	104.33
267	Cutting, shaping, and finishing of stone	86.87	94.68	95.82	97.32	100.40	97.81	100.36	93.86	97.30	100.00	94.56	97.25	98.59	100.39
275	Casting of metals	79.38	77.31	79.65	88.46	96.73	92.75	94.39	94.96	97.34	100.00	92.81	101.28	95.13	96.09

(continued)

Table 1 Continued

NACE	SECTOR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
281	Structural metal products	94.39	92.16	92.45	90.76	99.13	105.93	106.33	96.50	100.92	100.00	107.98	111.01	107.12	105.92
284	Forging, pressing, stamping of metal	83.45	89.87	88.30	95.32	106.38	100.27	96.61	97.95	101.23	100.00	103.44	107.16	98.15	91.43
285	Treatment and coating of metals	83.21	82.89	85.38	89.85	97.40	102.52	95.21	94.17	96.99	100.00	102.03	110.03	110.17	113.45
286	Cutlery, tools, and general hardware	87.93	88.48	89.71	93.71	96.35	92.91	95.43	93.78	97.04	100.00	100.03	101.76	99.26	104.49
287	Other fabricated metal products	89.05	92.89	96.31	100.07	105.38	102.91	96.91	97.38	96.12	100.00	98.25	98.68	97.04	99.53
291	Machinery for prod. and use of mech. power	81.16	88.59	91.50	99.02	101.84	98.71	92.20	90.27	95.95	100.00	98.59	107.62	102.81	109.09
292	Other general purpose machinery	90.49	93.23	94.77	99.76	103.89	107.39	98.34	97.32	97.17	100.00	100.16	101.89	102.24	104.73
294	Machine tools	84.66	79.91	80.92	87.50	94.61	95.61	94.61	97.11	87.68	100.00	99.15	93.63	84.29	91.21
295	Other special purpose machinery	86.72	86.37	94.46	99.57	105.12	96.78	98.31	92.84	94.52	100.00	99.15	94.13	93.56	97.27
297	Domestic appliances not e/where class	82.10	91.31	99.09	103.59	96.93	96.42	93.76	94.97	103.13	100.00	97.08	104.75	94.44	94.30
311	Electric motors, generators, and transform	83.15	81.84	83.81	87.05	92.03	89.62	90.54	88.90	90.25	100.00	91.91	97.52	100.71	98.38
312	Manuf. of electricity distrib, control equ	80.61	84.16	86.07	88.51	98.92	89.09	100.55	90.32	91.85	100.00	104.34	103.60	101.24	106.76
316	Electrical equipment not e/where class	99.42	101.90	100.77	111.56	105.59	99.04	100.30	99.73	100.01	100.00	101.20	102.87	103.85	108.60
343	Production of spare parts for cars	80.95	83.89	84.58	94.74	97.96	90.64	101.09	95.69	103.62	100.00	100.08	104.09	102.87	106.30
361	Furniture	88.70	90.11	93.06	94.63	97.10	90.26	91.13	94.02	96.53	100.00	99.19	95.79	90.37	91.71
362	Jewelry and related articles	80.59	78.77	78.21	79.33	84.72	92.89	88.88	100.04	106.81	100.00	102.34	100.29	102.62	105.53
366	Miscellaneous manufact. not elsewhere class	73.36	90.00	94.98	95.75	104.54	106.11	93.88	95.21	98.34	100.00	105.47	103.07	109.88	111.68
34	Motor vehicles, trailers, and semi-trailers	83.99	78.52	61.42	80.58	102.02	86.41	114.51	95.03	95.25	100.00	88.7	87.09	92.31	94.41
Total		86.55	90.80	93.22	97.16	101.54	98.84	97.84	95.80	97.39	100.00	98.81	101.69	98.93	102.06

Table 2 France—sectoral productivities at constant prices in selected 3-Digit industries, index numbers (2000 = 100)

NACE	SECTOR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
171	Preparation and spinning of textiles	86.33	79.71	88.30	93.89	92.20	103.59	90.55	88.10	94.23	90.26	88.84	100.00	89.00	94.92	97.58	105.03
172	Textiles weaving	77.99	72.18	73.66	78.36	84.00	92.05	92.00	89.35	90.23	96.99	91.90	100.00	90.45	96.83	94.90	100.19
175	Carpets, rugs, and other textiles	86.19	86.38	83.90	90.90	94.45	92.98	90.46	89.52	92.42	93.00	96.90	100.00	94.41	97.36	99.00	103.42
182	Wearing apparel	79.14	87.54	86.38	86.63	88.04	88.44	90.99	90.84	91.95	94.18	99.12	100.00	109.61	120.00	124.30	130.38
193	Footwear	81.54	87.93	90.27	88.08	89.92	91.02	91.49	90.47	94.19	95.41	100.83	100.00	101.82	105.30	103.14	98.33
204	Wooden containers	74.43	79.55	83.16	87.60	92.71	88.80	86.48	93.83	97.82	97.31	101.91	100.00	105.79	107.78	103.97	108.28
211	Pulp, paper, and paperboard	69.96	76.78	76.80	65.60	70.65	81.80	100.38	83.45	90.37	96.56	97.76	100.00	108.62	98.76	86.62	86.76
212	Articles of paper and paperboard	86.56	93.44	96.28	102.95	113.55	112.01	100.20	109.89	109.36	105.89	110.48	100.00	101.04	105.12	109.53	112.55
221	Publishing	77.31	76.81	77.16	79.44	82.47	83.54	83.77	89.28	92.57	93.82	95.56	100.00	96.54	93.68	96.95	95.93
222	Printing	96.27	98.07	98.75	100.35	99.59	101.62	101.88	95.81	97.81	97.04	99.66	100.00	95.99	98.92	99.25	102.86
241	Production of basic chemicals	60.90	61.59	68.31	72.73	75.86	82.81	91.37	86.80	90.19	91.63	102.69	100.00	93.54	78.48	76.10	76.68
244	Pharma., med. chemicals, botanical prod	69.21	74.25	76.39	79.82	82.78	95.16	105.84	107.40	112.95	99.89	98.02	100.00	102.33	103.29	101.15	99.40
245	Soap and deterg, and perfumes and toilet prep	78.60	78.72	80.17	86.54	87.08	95.22	98.06	89.21	95.75	92.89	91.25	100.00	93.29	99.05	99.95	105.76
246	Other chemical products	78.69	81.54	84.03	89.88	95.80	102.41	96.46	95.79	98.87	90.36	99.11	100.00	91.45	100.40	97.65	105.66
252	Plastic products	80.15	88.18	92.21	96.38	99.03	102.46	97.93	100.00	99.79	101.73	107.98	100.00	100.13	104.63	106.12	104.01
266	Concrete, plaster, and cement	95.30	97.40	97.15	95.00	92.57	96.05	97.07	86.27	85.41	93.02	95.09	100.00	101.66	104.44	108.11	112.79
281	Structural metal products	82.90	85.89	85.52	84.60	84.57	88.60	94.49	89.30	95.66	95.09	97.52	100.00	104.74	107.76	107.75	108.04
284	Forging, pressing, stamping of metal	89.96	97.33	99.96	103.62	103.17	106.40	101.21	98.99	101.70	99.39	101.51	100.00	98.35	100.46	101.00	101.06
286	Cutlery, tools, and general hardware	89.13	97.37	93.49	98.16	99.37	100.80	97.82	98.29	99.50	101.14	104.45	100.00	99.87	101.65	103.57	102.28
291	Machinery for prod. and use of mech. power	76.03	77.62	77.11	81.30	80.60	94.41	97.70	95.84	97.51	100.87	98.48	100.00	98.50	102.95	106.18	113.89

(continued)

Table 2 Continued

NACE	SECTOR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
292	Other general purpose machinery	75.24	79.56	79.45	80.15	83.12	88.05	93.24	93.69	93.15	95.14	98.66	100.00	98.23	101.27	105.44	110.79
293	Agricultural and forestry machinery	76.79	77.99	75.26	77.67	84.74	94.57	96.80	98.65	101.30	96.63	97.85	100.00	89.76	98.15	96.78	104.57
294	Machine tools	79.32	83.45	79.39	78.41	78.42	87.10	96.74	93.51	92.85	98.48	102.18	100.00	100.88	89.50	97.18	108.66
295	Other special purpose machinery	77.25	79.33	75.63	76.72	82.11	86.97	91.87	90.27	94.24	96.76	97.21	100.00	102.08	100.37	98.54	103.14
311	Electric motors, generators, and transform	50.06	54.81	59.37	61.45	66.48	69.37	72.78	74.50	84.11	93.35	96.90	100.00	109.89	113.46	124.32	131.73
312	Manuf. of electricity distrib, control equip	67.52	71.94	75.65	80.73	100.04	89.41	92.11	93.20	96.73	98.16	104.52	100.00	99.93	104.21	106.53	115.44
331	Medical and surgical equip, orthopedic appl	58.30	60.73	65.29	70.00	76.88	78.07	79.19	80.44	88.68	92.70	97.01	100.00	104.71	113.41	124.70	134.53
332	Measuring, checking, testing, and navigat app.	50.00	54.60	57.36	56.87	64.08	69.43	72.63	69.70	75.00	79.91	86.47	100.00	96.70	100.77	109.65	114.96
333	Industrial process control equipment	56.68	61.64	65.75	64.72	69.40	73.65	81.93	78.98	79.77	88.04	94.74	100.00	107.04	109.60	108.71	116.93
361	Furniture	87.68	89.70	90.70	92.37	94.08	95.22	96.48	94.83	95.75	100.00	101.82	100.00	98.11	102.09	102.93	107.81
366	Miscellaneous manuf. not elsewhere class	85.27	87.22	80.95	87.95	94.02	95.02	97.72	100.49	106.55	98.12	98.65	100.00	107.25	113.86	108.91	118.91
34	Motor vehicles, trailers, and semi-trailers	93.30	97.56	95.81	93.67	87.58	95.21	99.47	102.48	98.35	101.32	102.67	100.00	96.46	103.25	152.49	171.41
Total		80.04	83.74	84.66	86.58	89.77	94.12	95.19	94.46	96.16	97.32	100.93	100.00	99.87	102.88	105.13	108.04

the name of the game. The ratios of the 95th to the 5th percentile of firms' productivity distributions are quite high and persistent over time. In Italy they range from 2.78 to 6.02 in 1991 and from 3.28 to 8.55 in 2004, displaying a general growing trend. The same trend is observed in France, when they range from 2.31 to 9.40 in 1991 and from 2.46 to 13.16 in 2004. Similar considerations apply to our profitability measure.[9]

Given the deep and widespread differences in productivity levels among firms belonging to the same 3-Digit sector, it is interesting to investigate how these differences relate to the observed aggregate behavior. Some hints can be obtained performing a decomposition exercise. Let $\Pi_{i,t}$ be the labor productivity of firm i in year t, computed as value added per employee, and $AP_{j,t}$ the aggregate labor productivity of sector j, defined as

$$AP_{j,t} = \sum_{i \in j} (\Pi_{i,t} \cdot s_{i,t})$$

where $s_{i,t}$ represents the share of each firm i in the sector. The annual variation of sectoral productivity can thus be decomposed as

$$\Delta AP_{j,t} = AP_{j,t} - AP_{j,t-1} = \sum_{i \in j} (\Delta \Pi_i \cdot s_{i,t-1}) + \sum_{i \in j} (\Delta s_i \cdot \Pi_{i,t-1}) + \sum_{i \in j} (\Delta \Pi_i \cdot \Delta s_i).$$

The first term represents the *within* effect, i.e. the contribution of firm-specific productivity changes holding constant the share of the firm in the industry. The second term is the *between* effect, capturing the overall contribution due to variation in firm shares, holding initial productivities constant. Finally, the third term is an *interaction* effect, accounting for co-variations between firm productivities and shares.

We compute the percentage contribution of the three components for each sector and for each year in our database, and then average these percentages across all years and sectors. Results are reported in Table 3. Notice that sectoral productivity figures reported in previous Tables 1 and 2 are implicitly obtained by weighting productivity of each firm by employment shares.[10] However, since one of our objects of analysis will be the link between productivity and growth of sales, we also report results of the same decomposition with shares measured in terms of sales.[11] Notice also that

[9]Detailed, not reported for consideration of space, results are available upon request.

[10]Indeed, indicating value added with VA and employment with L, one has $AP_{j,t} = (\sum_{i \in j} \mathrm{VA}_{i,t})/(\sum_{i \in j} L_{i,t})$ when $s_{i,t}$ is in terms of employment.

[11]The decomposition in Equation (10) still holds when $s_{i,t}$ is measured in terms of sales, but resulting sectoral productivities will obviously assume different values with respect to the case when employment shares are used.

Table 3 Decomposition of productivity growth, cross-sectoral mean contributions

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

our datasets do not allow to study the contribution of entry and exit. Hence, our argument is limited to firms present in the dataset in the two consecutive years over which the variations are calculated.

The variability across sectors and across years is quite high, and results are subject to changes depending on the weights used (Appendix A presents the full set of results by industry). On average, however, idiosyncratic learning (the within component) tends to dominate upon selection effects (the between component).[12] And the apparent low effectiveness of selection dynamics is further highlighted by the impact of the covariance effects: those firms which increase more their productivities tend to undergo shrinking shares.[13]

Exercises of 'evolutionary accounting' such as those summarized in Table 3, however, just present broad tendencies, in that they sum up the different effects over all firms in an industry. Much finer interpretations can only come from the analysis of the relationships between efficiency and growth at the level of individual firms. This is precisely what we shall do in the following, in two steps. First, we directly explore the relationship between productivity and growth, the firm-level equivalent of the decomposition analysis done above. Second, by considering firm profitability, we decompose the productivity–growth interaction in two pieces, and explore the association of productivity with profit margins, on the one hand, and the relationship between profit margins and growth, on the other. All the analyses are conducted separately in the 3-Digit industries. In order to ease the presentation of results, we

[12] Sectoral evidence, in Appendix A, also reveals few cases displaying negative within components. It is hard to think of generalized drops in labor productivity in a sector, however. More likely candidates to an explanation are particularly noisy value added deflators—especially in sectors characterized by a lot of product differentiation.

[13] However, as suggested by an anonymous referee, this last phenomenon might not reveal so much lack of selection as such, but be the mask of restructuring processes: firms which restructure by downsizing tend to undergo both a growth in productivity and a decrease in size.

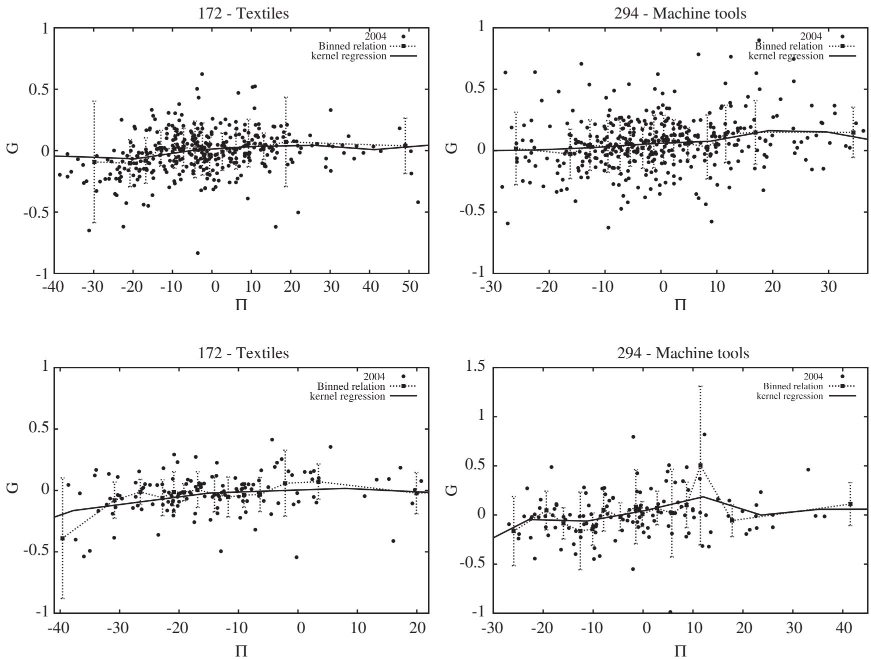

Figure 1 Productivity–growth relationship in selected 3-Digit sectors—binned statistics and kernel regression in 2004. Firm productivities are normalized with annual sectoral averages: Italy (top panel) versus France (bottom panel).

show graphs reporting estimates for 2004 on two sectors, Textiles (NACE 172) and Machine Tools (NACE 294), chosen because they are among the sectors with the highest number of observations. However, the results emerge as time- and sector invariant, suggesting that the structure of the relationships is independent from sectoral characteristics.[14]

Consider first the link between productivity (Π) and growth of sales (G), presented in Figure 1. The clouds of points represent the scatter plot of the raw data for the couples (Π_i,G_i). With dashed lines we represent binned statistics: the data are divided in equipopulated bins according to relative productivities, and the average within-bin values of Π are plotted against the average of G computed in the same bin, together with 2-standard deviation error bar. Finally, the thick lines represent kernel regressions of the conditional expectation of G given Π.[15]

[14]Results on other sectors and years are available from the authors upon request.

[15]Computation of binned statistics is based on 15 equipopulated bins, while kernel estimates employ an Epanenchnikov kernel function. Conclusions do not depend on these particular choices.

The evidence suggests a lack of any clear association between the variables. This applies to all sectors and to both countries. The clouds of points are quite dispersed and do not present any apparent shape. Further, notice that a flat line is a good first approximation connecting the pairs (average G, average Π) computed over the different productivity bins.[16] The impression is confirmed by the kernel estimates of the conditional expectation of G, which yield basically flat regression lines, in all of the sectors under analysis. Increasing or decreasing patterns can be considered only as a minor deviation from the general pattern, limited to the extreme parts of the productivity distribution (where kernel estimates become less reliable due to lower number of observations).

The absence of a clear positive relationship between relative productivity levels and growth testifies against the existence of any strong selection dynamics among incumbent firms. This evidence extends a similar finding on 2-Digit Italian manufacturing sectors reported in Bottazzi *et al.* (2005b), suggesting that the result does not depend on the disaggregation level. The question is whether this absence is due to the inability of firms to translate their technical advantages in internal resources, which can be in turn used for expanding their operations, or if a more abundant availability of resources does not translate automatically in an increased ability or willingness to grow. Some hints about this issue are obtained by investigating how productivity and growth relate to firm profitability. Plots in Figure 2 show results concerning the productivity–profitability relation. As before, a simple scatter plot of the raw data (Π_i,P_i) is depicted with dots, while binned statistics (within-bin average values of Π versus within-bin average of P, with 2-standard deviation error bar) are in dashed lines, and kernel estimates of the conditional expectation of P given Π are reported as a thick line. The tendency displayed by the graphs is in this case revealing of a positive association between the variables. This is a clearcut result highlighted by both binned statistics and kernel regressions, which indeed show steeper patterns as compared with the productivity–growth relations. Moreover, the relationship is steeper for those firms with relatively low values of productivity, and becomes weaker, yet still positive, as one moves toward higher productivity levels. This hints at the emergence of a peculiar nonlinearity, already noted in Bottazzi *et al.* (2008) on a different sample of Italian firms. The result is more pronounced for Italian firms, and applies to all sectors. It is then clear that, at least on average, firms with higher productivity levels are characterized by higher profit margins.

Conversely, no evident pattern emerges in the relationship between growth and profitability, shown in Figure 3. Here, the findings closely resemble what was observed for the productivity–growth relationship. The clouds of points remain much dispersed, while both binned statistics and kernel regressions allow us to

[16]These pairs always fall within the confidence band, suggesting that growth performance does not display any statistically significant difference in the different productivity bins.

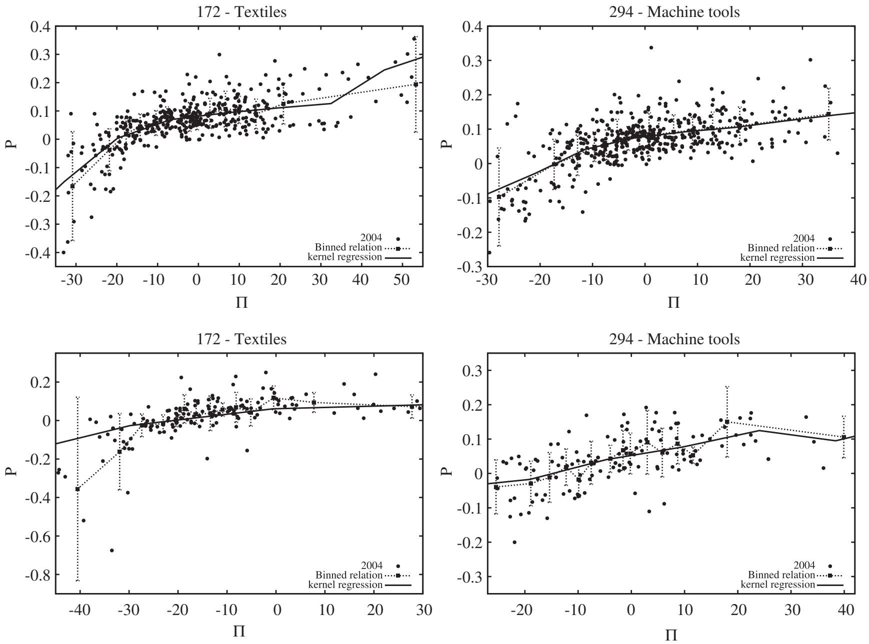

Figure 2 Productivity–profitability relationship in selected 3-Digit sectors—binned statistics and kernel regression in 2004. Firm productivity is normalized with annual sectoral averages: Italy (top panel) versus France (bottom panel).

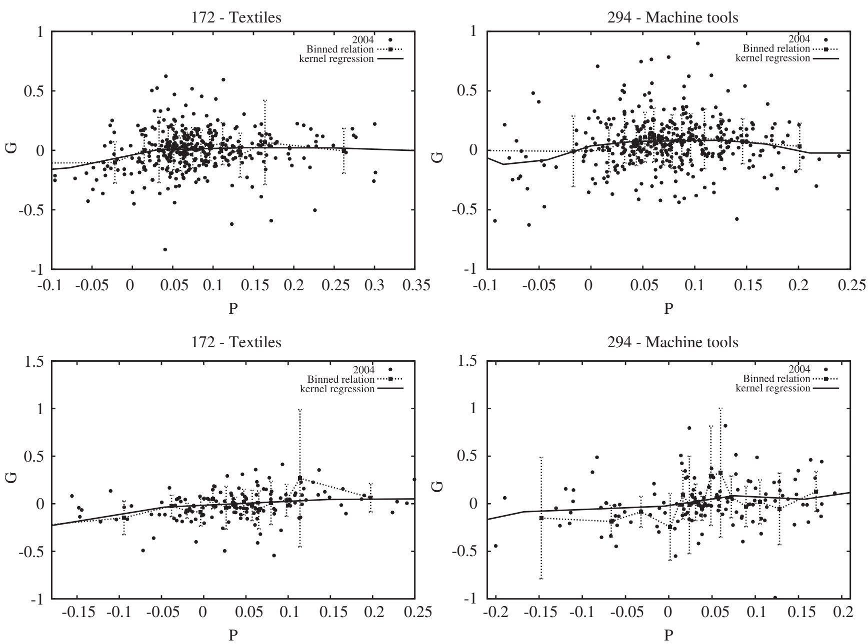

Figure 3 Profitability–growth relationship in selected 3-Digit sectors—binned statistics and kernel regression in 2004: Italy (top panel) versus France (bottom panel).

conclude that a flat line provides a good approximation of the data. Again, this applies to both countries and irrespective of the sectors considered.

Summarizing, the relations linking productivity, profitability, and growth seem considerably weaker than what one would have expected on the grounds of any simple view that market competition would lead to reallocation of production and market shares toward the more efficient and/or the more profitable firms. The productivity–profitability relationship seems indeed the only link displaying relevance in the data, whereas the relationships of growth with either productivity or profitability appear much weaker, if at all existent. The following section explores to what extent this picture survives if we control for the effect of firm-specific unobserved variables, and analyzes the unfolding of such relationships over time.

4. Panel analysis

The nonparametric exercises presented in Section 3 look at the relation between productivity, profitability, and growth by comparing the values of these variables for all the firms belonging to one sector in one particular year. In this section, we start by investigating the same contemporaneous relationships, but introduce a parametric specification that allows us to exploit the panel structure of the data to control for possibly unobserved firm-specific factors. The basic regression specification is a bivariate model of the form

$$Y_{i,t} = c + \alpha X_{i,t} + u_i + \varepsilon_{i,t}\,, \qquad (1)$$

where Y and X represent the pair of productivity–profitability–growth measures considered in the different regressions, while the term u_i is a firm-specific constant, modeling unobserved characteristics, and $\varepsilon_{i,t}$ a standard *i.i.d.* error term. All the estimates are undertaken separately for each 3-Digit sector, adding a full set of year dummies that control for possible time effects common to all the firms in the same sector. In line with the unconditional pairwise analysis of previous section, we want to isolate the association of each variable with another, and therefore we do not augment the regressions with further explanatory variables. However, we did compare estimated effects across sectors sharing similar characteristics in terms of information and communication technologies (ICT) intensity, skill composition of the labor force, and patterns of innovation, based on standard taxonomies used in international studies (O'mahony and Van Ark, 2003).[17] The results of this comparison tell that the effects are very similar across taxonomy classes for all the investigated relationships: distribution of effects in one class do not differ from distributions of effects in another class defined by the same taxonomy. This suggests

[17]See Appendix B for details and precise definitions.

a minor impact of sector-specific technological and organizational characteristics on the relations under study.

Notice also that a sheer comparison of the estimated α across the different regressions is not very informative about the relative strength of the association between the pair of variables involved, since the values of α obviously depend on the scale (or unit of measurement) of the variables. The strength of association is better captured by the index

$$S^2_{Y,X} = \left(\hat{\alpha}\frac{\sigma_X}{\sigma_Y}\right)^2, \tag{2}$$

where $\hat{\alpha}$ is the Fixed Effects estimate of the coefficient in Equation (1), while σ_X and σ_Y represent the sample standard deviation of X and Y, respectively. Thus, $S^2_{Y,X}$ yields a measure of the fraction of total explained variance which is accounted for by the variance of X. That is, it captures the explanatory power due to the economic regressor X alone, net of the contribution of annual dummies and unobserved heterogeneity. We shall compare its values with the canonical $R^2 = (1 - \frac{\sigma^2_\varepsilon}{\sigma^2_Y})$ which gives a measure of the overall explanatory power of the model, including the contribution of annual dummies and unobserved heterogeneity. However, in all our regressions the explanatory power associated with year dummies is negligible and, thus, the fraction of the R^2 which is not captured by $S^2_{Y,X}$ can be seen as a proxy for the explanatory power due to unobserved heterogeneity alone. Of course, given that the heterogeneity is assumed to be time invariant in panel models, the contribution of the u_i terms tend to be higher in specifications where the dependent Y displays higher persistence over time. Indeed, to check this, we estimated a simple AR(1) model on each variable. The average of the coefficients obtained in the different sectors considered is 1.01 in the case of productivity, for both Italy and France; average coefficients obtained in the case of profitability equal 0.94 in Italy and 0.97 in France. The average AR(1) coefficients on growth are instead significantly lower, and equal 0.19 in Italy and 0.17 in France. These results are consistent with other previous studies (see Bottazzi, *et al.*, 2008; Coad, *et al.*, 2010, and the works cited therein) and should be kept in mind in interpreting the following results.

We start by exploring the direct association of productivity with growth. The estimated equation is

$$G_{i,t} = c + \alpha\Pi_{i,t} + u_i + \varepsilon_{i,t}, \tag{3}$$

where productivities are again normalized with the annual sectoral averages (i.e. they are relative productivities).

Table 4 shows coefficient estimates obtained for the sample of sectors available in the two countries, as well as the associated values of $S^2_{Y,X}$ and R^2. As a general result, we observe a clearcut pattern, with positive (and significant) estimates in practically all sectors, in both countries. Notice, however, that while the productivity variable

Table 4 Contemporaneous relationship between productivity and growth—Fixed Effects estimates of Equation (3)

NACE	Sector	Italy $\hat{\alpha}$	Italy S^2_{YX}	Italy R^2	France $\hat{\alpha}$	France S^2_{YX}	France R^2
151	Production, process and preserv. of meat	0.0023[a]	0.0477	0.2185	–	–	–
155	Dairy products	0.0020[a]	0.0317	0.1490	–	–	–
158	Prod. of other food (bread, sugar, etc.)	0.0011[a]	0.0272	0.2930	–	–	–
159	Beverages (alcoholic and not)	0.0022[a]	0.1098	0.1757	–	–	–
171	Preparation and spinning of textiles	0.0045[a]	0.0936	0.2561	0.0004[a]	0.0049	0.1907
172	Textiles weaving	0.0023[a]	0.0623	0.2916	0.0003[a]	0.0046	0.2415
175	Carpets, rugs, and other textiles	0.0039[a]	0.2383	0.3585	0.0003[a]	0.0033	0.1946
177	Knitted and crocheted articles	0.0071[a]	0.2433	0.2913	–	–	–
182	Wearing apparel	0.0052[a]	0.1543	0.3269	0.0028[a]	0.0000	0.0601
193	Footwear	0.0086[a]	0.2048	0.2859	0.0100[a]	0.0000	0.1178
203	Wood products for construction	0.0066[a]	0.1564	0.2836	–	–	–
204	Wooden containers	–	–	–	0.0072[a]	0.0000	0.1429
211	Pulp, paper, and paperboard	–	–	–	0.0022[a]	0.0954	0.1354
212	Articles of paper and paperboard	0.0021[a]	0.0632	0.2412	0.0026[a]	0.0388	0.1973
221	Publishing	0.0012[a]	0.0746	0.3028	0.0005[a]	0.0640	0.2113
222	Printing	0.0027[a]	0.1063	0.3688	0.0062[a]	0.1169	0.1975
241	Production of basic chemicals	0.0006[a]	0.0158	0.1255	0.0009[a]	0.1056	0.1470
243	Paints, varnishes, inks and mastics	0.0015[a]	0.0290	0.1961	–	–	–
244	Pharma., med. chemicals, botanical prod	0.0012[a]	0.0310	0.3863	0.0004[a]	0.0570	0.2306
245	Soap and deterg and perfumes and toilet prep	–	–	–	0.0001[a]	0.0094	0.1555
246	Other chemical products	0.0023[a]	0.1166	0.3168	0.0022[a]	0.1367	0.2317
251	Rubber products	0.0026[a]	0.0532	0.2833	–	–	–
252	Plastic products	0.0032[a]	0.1200	0.2789	0.0014[a]	0.0245	0.1711
263	Ceramic goods for construction	0.0033[a]	0.1125	0.3327	–	–	–
266	Concrete, plaster, and cement	0.0025[a]	0.0851	0.3158	0.0011[a]	0.0210	0.1857
267	Cutting, shaping, and finishing of stone	0.0039[a]	0.2360	0.3045	–	–	–
275	Casting of metals	0.0051[a]	0.1436	0.2758	–	–	–
281	Structural metal products	0.0060[a]	0.1183	0.3131	0.0096[a]	0.1319	0.2179
284	Forging, pressing, stamping of metal	0.0059[a]	0.2009	0.2812	0.0080[a]	0.1942	0.2391
285	Treatment and coating of metals	0.0060[a]	0.1957	0.3556	–	–	–
286	Cutlery, tools, and general hardware	0.0054[a]	0.2267	0.2850	0.0085[a]	0.2079	0.2101

(continued)

Table 4 Continued

NACE	Sector	Italy $\hat{\alpha}$	Italy S^2_{YX}	Italy R^2	France $\hat{\alpha}$	France S^2_{YX}	France R^2
287	Other fabricated metal products	0.0037[a]	0.0928	0.2719	–	–	–
291	Machinery for prod. and use of mech. power	0.0035[a]	0.0942	0.2823	0.0052[a]	0.1671	0.2203
292	Other general purpose machinery	0.0052[a]	0.1613	0.2626	0.0083[a]	0.1885	0.1961
293	Agricultural and forestry machinery	–	–	–	0.0086[a]	0.1450	0.2093
294	Machine tools	0.0062[a]	0.1525	0.3340	0.0099[a]	0.1932	0.3316
295	Other special purpose machinery	0.0061[a]	0.1553	0.2389	0.0087[a]	0.1948	0.2072
297	Domestic appliances not e/where class	0.0027[a]	0.0607	0.2552	–	–	–
311	Electric motors, generators, and transform	0.0040[a]	0.1147	0.3973	0.0097[a]	0.1518	0.2434
312	Manuf. of electricity distrib, control equip	0.0046[a]	0.1059	0.3092	0.0104[a]	0.2508	0.2728
316	Electrical equipment not e/where class	0.0050[a]	0.1771	0.2849	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	0.0053[a]	0.1455	0.2417
332	Measuring, checking, testing, and navigat app.	–	–	–	0.0068[a]	0.1217	0.2885
333	Industrial process control equipment	–	–	–	0.0088[a]	0.1990	0.2705
343	Production of spare parts for cars	0.0043[a]	0.0845	0.2259	–	–	–
361	Furniture	0.0057[a]	0.1331	0.2826	0.0119[a]	0.2633	0.2604
362	Jewelry and related articles	0.0047[a]	0.0870	0.2231	–	–	–
366	Miscellaneous manufact. not elsewhere class	0.0043[a]	0.1590	0.3188	0.0000[a]	0.0017	0.1649
34	Motor vehicles, trailers, and semi-trailers	0.0038[a]	0.0707	0.2470	0.0025[a]	0.1122	0.2214
	S^2_{YX} statistics	AVG	MIN	MAX	AVG	MIN	MAX
		0.1186	0.0158	0.2433	0.1268	0.0000	0.2633

Productivity is in deviation from annual sectoral average. [a]Coefficient significant at 5% confidence level.

has the expected sign, the strength of the relationship is actually very weak. The values of $S^2_{Y,X}$ reveal indeed that only a small fraction of the total explained variance measured by R^2 comes from productivity alone, while the contribution of unobserved heterogeneity is always much larger. Take sector 151 as an example. Out of about 22% of total variance explained by the model ($R^2 = 0.2185$), we observe that less than 5% is due to variation in productivity ($S^2_{Y,X} = 0.0477$): this means only a mere 1% of the growth rates' variance is accounted for by productivity. Similar patterns emerge also in the other sectors, where the contribution of productivity to the explanation of the variance in growth rates is typically less than 5% and most often less than 3%. Overall, even if industry-wide forces driving toward selection/reallocation of resources in favor of more efficient firms are present, their strength is extremely low, at least in the short term.

Let us move a step further and ask whether selection operates via profitability. We again consider the two relationships capturing the association of productivity with profitability, on the one hand, and that of profitability with growth, on the other. Results in Table 5 present the estimates of the regression model

$$P_{i,t} = c + \alpha \Pi_{i,t} + u_i + \varepsilon_{i,t}. \qquad (4)$$

where productivity is again measured in relative terms.

In general the association between the two variables is positive and significant, in both countries, irrespective of the sectors. Moreover, the relationship stands out as considerably stronger as compared with the results obtained for the productivity–growth relation. The total explained variance is higher than before (cf. R^2 greater than 60 or 70% in most cases) and we also observe a significant increase in the estimates of $S^2_{Y,X}$, which display average values of about 35%, in fact greater in the vast majority of the sectors, with peaks above 60%.[18] Thus, the explanatory power of relative productivity is comparable with that stemming from firm-specific factors capturing unobserved heterogeneity: more efficient firms do tend to be more profitable.

Finally, let us consider the profitability–growth relationship. Here, the issue is whether gross profits spur growth, which we capture through the regression model

$$G_{i,t} = c + \alpha P_{i,t} + u_i + \varepsilon_{i,t}. \qquad (5)$$

The estimates, reported in Table 6, provide a picture that is quite similar to that offered by the productivity–growth regressions. The estimated coefficients are positive and significant, but the values of $S^2_{Y,X}$ and R^2 are once again revealing that the relationship is almost entirely driven by the firm-specific components u_i. With R^2's in the range of 0.2–0.4, and $S^2_{Y,X}$'s on average around 0.1 (indeed lower in most

[18]An higher R^2 is also due to the higher persistence of the dependent variable.

Table 5 Contemporaneous relationship between productivity and profitability—Fixed Effects estimates of Equation (4)

		Italy			France		
NACE	Sector	$\hat{\alpha}$	S^2_{YX}	R^2	$\hat{\alpha}$	S^2_{YX}	R^2
151	Production, process, and preserv. of meat	0.0019[a]	0.3285	0.6392	–	–	–
155	Dairy products	0.0019[a]	0.2706	0.4214	–	–	–
158	Prod. of other food (bread, sugar, etc.)	0.0019[a]	0.4542	0.8100	–	–	–
159	Beverages (alcoholic and not)	0.0020[a]	0.3880	0.4465	–	–	–
171	Preparation and spinning of textiles	0.0033[a]	0.3358	0.7226	0.0004[a]	0.0554	0.4612
172	Textiles weaving	0.0023[a]	0.3378	0.7294	0.0002[a]	0.0269	0.5069
175	Carpets, rugs, and other textiles	0.0031[a]	0.5200	0.7122	0.0002[a]	0.0192	0.5238
177	Knitted and crocheted articles	0.0041[a]	0.3711	0.6082	–	–	–
182	Wearing apparel	0.0033[a]	0.0570	0.4543	0.0011[a]	0.1502	0.5231
193	Footwear	0.0043[a]	0.3193	0.5284	0.0035[a]	0.2313	0.6318
203	Wood products for construction	0.0045[a]	0.5588	0.6670	–	–	–
204	Wooden containers	–	–	–	0.0038[a]	0.6098	0.7159
211	Pulp, paper, and paperboard	–	–	–	0.0024[a]	0.6674	0.8393
212	Articles of paper and paperboard	0.0024[a]	0.5459	0.7218	0.0019[a]	0.2481	0.6614
221	Publishing	0.0018[a]	0.3503	0.6948	0.0001[a]	0.0482	0.6707
222	Printing	0.0026[a]	0.3479	0.6672	0.0026[a]	0.3904	0.6153
241	Production of basic chemicals	0.0006[a]	0.1053	0.5202	0.0004[a]	0.1312	0.7240
243	Paints, varnishes, inks, and mastics	0.0020[a]	0.5437	0.8200	–	–	–
244	Pharma., med. chemicals, botanical prod	0.0011[a]	0.2682	0.5029	0.0002[a]	0.0275	0.7751
245	Soap and deterg and perfumes and toilet prep	–	–	–	0.0001[a]	0.0504	0.5885
246	Other chemical products	0.0019[a]	0.3325	0.4788	0.0009[a]	0.2170	0.6271
251	Rubber products	0.0030[a]	0.4570	0.7896	–	–	–
252	Plastic products	0.0023[a]	0.3510	0.7132	0.0009[a]	0.1378	0.5832
263	Ceramic goods for construction	0.0031[a]	0.4818	0.7029	–	–	–
266	Concrete, plaster and cement	0.0007[a]	0.0584	0.6106	0.0005[a]	0.0551	0.6049
267	Cutting, shaping, and finishing of stone	0.0020[a]	0.3579	0.6700	–	–	–
275	Casting of metals	0.0025[a]	0.3003	0.6580	–	–	–
281	Structural metal products	0.0033[a]	0.3410	0.6435	0.0042[a]	0.6292	0.7275
284	Forging, pressing, stamping of metal	0.0034[a]	0.4029	0.5412	0.0040[a]	0.5303	0.7160

(continued)

Table 5 Continued

		Italy			France		
NACE	Sector	$\hat{\alpha}$	S^2_{YX}	R^2	$\hat{\alpha}$	S^2_{YX}	R^2
285	Treatment and coating of metals	0.0040[a]	0.4132	0.6952	–	–	–
286	Cutlery, tools, and general hardware	0.0035[a]	0.3188	0.6038	0.0048[a]	0.6753	0.7034
287	Other fabricated metal products	0.0031[a]	0.4788	0.7096	–	–	–
291	Machinery for prod. and use of mech. power	0.0031[a]	0.3929	0.6945	0.0033[a]	0.5360	0.7326
292	Other general purpose machinery	0.0029[a]	0.4341	0.7503	0.0041[a]	0.6293	0.7198
293	Agricultural and forestry machinery	–	–	–	0.0044[a]	0.5913	0.7028
294	Machine tools	0.0024[a]	0.3433	0.6764	0.0048[a]	0.6061	0.7145
295	Other special purpose machinery	0.0035[a]	0.5164	0.6621	0.0049[a]	0.6817	0.7104
297	Domestic appliances not e/where class	0.0023[a]	0.4152	0.7349	–	–	–
311	Electric motors, generators, and transform	0.0029[a]	0.4990	0.7598	0.0051[a]	0.4939	0.7714
312	Manuf. of electricity distrib, control equip	0.0033[a]	0.3516	0.7454	0.0035[a]	0.4427	0.6711
316	Electrical equipment not e/where class	0.0024[a]	0.3247	0.7587	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	0.0031[a]	0.3913	0.6871
332	Measuring, checking, testing, and navigat app.	–	–	–	0.0030[a]	0.2919	0.6221
333	Industrial process control equipment	–	–	–	0.0037[a]	0.5462	0.6334
343	Production of spare parts for cars	0.0139[a]	0.0060	0.1296	–	–	–
361	Furniture	0.0035[a]	0.4313	0.6371	0.0056[a]	0.6517	0.7337
362	Jewelry and related articles	0.0019[a]	0.2132	0.5142	–	–	–
366	Miscellaneous manufact. not elsewhere class	0.0032[a]	0.5358	0.6848	0.0000[a]	0.0060	0.5637
34	Motor vehicles, trailers, and semi-trailers	0.0105[a]	0.0046	0.1287	0.0015[a]	0.2664	0.5716
	S^2_{YX} statistics	AVG	MIN	MAX	AVG	MIN	MAX
		0.3471	0.0046	0.5588	0.4172	0.0060	0.6753

Productivity is in deviation from annual sectoral average. [a]Coefficient significant at 5% confidence level.

Table 6 Contemporaneous relationship between profitability and growth—Fixed Effects estimates of Equation (5)

		Italy			France		
NACE	Sector	$\hat{\alpha}$	S^2_{YX}	R^2	$\hat{\alpha}$	S^2_{YX}	R^2
151	Production, process and preserv. of meat	1.2511[a]	0.1754	0.2901	–	–	–
155	Dairy products	1.7550[a]	0.3299	0.3728	–	–	–
158	Prod. of other food (bread, sugar, etc.)	0.4858[a]	0.0364	0.3067	–	–	–
159	Beverages (alcoholic and not)	1.2601[a]	0.3196	0.3561	–	–	–
171	Preparation and spinning of textiles	0.6340[a]	0.0545	0.2449	0.7440[a]	0.0923	0.2546
172	Textiles weaving	0.5265[a]	0.0478	0.2943	1.0546[a]	0.0923	0.2890
175	Carpets, rugs, and other textiles	0.4540[a]	0.0553	0.3291	1.1378[a]	0.1048	0.2419
177	Knitted and crocheted articles	0.7578[a]	0.1472	0.3055	–	–	–
182	Wearing apparel	0.1096[a]	0.0147	0.3138	0.5653[a]	0.0757	0.2550
193	Footwear	0.8679[a]	0.1056	0.2997	1.3384[a]	0.1159	0.2207
203	Wood products for construction	0.5279[a]	0.0359	0.2892	–	–	–
204	Wooden containers	–	–	–	0.8592[a]	0.0581	0.1908
211	Pulp, paper and paperboard	–	–	–	0.1758	0.0070	0.1006
212	Articles of paper, and paperboard	0.7236[a]	0.0747	0.2582	0.5924[a]	0.0318	0.1946
221	Publishing	0.1706[a]	0.0121	0.2939	0.0429[a]	0.0068	0.1875
222	Printing	0.6643[a]	0.1376	0.3542	0.7332[a]	0.0438	0.1695
241	Production of basic chemicals	1.4128[a]	0.3470	0.3491	0.5441[a]	0.1165	0.1627
243	Paints, varnishes, inks, and mastics	0.9854[a]	0.0653	0.2206	–	–	–
244	Pharma., med. chemicals, botanical prod	1.0134[a]	0.1213	0.4519	0.3796[a]	0.0829	0.2632
245	Soap and deterg, and perfumes and toilet prep	–	–	–	0.9769[a]	0.1026	0.1872
246	Other chemical products	0.8846[a]	0.2527	0.4737	0.6959[a]	0.0873	0.2203
251	Rubber products	0.2447[a]	0.0095	0.2852	–	–	–
252	Plastic products	0.8717[a]	0.1263	0.2904	0.5802[a]	0.0285	0.1761
263	Ceramic goods for construction	0.3509[a]	0.0240	0.3070	–	–	–
266	Concrete, plaster, and cement	0.4693[a]	0.0200	0.2790	0.8573[a]	0.0627	0.2035
267	Cutting, shaping, and finishing of stone	0.5609[a]	0.0563	0.2697	–	–	–
275	Casting of metals	0.8911[a]	0.1018	0.2873	–	–	–
281	Structural metal products	0.8370[a]	0.0684	0.3142	1.1263[a]	0.0544	0.1998
284	Forging, pressing, stamping of metal	0.8923[a]	0.1239	0.2989	0.9334[a]	0.0926	0.2110

(continued)

Table 6 Continued

NACE	Sector	Italy $\hat{\alpha}$	Italy S^2_{YX}	Italy R^2	France $\hat{\alpha}$	France S^2_{YX}	France R^2
285	Treatment and coating of metals	0.6561[a]	0.0911	0.3456	–	–	–
286	Cutlery, tools, and general hardware	0.3338[a]	0.0342	0.2474	0.6970[a]	0.0586	0.1841
287	Other fabricated metal products	0.9017[a]	0.1189	0.3106	–	–	–
291	Machinery for prod. and use of mech. power	0.8954[a]	0.1487	0.3153	0.8816[a]	0.0979	0.2170
292	Other general purpose machinery	0.8271[a]	0.0701	0.2553	1.0287[a]	0.0832	0.1678
293	Agricultural and forestry machinery	–	–	–	1.1647[a]	0.1388	0.2208
294	Machine tools	0.6543[a]	0.0382	0.2998	1.1168[a]	0.1029	0.3195
295	Other special purpose machinery	0.9698[a]	0.0828	0.2307	1.0194[a]	0.0995	0.1849
297	Domestic appliances not e/where class	0.3325[a]	0.0103	0.2403	–	–	–
311	Electric motors, generators, and transform	0.7281[a]	0.0628	0.3965	1.0876[a]	0.1020	0.2356
312	Manuf. of electricity distrib, control equip	0.4637[a]	0.0390	0.2864	0.0021	0.0000	0.2834
316	Electrical equipment not e/where class	0.7113[a]	0.0557	0.2767	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	0.4818[a]	0.0684	0.2292
332	Measuring, checking, testing, and navigat app.	–	–	–	0.7112[a]	0.0633	0.2672
333	Industrial process control equipment	–	–	–	0.5837[a]	0.0896	0.2598
343	Production of spare parts for cars	0.0306[a]	0.1770	0.3518	–	–	–
361	Furniture	0.6915[a]	0.0546	0.2846	1.0099[a]	0.0960	0.2312
362	Jewelry and related articles	1.5110[a]	0.1609	0.2871	–	–	–
366	Miscellaneous manufact. not elsewhere class	0.7875[a]	0.0958	0.3261	1.0989[a]	0.0921	0.2079
34	Motor vehicles, trailers, and semi-trailers	0.0307[a]	0.1375	0.3385	0.0001[a]	0.0132	0.2573
	S^2_{YX} statistics	AVG	MIN	MAX	AVG	MIN	MAX
		0.1032	0.0095	0.3470	0.0699	0.0000	0.1388

[a]Coefficient significant at 5% confidence level.

sectors), the profitability variable accounts for about 5% of the variance in growth rates in most cases. The relationship is generally there, but appears to be extremely weak.

An overall reading of the findings yields conclusions which closely agree with the impression drawn from previous nonparametric investigations. The contemporaneous relations between firm growth, on the one hand, and both productivity and profitability, on the other, appear to be rather weak. This, in turn, witnesses for relatively weak selection forces at work, at least in the short term, neither through a productivity effect—efficiency spurring differential growth—nor via a profitability one—higher margins entailing greater cash flows and through that greater possibilities of expansion. Greater degrees of efficiency are indeed robustly associated with higher profitability, but the latter does not display any straightforward association with growth.

As compared with the nonparametric analysis of the previous section, panel regressions allow us to disentangle the importance of idiosyncratic, firm-specific unobserved factors. In fact, the regression modeling profitability as dependent on productivity stands out as the only case where the statistical relevance of the economic regressor is comparable with the explanatory power of unaccounted sources of micro heterogeneity. Conversely, the relevance of systematic, economically interpretable regressors is weak in both the productivity–growth and the profitability–growth relationships, where a good deal of the explained variance rests upon unobserved fixed effects.

Of course, contemporaneous relations capture linkages only over the very short run, while it is indeed reasonable that the relationships we are investigating have an essentially dynamic and structural nature. Hence, one should consider the workings of the relationships over a longer time scale, allowing for the effect of each variable on the others to take some time to emerge. In this perspective we now investigate panel estimates of the links between average values of productivity, profitability, and growth records computed over multi-year subperiods.

Indicating with s the period and with T_s the number of years spanned by each period, the time series average of the variables are defined over three periods p_1, p_2, and p_3, as follows

$$\bar{Z}_{i,s} = \frac{1}{T_s} \sum_{t \in s} Z_{i,t} \qquad s \in \{p_1, p_2, p_3\} \qquad Z \in \{\ \Pi, P, G\ \}. \tag{6}$$

Then, we set $p_1 = 1992–1995$, $p_2 = 1996–1999$, and $p_3 = 2000–2004$ for Italian data, while $p_1 = 1990–1994$, $p_2 = 1995–1999$, and $p_3 = 2000–2004$ for the French data.[19]

[19]Previous analysis on similar database in Bottazzi *et al.* (2005a) show that a period of 4–5 years is enough to smooth out fluctuations in production structure due to structural adjustments. An alternative strategy looking at time effects would be to still consider yearly values of the variables, but include lagged regressors, experimenting with different orders of lag. However, taking

This leaves us with a panel of three periods, which can be used to replicate the same kind of analysis explored above. The baseline empirical model thus becomes

$$\bar{Y}_{i,s} = c + \alpha \bar{X}_{i,s} + u_i + \varepsilon_{i,s}, \tag{7}$$

where Y and X represent the pair of economic performance considered in each pairwise regression, and u_i is again a firm-specific constant absorbing unobserved characteristics. For consistency with previous analysis, we present Fixed Effects estimates obtained separately for each sector, also including time (period) dummies. As compared with the previous models where we take yearly values, averaging over time is likely to entail a reduction in the intertemporal variability of the variables, and thus we expect an increase in the R^2's, due to an increased explanatory power of time-invariant heterogeneity. The question is whether we can confirm the above finding of a relatively weak explanatory power of the economic regressors.

Table 7 shows results for the specification exploring the link between average productivity and average growth

$$\bar{G}_{i,s} = c + \alpha \bar{\Pi}_{i,s} + u_i + \varepsilon_{i,s}. \tag{8}$$

The main conclusions are consistent with results drawn from contemporaneous yearly regressions. The weakness of the association between the variables is even more apparent, if one considers that the estimates of α turn out not statistically different from zero in about a half of the sectors. The expected increase in the overall explained variance (R^2 generally equals 60–70%) is entirely due to the increased explanatory power of the firm-specific constants u_i, while the contribution attributable to average productivity is negligible (cf. very small $S^2_{Y,X}$'s, equal to about 0.04 on average).

Table 8 reports results concerning the pairwise regressions between average productivity and average profitability

$$\bar{P}_{i,s} = c + \alpha \bar{\Pi}_{i,s} + u_i + \varepsilon_{i,s}. \tag{9}$$

The estimates confirm statistical relevance of this relationship. First, estimates are significant in almost all the sectors. Second, the values of $S^2_{Y,X}$ confirm that, despite some sectoral variability, the explanatory power of productivity, net of the contribution of fixed effects and period dummies, is sizeable and ranges between around 30–60% of total variance explained by the model. The overall message is consistent with the evidence from contemporaneous yearly regressions.

Similar conclusions emerge also from Table 9, where we show the estimation results for the specification

$$\bar{G}_{i,s} = c + \alpha \bar{P}_{i,s} + u_i + \varepsilon_{i,s}, \tag{10}$$

multi-year averages is preferable, as it is likely to reduce possible biases due to measurement errors in yearly figures. Anyhow, we did estimate specifications with lagged regressors, but the results do not depart from the patterns stemming from the yearly contemporaneous analyses.

Table 7 Multi-year averages: productivity and growth—Fixed Effects estimates of Equation (8)

NACE	Sector	Italy			France		
		$\hat{\alpha}$	S^2_{YX}	R^2	$\hat{\alpha}$	S^2_{YX}	R^2
151	Production, process and preserv. of meat	0.0014[a]	0.0379	0.7211	–	–	–
155	Dairy products	−0.0003	0.0018	0.6144	–	–	–
158	Prod. of other food (bread, sugar, etc.)	−0.0014[a]	0.0280	0.6207	–	–	–
159	Beverages (alcoholic and not)	0.0005	0.0108	0.6031	–	–	–
171	Preparation and spinning of textiles	0.0005	0.0012	0.4750	0.0010[a]	0.0429	0.7193
172	Textiles weaving	0.0008	0.0081	0.6141	0.0008[a]	0.0244	0.8598
175	Carpets, rugs, and other textiles	0.0024[a]	0.1389	0.6029	0.0000	0.0003	0.8461
177	Knitted and crocheted articles	0.0022[a]	0.0393	0.7248	–	–	–
182	Wearing apparel	0.0021[a]	0.0325	0.7179	0.0009[a]	0.0068	0.7786
193	Footwear	0.0053[a]	0.0652	0.6343	0.0032[a]	0.0150	0.7519
203	Wood products for construction	0.0022	0.0213	0.6586	–	–	–
204	Wooden containers	–	–	–	−0.0002	0.0002	0.7713
211	Pulp, paper, and paperboard	–	–	–	−0.0001	0.0006	0.4445
212	Articles of paper and paperboard	−0.0001	0.0001	0.6265	0.0011[a]	0.0085	0.7753
221	Publishing	0.0010[a]	0.0491	0.6984	0.0004[a]	0.0535	0.7313
222	Printing	0.0026[a]	0.0667	0.6038	0.0015[a]	0.0107	0.7345
241	Production of basic chemicals	0.0003	0.0104	0.5634	0.0002	0.0104	0.7651
243	Paints, varnishes, inks, and mastics	−0.0031	0.0745	0.5441	–	–	–
244	Pharma., med. chemicals, botanical prod	0.0007[a]	0.0157	0.8952	0.0001	0.0019	0.7274
245	Soap and deterg, and perfumes and toilet prep	–	–	–	0.0000	0.0001	0.6974
246	Other chemical products	0.0002	0.0008	0.5985	0.0009[a]	0.0444	0.7232
251	Rubber products	0.0009	0.0094	0.6536	–	–	–
252	Plastic products	0.0015[a]	0.0333	0.6604	0.0002	0.0006	0.7142
263	Ceramic goods for construction	0.0030[a]	0.1226	0.6484	–	–	–
266	Concrete, plaster, and cement	0.0011[a]	0.0118	0.6197	0.0025[a]	0.1003	0.7072
267	Cutting, shaping, and finishing of stone	0.0020[a]	0.0742	0.6633	–	–	–
275	Casting of metals	0.0024[a]	0.0325	0.5464	–	–	–
281	Structural metal products	0.0024[a]	0.0213	0.7133	0.0015	0.0045	0.6871
284	Forging, pressing, stamping of metal	0.0026[a]	0.0621	0.5928	0.0029[a]	0.0379	0.6902

(continued)

Table 7 Continued

NACE	Sector	Italy			France		
		$\hat{\alpha}$	S^2_{YX}	R^2	$\hat{\alpha}$	S^2_{YX}	R^2
285	Treatment and coating of metals	0.0040[a]	0.0902	0.7124	–	–	–
286	Cutlery, tools, and general hardware	0.0002	0.0003	0.6131	0.0019[a]	0.0213	0.7240
287	Other fabricated metal products	0.0019[a]	0.0332	0.6663	–	–	–
291	Machinery for prod and use of mech. power	0.0011[a]	0.0148	0.6681	−0.0007	0.0042	0.6751
292	Other general purpose machinery	0.0024[a]	0.0521	0.6547	0.0022[a]	0.0272	0.7251
293	Agricultural and forestry machinery	–	–	–	0.0037[a]	0.0539	0.6998
294	Machine tools	0.0042[a]	0.1308	0.7345	0.0027	0.0194	0.8444
295	Other special purpose machinery	0.0018[a]	0.0180	0.6049	0.0034[a]	0.0596	0.7592
297	Domestic appliances not e/where class	−0.0009	0.0091	0.7017	–	–	–
311	Electric motors, generators and transform	0.0014	0.0160	0.7934	0.0059[a]	0.0863	0.7617
312	Manuf. of electricity distrib. control equip	0.0001	0.0001	0.7530	0.0001	0.0000	0.8215
316	Electrical equipment not e/where class	0.0043[a]	0.1525	0.6848	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	0.0011	0.0091	0.8189
332	Measuring, checking, testing, and navigat app.	–	–	–	0.0012	0.0039	0.8032
333	Industrial process control equipment	–	–	–	0.0047[a]	0.0832	0.8254
343	Production of spare parts for cars	0.0046[a]	0.0759	0.2681	–	–	–
361	Furniture	0.0014[a]	0.0111	0.6036	0.0025[a]	0.0206	0.8211
362	Jewelry and related articles	0.0011	0.0115	0.6238	–	–	–
366	Miscellaneous manufact. not elsewhere class	0.0010	0.0120	0.6372	0.0000	0.0007	0.7118
34	Motor vehicles, trailers, and semi-trailers	0.0039[a]	0.0592	0.3224	0.0010	0.3529	0.6997
	S^2_{YX} statistics	AVG	MIN	MAX	AVG	MIN	MAX
		0.0399	0.0001	0.1525	0.0347	0.0000	0.3529

[a]Coefficient significant at 5% confidence level.

Table 8 Multi-year averages: productivity and profitability—Fixed Effects estimates of Equation (9)

		Italy			France		
NACE	Sector	$\hat{\alpha}$	S^2_{YX}	R^2	$\hat{\alpha}$	S^2_{YX}	R^2
151	Production, process, and preserv. of meat	0.0019[a]	0.3053	0.8893	–	–	–
155	Dairy products	0.0015[a]	0.2923	0.7367	–	–	–
158	Prod. of other food (bread, sugar, etc.)	0.0022[a]	0.4965	0.9243	–	–	–
159	Beverages (alcoholic and not)	0.0020[a]	0.5558	0.7913	–	–	–
171	Preparation and spinning of textiles	0.0034[a]	0.3374	0.8690	0.0004[a]	0.0262	0.6912
172	Textiles weaving	0.0024[a]	0.3268	0.8772	0.0004[a]	0.0900	0.7940
175	Carpets, rugs, and other textiles	0.0031[a]	0.4643	0.8174	0.0001[a]	0.0066	0.7600
177	Knitted and crocheted articles	0.0029[a]	0.2036	0.7825	–	–	–
182	Wearing apparel	0.0032	0.0515	0.7163	0.0009[a]	0.0546	0.8153
193	Footwear	0.0034[a]	0.1362	0.7146	0.0032[a]	0.1756	0.8210
203	Wood products for construction	0.0040[a]	0.4101	0.8417	–	–	–
204	Wooden containers	–	–	–	0.0035[a]	0.5586	0.8166
211	Pulp, paper, and paperboard	–	–	–	0.0026[a]	0.5860	0.8953
212	Articles of paper and paperboard	0.0020[a]	0.4259	0.8906	0.0028[a]	0.4408	0.8432
221	Publishing	0.0022[a]	0.4649	0.8895	0.0001[a]	0.0220	0.8771
222	Printing	0.0027[a]	0.3654	0.8331	0.0026[a]	0.6113	0.8444
241	Production of basic chemicals	0.0008[a]	0.1287	0.8820	0.0003[a]	0.0885	0.8618
243	Paints, varnishes, inks, and mastics	0.0020[a]	0.3350	0.9589	–	–	–
244	Pharma., med. chemicals, botanical prod	0.0006[a]	0.1142	0.6978	0.0001	0.0008	0.6043
245	Soap and deterg and perfumes and toilet prep	–	–	–	0.0001[a]	0.0336	0.8030
246	Other chemical products	0.0019[a]	0.4896	0.7408	0.0003[a]	0.0306	0.9035
251	Rubber products	0.0030[a]	0.4475	0.9004	–	–	–
252	Plastic products	0.0020[a]	0.2614	0.8723	0.0005[a]	0.0038	0.9740
263	Ceramic goods for construction	0.0026[a]	0.3370	0.8280	–	–	–
266	Concrete, plaster, and cement	0.0015[a]	0.1616	0.8564	0.0005[a]	0.0322	0.8499
267	Cutting, shaping, and finishing of stone	0.0015[a]	0.1808	0.8133	–	–	–
275	Casting of metals	0.0033[a]	0.4852	0.8533	–	–	–
281	Structural metal products	0.0036[a]	0.3468	0.8640	0.0040[a]	0.6322	0.8671
284	Forging, pressing, stamping, of metal	0.0032[a]	0.4178	0.7814	0.0041[a]	0.5007	0.9136

(continued)

Table 8 Continued

NACE	Sector	Italy $\hat{\alpha}$	Italy S^2_{YX}	Italy R^2	France $\hat{\alpha}$	France S^2_{YX}	France R^2
285	Treatment and coating of metals	0.0050[a]	0.6199	0.8630	–	–	–
286	Cutlery, tools, and general hardware	0.0037[a]	0.3810	0.8407	0.0051[a]	0.7388	0.8655
287	Other fabricated metal products	0.0037[a]	0.5749	0.8602	–	–	–
291	Machinery for prod. and use of mech. power	0.0040[a]	0.6019	0.8118	0.0027[a]	0.3717	0.8760
292	Other general purpose machinery	0.0026[a]	0.2514	0.9167	0.0039[a]	0.5323	0.8240
293	Agricultural and forestry machinery	–	–	–	0.0040[a]	0.4003	0.9184
294	Machine tools	0.0031[a]	0.5748	0.8658	0.0056[a]	0.1825	0.9724
295	Other special purpose machinery	0.0032[a]	0.4399	0.8565	0.0049[a]	0.6987	0.8742
297	Domestic appliances not e/where class	0.0022[a]	0.4149	0.8509	–	–	–
311	Electric motors, generators, and transform	0.0032[a]	0.6548	0.8547	0.0047[a]	0.4780	0.8877
312	Manuf. of electricity distrib, control equip	0.0037[a]	0.6102	0.9252	0.0024[a]	0.2654	0.8888
316	Electrical equipment not e/where class	0.0026[a]	0.4285	0.9064	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	0.0027[a]	0.1784	0.9223
332	Measuring, checking, testing, and navigat app.	–	–	–	0.0039[a]	0.3813	0.8708
333	Industrial process control equipment	–	–	–	0.0034[a]	0.4914	0.8533
343	Production of spare parts for cars	0.0204	0.0162	0.3375	–	–	–
361	Furniture	0.0028[a]	0.2652	0.8346	0.0051[a]	0.5101	0.8858
362	Jewelry and related articles	0.0031[a]	0.4965	0.7477	–	–	–
366	Miscellaneous manufact. not elsewhere class	0.0036[a]	0.5801	0.8253	0.0000	0.0044	0.7429
34	Motor vehicles, trailers, and semi-trailers	0.0169	0.0140	0.3370	0.0016[a]	0.0684	0.9985
	S^2_{YX} statistics	AVG	MIN	MAX	AVG	MIN	MAX
		0.3639	0.0140	0.6548	0.2716	0.0008	0.7388

[a]Coefficient significant at 5% confidence level.

Table 9 Multi-year averages: profitability and growth—Fixed Effects estimates of Equation (10)

NACE	Sector	Italy $\hat{\alpha}$	Italy S^2_{YX}	Italy R^2	France $\hat{\alpha}$	France S^2_{YX}	France R^2
151	Production, process, and preserv. of meat	0.3948[a]	0.0308	0.7203	–	–	–
155	Dairy products	−0.4148[a]	0.0363	0.6239	–	–	–
158	Prod. of other food (bread, sugar, etc.)	0.2372[a]	0.0071	0.6193	–	–	–
159	Beverages (alcoholic and not)	−0.7192[a]	0.1357	0.6456	–	–	–
171	Preparation and spinning of textiles	−0.2303	0.0083	0.4756	0.2802[a]	0.0189	0.7337
172	Textiles weaving	0.3926[a]	0.0329	0.6280	0.7447[a]	0.0499	0.8593
175	Carpets, rugs, and other textiles	0.3471[a]	0.0494	0.5968	−0.0667	0.0017	0.8442
177	Knitted and crocheted articles	0.2192[a]	0.0220	0.7266	–	–	–
182	Wearing apparel	0.0394	0.0016	0.7160	0.5176[a]	0.1141	0.7844
193	Footwear	0.2886[a]	0.0116	0.6312	1.1300[a]	0.1192	0.7705
203	Wood products for construction	0.5587[a]	0.0441	0.6611	–	–	–
204	Wooden containers	–	–	–	0.5559[a]	0.0462	0.7836
211	Pulp, paper, and paperboard	–	–	–	−0.3544[a]	0.1010	0.4529
212	Articles of paper and paperboard	0.9324[a]	0.1185	0.6474	0.4375[a]	0.0249	0.7792
221	Publishing	0.2346[a]	0.0218	0.6921	0.0107	0.0046	0.7256
222	Printing	0.6338[a]	0.0645	0.6076	0.4789[a]	0.0258	0.7375
241	Production of basic chemicals	−0.0145	0.0001	0.5842	0.2872[a]	0.0666	0.7707
243	Paints, varnishes, inks, and mastics	1.4104[a]	0.0641	0.5525	–	–	–
244	Pharma., med. chemicals, botanical prod	0.1661[a]	0.0036	0.8920	−0.2391[a]	0.3285	0.8312
245	Soap and deterg and perfumes and toilet prep	–	–	–	0.6632[a]	0.0899	0.7084
246	Other chemical products	1.6332[a]	0.3780	0.7114	0.7734[a]	0.1199	0.7264
251	Rubber products	0.4371[a]	0.0413	0.6836	–	–	–
252	Plastic products	0.2268[a]	0.0106	0.6574	0.1400	0.0203	0.7107
263	Ceramic goods for construction	0.2111	0.0104	0.6237	–	–	–
266	Concrete, plaster, and cement	0.0801	0.0007	0.6338	0.3134	0.0128	0.7036
267	Cutting, shaping, and finishing of stone	0.5938[a]	0.1021	0.6833	–	–	–
275	Casting of metals	−0.0803	0.0008	0.5501	–	–	–
281	Structural metal products	0.2752[a]	0.0085	0.7121	0.6330[a]	0.0188	0.6901
284	Forging, pressing, stamping of metal	−0.2829[a]	0.0186	0.5877	0.5110[a]	0.0391	0.6916

(continued)

Table 9 Continued

NACE	Sector	Italy $\hat{\alpha}$	Italy S^2_{YX}	Italy R^2	France $\hat{\alpha}$	France S^2_{YX}	France R^2
285	Treatment and coating of metals	0.7119[a]	0.1100	0.7277	–	–	–
286	Cutlery, tools, and general hardware	0.5823[a]	0.1005	0.6463	0.3760[a]	0.0272	0.7282
287	Other fabricated metal products	0.5104[a]	0.0445	0.6714	–	–	–
291	Machinery for prod. and use of mech. power	0.4656[a]	0.0540	0.6779	−0.0646	0.0008	0.6748
292	Other general purpose machinery	0.4216[a]	0.0250	0.6529	0.2509[a]	0.0101	0.7235
293	Agricultural and forestry machinery	–	–	–	1.0035[a]	0.1595	0.7203
294	Machine tools	0.6531[a]	0.0500	0.7286	0.4937[a]	0.1253	0.8467
295	Other special purpose machinery	0.3336[a]	0.0128	0.6067	0.4594[a]	0.0418	0.7600
297	Domestic appliances not e/where class	−0.7356[a]	0.0723	0.7156	–	–	–
311	Electric motors, generators and transform	0.5501[a]	0.0387	0.8035	1.0222[a]	0.1251	0.7690
312	Manuf. of electricity distrib. control equip.	−0.0082	0.0000	0.7418	0.4016	0.3727	0.8648
316	Electrical equipment not e/where class	0.4452[a]	0.0280	0.6755	–	–	–
331	Medical and surgical equip. orthopedic appl	–	–	–	0.1021	0.0044	0.8181
332	Measuring, checking, testing, and navigat app.	–	–	–	0.4727[a]	0.0252	0.8087
333	Industrial process control equipment	–	–	–	0.4387[a]	0.1277	0.8335
343	Production of spare parts for cars	0.0760[a]	0.6714	0.7043	–	–	–
361	Furniture	0.3311[a]	0.0141	0.6055	0.4675[a]	0.0366	0.8252
362	Jewelry and related articles	0.2261	0.0079	0.6269	–	–	–
366	Miscellaneous manufact. not elsewhere class	0.5076[a]	0.0585	0.6568	0.8539[a]	0.1108	0.7386
34	Motor vehicles, trailers, and semi-trailers	0.0761[a]	0.5771	0.6951	0.0002[a]	0.0694	0.6659
	S^2_{YX} statistics	AVG	MIN	MAX	AVG	MIN	MAX
		0.0761	0.0000	0.6714	0.0718	0.0008	0.3727

[a]Coefficient significant at 5% confidence level.

concerning the relation between average growth and average profitability. The estimates tend to be positive and significant, with the fraction of sectors displaying statistical significance rising up to 2/3. Still, comparisons of $S^2_{Y,X}$ with R^2 once again highlight that the strength of the relationships is low. With few exceptions, the small values of $S^2_{Y,X}$ (about 0.08 on average) imply that profitability can hardly contribute to more than 5–10% to the overall explanatory power of the model captured by the R^2 (actually much less in most of the sectors).

Summarizing, results are quite in accordance with what we find in the case of contemporaneous estimates. The productivity–profitability link turns out to be the only one where the explanatory power of the 'systematic economic regressor' is comparable with, or even higher than, that coming from firm-specific terms. Conversely, selection mechanisms are at best weak along the productivity–growth and the profitability–growth links. Such patterns do not display striking differences between the two countries and, despite some variations, tend to apply quite generally across sectors. Moreover, as found in the case of contemporaneous yearly regression, estimates do not vary significantly if we compare the estimated effects across groups of sectors corresponding to the different classes identified by taxonomies on ICT intensity, skill composition of the labor force, and patterns of innovation.

5. A weak selective hand of market competition? Some conclusions

The micro evidence presented in this work reinforces the robust stylized fact on widespread and persistent inter-firm heterogeneity revealed by widely different degrees of efficiencies. Such evidence is also well in tune with an evolutionary notion of idiosyncratic learning, innovation (or lack of it), and adaptation. Heterogeneous firms compete with each other and, given (possibly firm- or location-specific) input and output prices, obtain different returns. Putting it in a different language, they obtain different "quasi-rent" or, conversely, losses above/below the notional "pure competition" profit rates. At the same time, market selection among firms—the other central mechanism at work, together with firm-specific learning, in evolutionary interpretations of economic change—does not seem to be particularly powerful, at least on the yearly or multi-yearly time scale at which statistics are reported (the available time series are not long enough to assess what happens in the very long run, say decades). Diverse degrees of efficiencies seem to yield primarily relatively persistent profitability differentials. That is, markets do not appear to be too effective selectors delivering rewards and punishments in terms of relative sizes or shares according to differential efficiencies. Moreover, the absence of any strong relationship between profitability and growth militates against the "naively Schumpeterian" or "classic" notion that profits feed growth (by plausibly feeding investments).

Selection amongst different variants of a technology, different vintages of equipment, different lines of production does occur, and is a major driver of industrial dynamics. However, it seems to occur, to a good extent, within firms, driven by the implementation of "better" processes of production and the abandonment of older less productive ones. Finally, the same evidence appears to run against the conjecture, put forward in the 1960s and 1970s by the managerial theories of the firm on a trade-off between profitability and growth with managerialized firms trying to maximize growth subject to a minimum profit constraint.[20]

Note that weakness of differential efficiency as direct or indirect driver of differential growth and inter-firm reallocation of resources, as we have shown, robustly applies across different industrial sectors and across countries—in our case Italy and France—characterized by quite different institutional set-ups and forms of industrial organization. In turn, the observation that market selection that winnows directly on firms may play less of a role than that assumed in many models (of heterogeneous inspiration) demands further advances in the understanding of how markets work (or do not), and of the structure of demand. Here note the following.

First, one measures efficiency—supposedly a driver of differential selection—very imperfectly: we have already mentioned, as emphasized by Foster *et al.* (2008), that one ought to disentangle the price component of value added (and thus the price effect upon competitiveness) from physical efficiency to which productivity strictly speaking refers. This applies to homogeneous products and even more so when products differ in their characteristics and performances: as this is often the case in modern industries, one ought to explicitly account for the impact of the latter upon competitiveness and revealed selection processes.

Second, but relatedly, the notion of generalized inter-industry competition is too heroic to hold. It might be more fruitful in many industries to think of different sub-market of different sizes as the locus of competition (cf. Sutton, 1998). The characteristics and size of such sub-markets offer also different constraints and opportunities for corporate growth. Ferrari and Fiat operate in different sub-markets, face different growth opportunities and do not compete with each other. However, the example is interesting also in another respect: Fiat can grow, as it actually happened, by acquiring Ferrari. But such a dynamics has little bearing on the relative initial productivities of Fiat and Ferrari.

Third, in any case, the links between efficiency (and innovation), on the one hand, and corporate growth, on the other, are likely to be profoundly mediated by large degrees of behavioral freedom, in terms, e.g. of propensities to invest, export, expand abroad, pricing strategies, and patterns of diversification. In fact, such degrees of

[20]In fact the absence of such a trade-off had been already noted by Barna (1962). Note also that this proposition is compatible with the finding (cf. Geroski *et al.*, 1997) that current growth appears to be correlated with future long-term profitability.

behavioral freedom can only be possible if market interactions occur over "selection landscapes" which are roughly flat over significant intervals. In turn, such a "flatness" is likely to be the consequence of various forms of market imperfections—including informational ones. Such imperfections, together with endemic satisficing behaviors, would allow firms characterized by diverse degrees of efficiency (and product qualities) to co-exist without too much competitive pressures.

The broad patterns discussed in this work need to be corroborated with evidence from other countries and on longer time periods. And, at least equally important, they have to be matched by complementary evidence on the impact of entry and exit. However, were they to hold, they would bear far-reaching implications for theory, empirical analysis, and polices. On the side of both theory and empirical investigations, much more work awaits to be done on how markets work, the nature of competitive interactions, and the dimensions over which competitive selection occurs, if any. On the policy side, a much more sobering view might have to be taken on the "magic of market competition". It could well be that policy measures aimed at *creative accumulation* of technological knowledge and equipment might be more effective in fostering progress than trying to wag the forces of *creative destruction*. Together, if proved robust, our evidence on the negligible impact of profit margins upon growth takes away a lot of plausibility from the argument that taxing profits is bad for the economy because it harms growth. Rather, corporate growth seems to be driven much more by elusive and idiosyncratic "animal spirits".

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Appendix A

A.1. Sectoral productivity decomposition

For completeness, we present here results of productivity decomposition analysis broken down by each industry, pooling over time. Table A1 reports figures obtained by weighting firm-level productivities with employment shares, while in Table A2 weights are measured as shares of sales.

Appendix B

B.1. Sectoral taxonomies

Table B1 shows how the sectors included by us in the analysis are classified according to the taxonomies presented in O'Mahony and Van Ark (2003). These taxonomies try to capture in different ways the technological characteristics of sectors, and can

Table A1 Decomposition of productivity growth by sector—within, between, and interaction effects, employment weights

		Italy			France		
NACE	Sector	With.(%)	Bet.(%)	Int.(%)	With.(%)	Bet.(%)	Int.(%)
151	Production, process, and preserv. of meat	87.57	2.48	9.95	–	–	–
155	Dairy products	91.74	−22.97	31.23	–	–	–
158	Prod. of other food (bread, sugar, etc.)	96.57	80.63	−77.21	–	–	–
159	Beverages (alcoholic and not)	107.07	−14.39	7.32	–	–	–
171	Preparation and spinning of textiles	104.27	−5.86	1.59	111.16	−7.33	−3.83
172	Textiles weaving	89.82	24.01	−13.82	−52.41	3.92	148.49
175	Carpets, rugs, and other textiles	94.09	14.34	−8.43	150.35	−76.53	26.18
177	Knitted and crocheted articles	93.73	35.11	−28.85	–	–	–
182	Wearing apparel	88.81	−99.84	111.03	−234.83	672.76	−337.93
193	Footwear	180.25	−131.65	51.40	103.23	−5.14	1.91
203	Wood products for construction	75.23	43.00	−18.24	–	–	–
204	Wooden containers	–	–	–	113.98	−12.12	−1.86
211	Pulp, paper, and paperboard	–	–	–	99.33	25.75	−25.08
212	Articles of paper and paperboard	95.42	−13.17	17.75	99.76	1.65	−1.41
221	Publishing	100.59	−148.28	147.69	−85.73	−135.56	321.30
222	Printing	124.87	−7.86	−17.00	94.11	7.68	−1.79
241	Production of basic chemicals	88.86	45.73	−34.59	109.32	7.42	−16.74
243	Paints, varnishes, inks, and mastics	59.41	38.76	1.83	–	–	–
244	Pharma., med. chemicals, botanical prod	116.58	21.61	−38.19	45.18	9.42	45.40
245	Soap and deterg and perfumes and toilet prep	–	–	–	−604.58	−273.29	977.87
246	Other chemical products	113.73	−6.90	−6.84	90.23	25.11	−15.35
251	Rubber products	84.22	−7.92	23.69	–	–	–
252	Plastic products	88.79	−11.97	23.18	92.56	16.97	−9.53
263	Ceramic goods for construction	107.07	−37.45	30.38	–	–	–
266	Concrete, plaster, and cement	311.65	744.86	−956.51	154.61	38.22	−92.82
267	Cutting, shaping, and finishing of stone	−240.02	918.20	−578.19	–	–	–
275	Casting of metals	54.99	43.91	1.09	–	–	–
281	Structural metal products	103.18	−40.94	37.76	107.87	21.93	−29.80

(continued)

Table A1 Continued

NACE	Sector	Italy With.(%)	Italy Bet.(%)	Italy Int.(%)	France With.(%)	France Bet.(%)	France Int.(%)
284	Forging, pressing, stamping, of metal	102.76	−14.52	11.76	117.42	−41.74	24.31
285	Treatment and coating of metals	33.38	20.57	46.05	–	–	–
286	Cutlery, tools and general hardware	69.73	153.00	−122.73	73.75	−24.33	50.57
287	Other fabricated metal products	91.26	−16.33	25.07	–	–	–
291	Machinery for prod. and use of mech. power	95.66	−34.30	38.64	100.35	11.79	−12.14
292	Other general purpose machinery	272.01	−725.11	553.10	89.83	23.51	−13.34
293	Agricultural and forestry machinery	–	–	–	109.11	8.09	−17.20
294	Machine tools	130.91	204.43	−235.34	110.11	−15.12	5.01
295	Other special purpose machinery	102.93	−20.86	17.92	94.86	2.60	2.54
297	Domestic appliances not e/where class	24.86	24.33	50.81	–	–	–
311	Electric motors, generators and transform	35.86	29.65	34.49	94.50	22.32	−16.82
312	Manuf. of electricity distrib, control equip	248.46	−18.08	−130.38	103.90	−5.85	1.96
316	Electrical equipment not e/where class	57.92	7.51	34.57	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	100.64	14.57	−15.21
332	Measuring, checking, testing, and navigat app.	–	–	–	111.59	−10.25	−1.35
333	Industrial process control equipment	–	–	–	−10.97	−127.31	238.28
343	Production of spare parts for cars	108.38	44.06	−52.45	–	–	–
361	Furniture	95.86	10.13	−5.99	93.01	35.11	−28.12
362	Jewelry and related articles	570.46	93.61	−564.06	–	–	–
366	Miscellaneous manufact. not elsewhere class	135.30	−0.16	−35.14	295.42	−352.35	156.92
34	Motor vehicles, trailers, and semi-trailers	120.13	6.20	−26.34	61.19	84.83	−46.02

Table A2 Decomposition of productivity growth by sector—within, between and interaction effects, sales weights

		Italy			France		
NACE	Sector	With.(%)	Bet.(%)	Int.(%)	With.(%)	Bet.(%)	Int.(%)
151	Production, process, and preserv. of meat	77.43	15.94	6.63	–	–	–
155	Dairy products	36.44	9.85	53.71	–	–	–
158	Prod. of other food (bread, sugar, etc.)	1060.56	−991.83	31.28	–	–	–
159	Beverages (alcoholic and not)	−162.35	585.59	−323.24	–	–	–
171	Preparation and spinning of textiles	−25.06	−23.14	148.19	85.28	−17.99	32.71
172	Textiles weaving	94.82	5.10	0.08	−113.76	−167.61	381.37
175	Carpets, rugs, and other textiles	112.83	−9.64	−3.19	47.33	−4.27	56.94
177	Knitted and crocheted articles	105.90	13.40	−19.30	–	–	–
182	Wearing apparel	158.47	−49.50	−8.97	116.14	−8.89	−7.25
193	Footwear	66.06	3.40	30.54	59.38	−15.68	56.30
203	Wood products for construction	145.71	−87.60	41.89	–	–	–
204	Wooden containers	–	–	–	114.88	−35.30	20.41
211	Pulp, paper and paperboard	–	–	–	97.13	1.47	1.40
212	Articles of paper, and paperboard	125.93	0.07	−26.00	94.66	−2.13	7.47
221	Publishing	126.72	−10.29	−16.43	15.16	−52.92	137.76
222	Printing	92.07	63.58	−55.65	66.72	−46.79	80.08
241	Production of basic chemicals	82.38	5.73	11.89	165.71	−37.20	−28.52
243	Paints, varnishes, inks, and mastics	93.30	−7.10	13.81	–	–	–
244	Pharma., med. chemicals, botanical prod	57.07	−8.34	51.26	57.11	50.00	−7.11
245	Soap and deterg and perfumes and toilet prep	–	–	–	55.71	15.44	28.84
246	Other chemical products	237.26	−105.70	−31.56	72.73	6.62	20.64
251	Rubber products	109.82	−10.41	0.59	–	–	–
252	Plastic products	89.78	1.28	8.95	97.31	−28.00	30.70
263	Ceramic goods for construction	37.27	−35.12	97.85	–	–	–
266	Concrete, plaster, and cement	97.12	4.76	−1.88	376.93	27.22	−304.15
267	Cutting, shaping, and finishing of stone	949.55	−366.76	−482.79	–	–	–
275	Casting of metals	69.83	−28.36	58.53	–	–	–
281	Structural metal products	708.61	378.03	−986.64	121.83	88.92	−110.75

(continued)

Table A2 Continued

NACE	Sector	Italy With.(%)	Italy Bet.(%)	Italy Int.(%)	France With.(%)	France Bet.(%)	France Int.(%)
284	Forging, pressing, stamping of metal	152.29	−44.37	−7.92	−42.07	−37.59	179.66
285	Treatment and coating of metals	18.00	−117.06	199.07	–	–	–
286	Cutlery, tools and general hardware	82.04	−24.99	42.95	126.22	1.16	−27.38
287	Other fabricated metal products	−107.86	−23.90	231.76	–	–	–
291	Machinery for prod. and use of mech. power	830.16	−761.11	30.95	41.10	21.70	37.20
292	Other general purpose machinery	−75.65	−129.13	304.79	163.26	60.25	−123.52
293	Agricultural and forestry machinery	–	–	–	65.27	5.25	29.48
294	Machine tools	125.43	3.62	−29.05	100.96	−6.21	5.25
295	Other special purpose machinery	88.12	25.64	−13.77	115.91	77.28	−93.18
297	Domestic appliances not e/where class	294.49	−96.13	−98.36	–	–	–
311	Electric motors, generators and transform	74.69	−4.12	29.42	−284.35	187.72	196.63
312	Manuf. of electricity distrib. control equip	23.92	129.93	−53.85	60.99	2.06	36.95
316	Electrical equipment not e/where class	111.00	13.33	−24.33	–	–	–
331	Medical and surgical equip, orthopedic appl	–	–	–	96.62	38.18	−34.80
332	Measuring, checking, testing, and navigat app.	–	–	–	66.97	8.96	24.07
333	Industrial process control equipment	–	–	–	38.26	−110.57	172.31
343	Production of spare parts for cars	175.34	−13.83	−61.51	–	–	–
361	Furniture	72.86	−18.22	45.36	−86.62	−62.80	249.42
362	Jewelry and related articles	37.64	33.99	28.37	–	–	–
366	Miscellaneous manufact. not elsewhere class	111.22	−22.89	11.67	79.35	20.55	0.10
34	Motor vehicles, trailers, and semi-trailers	249.57	−12.70	−136.87	−244.88	330.90	13.97

Table B1 Sectoral taxonomies for selected 3-Digit industries

NACE	SECTOR	Taxonomy classes		
		I-ICT classes	II-Skill classes	III-Pavitt classes
151	Production, process, and preserv. of meat	N-ICT	LS	SI
155	Dairy products	N-ICT	LS	SI
158	Prod. of other food (bread, sugar, etc.)	N-ICT	LS	SI
159	Beverages (alcoholic and not)	N-ICT	LS	SI
171	Preparation and spinning of textiles	N-ICT	LS	SD
172	Textiles weaving	N-ICT	LS	SD
175	Carpets, rugs, and other textiles	N-ICT	LS	SD
177	Knitted and crocheted articles	N-ICT	LS	SD
182	Wearing apparel	ICT-U	LS	SD
193	Footwear	N-ICT	LS	SD
203	Wood products for construction	N-ICT	LIS	SD
204	Wooden containers	N-ICT	LIS	SD
211	Pulp, paper, and paperboard	N-ICT	LIS	SI
212	Articles of paper and paperboard	N-ICT	LIS	SD
221	Publishing	ICT-U	LIS	SD
222	Printing	ICT-U	LIS	SD
241	Production of basic chemicals	N-ICT	HS	SI
243	Paints, varnishes, inks, and mastics	N-ICT	HS	SI
244	Pharma., med. chemicals, botanical prod	N-ICT	HS	SB
245	Soap and deterg and perfumes and toilet prep	N-ICT	HS	SI
246	Other chemical products	N-ICT	HS	SI
251	Rubber products	N-ICT	LS	SD
252	Plastic products	N-ICT	LS	SD
263	Ceramic goods for construction	N-ICT	LS	SI
266	Concrete, plaster, and cement	N-ICT	LS	SD
267	Cutting, shaping, and finishing of stone	N-ICT	LS	SD
275	Casting of metals	N-ICT	LS	SI
281	Structural metal products	N-ICT	LIS	SD
284	Forging, pressing, stamping of metal	N-ICT	LIS	SI
285	Treatment and coating of metals	N-ICT	LIS	SD
286	Cutlery, tools and general hardware	N-ICT	LIS	SD
287	Other fabricated metal products	N-ICT	LIS	SD
291	Machinery for prod. and use of mech. power	ICT-U	LIS	SS
292	Other general purpose machinery	ICT-U	LIS	SS
293	Agricultural and forestry machinery	ICT-U	LIS	SI
294	Machine tools	ICT-U	LIS	SS

(continued)

Table B1 Continued

NACE	SECTOR	Taxonomy classes		
		I-ICT classes	II-Skill classes	III-Pavitt classes
295	Other special purpose machinery	ICT-U	LIS	SS
297	Domestic appliances not e/where class	ICT-U	LIS	SI
311	Electric motors, generators and transform	ICT-U	LIS	SS
312	Manuf. of electricity distrib. control equip	ICT-U	LIS	SS
316	Electrical equipment not e/where class	ICT-U	LIS	SS
331	Medical and surgical equip. orthopedic appl	ICT-P	HIS	SB
332	Measuring, checking, testing, and navigat app.	ICT-P	HIS	SB
333	Industrial process control equipment	ICT-P	HIS	SB
343	Production of spare parts for cars	N-ICT	LS	SI
361	Furniture	ICT-U	LS	SD
362	Jewelry and related articles	ICT-U	LS	SD
366	Miscellaneous manufact. not elsewhere class	ICT-U	LS	SI
34	Motor vehicles, trailers, and semi-trailers	N-ICT	LS	SI

be usefully taken as a meaningful guidance to compare estimates across sectors sharing similar characteristics. Taxonomy-I looks at the role of Information and Communication Technologies (ICT). Following OECD (2002), three types of industries are identified, based on sectoral ICT intensities in the United States (with ICT intensity defined as the share of ICT capital on total capital stock of a sector): ICT producing (ICT-P), ICT using (ICT-U), and non-ICT (N-ICT) sectors. Taxonomy-II distinguishes sectors according to the relative intensity of skilled and unskilled labor force, based on an integration of United States, UK, and Eurostat skills classifications. Four classes are defined: Low Skilled (LS), Low-Intermediate Skilled (LIS), High-Intermediate Skilled (HIS), and High Skilled (HS). Finally, Taxonomy-III considers sectoral patterns of innovation. Based on the early work of Pavitt (1984), one identifies four groups: Science Based (SB), Specialized Supplier (SS), Scale Intensive (SI), and Supplier Dominated (SD) industries. Original Pavitt's classification employed in O'Mahony and Van Ark (2003) straightforwardly applies to 2-Digit industries. Here, we extend to 3-Digit sectors drawing from Marsili (2001) and Dosi *et al.* (2008).