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The productivity puzzle: firms, workers, and industry characteristics

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Abstract

Labor productivity is recognized as the key driver of economic growth. Its current dynamics reveals contrasting patterns in that, although technology improved over the last two decades, productivity has not grown accordingly. For this reason, it is worth understanding the significance and the magnitude of firms' labor productivity determinants to gauge possible aggregate effects at the industry and economy-wide levels. Therefore, we assess the extent of different drivers of firm productivity by using a novel firm-worker database for Italy. We can, accordingly, estimate the impact of workers' human capital, age, and occupational status, together with industry technological level and other firm-specific characteristics. We find that these factors are significant, but a more relevant role is played by the ability to compete in international markets together with firm size. These two latter factors thus explain the poor performance of the Italian aggregate productivity and suggest how a firm's ability to grow and its internationalization are generally critical drivers of labor productivity.

Keywords: Productivity, Matched employer-employee data,
Production function
JEL Classification: J24, O4

1. Introduction

It is well established that labor productivity growth is a crucial factor affecting an economy's long-run growth path. Aggregate neoclassical models typically refer to exogenous technical progress that enhances labor efficiency and, through this route, output growth rate. Endogenous growth models endogenize productivity, assuming a crucial role of either human capital (Lucas 1988), physical capital (Rebelo, 1991), or R&D (Romer, 1990; Jones, 2002).

A different perspective is taken by those approaches inspired by the seminal work by Verdoorn (1980), in which productivity results from changes in aggregate demand and, therefore, output growth. However, this latter is strictly related to new investments, mainly machinery and equipment (Schmookler, 1966) that incorporate new technologies. Therefore, following this demand-side approach, technological change and productivity in the sector producing new machinery are crucial in affecting output growth (De Long and Summers, 1991, Baussola, 2000).

The economic outcomes challenged the predictions resulting from such macro models over the last 60 years. Indeed, the neoclassical Solow model well described economic growth within the group of advanced industrialized countries until the first oil shock. Afterward, the so-called declining productivity growth puzzle emerged at a time when the diffusion of information and communication technology increased significantly.

In this new scenario, endogenous growth models tried to fill the interpretative gap left behind by the traditional models. These approaches stimulated macro but also microeconomic empirical analysis to ascertain the validity of the implied assumptions and conclusions. However, even in the '90s and the 2000s the pattern of labor productivity was unsatisfactory and not aligned with the evolution of the digital revolution.

For these reasons, it is relevant to use microeconomic investigations of firms' labor productivity intensity, focusing mainly on input quality in driving differences in firms' productivity. Our investigation falls within the debate on the determinants of labor productivity and focuses on the Italian economy, characterized by structural stagnation of labor productivity over the last two decades. We consider the period 2012-2017, characterized by the impact of the Euro Area sovereign debt crisis and, therefore, by stagnant GDP growth. However, it is relevant to analyze the drivers of productivity even in such a framework, as their impact will be more significant *a fortiori* once the economy is normalized.

We use a unique and extensive data set that enables us to contribute to such a debate by measuring the impact of firm-specific characteristics and taking into account industry-specific features, i.e., their technological level. Therefore, we aim to assess the relative impact of these variables with a more specific emphasis on a firm's attitude towards internationalization, proxied by its export attitude. For this reason, we also present estimates that endogenize firms' internationalization behavior by using a more appropriate specification. This modeling strategy enables us to explain the determinants of labor productivity at the firm level and, at the same time, rationalize the macroeconomic implications.

The paper is structured as follows. Section 2 discusses the theoretical interpretation of the productivity dynamics, focusing on the microeconometric approaches used to assess the impact of different firms' productivity specifications. Section 3 describes the data set and the stylized fact characterizing labor productivity in the Italian economy. Section 4, 5, and 6 present the empirical specification, the discussion of the baseline results, and the endogeneity and omitted variables issues, respectively. Finally, Section 7 concludes.

2. Productivity determinants and microeconometric evidence

Firm-level analysis on labour productivity has contributed significantly to understanding the mechanisms that drive economic growth. These contributions complement those macroeconomic investigations based on either growth accounting or macroeconometric test (Taylor, 2008; De Long, 2002; Oliner and Sichel, 2003) and thus help understand how companies may indeed improve their efficiency.

In the endogenous growth models, knowledge has a key role in fostering economic growth and, thus, it is considered similar to other production inputs. Knowledge has been incorporated into the aggregate production functions, alternatively, as human capital input (Lucas, 1988), fixed capital (Rebelo, 1991), or generated by a specific sector (R&D) (Romer, 1990).

Although on theoretical grounds, these representations stimulated quite a significant and comprehensive debate, on empirical grounds, the implications of these approaches are still controversial as their conclusions are somewhat difficult to reconcile with the stylized macroeconomic facts. In particular, the measurement issues are crucial, as suggested by Howitt (1996), looking specifically at the quality improvement and the obsolescence problems.

Microeconometrics have tried to overcome some of the controversies faced at the macro level by using firm data eventually matched with complementary information and considering firm and industry features to describe the level and variation of labor productivity.

In particular, the microeconometric literature linked with the analysis of innovation and technological diffusion tried to measure the impact of companies' innovative efforts on their performance measured in terms of innovation inputs (new process, or R&D expenditure) or innovation output, e.g., patents (Crépon et al., 1998). These approaches contribute to understanding productivity determinants and its dynamics. Additional investigations aimed to investigate the role of managerial practices and, generally, the attitude toward innovation to describe productivity behavior among companies (Syverson, 2011; Bartoloni and Baussola, 2018).

A great deal of attention has been devoted to the impact of human capital and occupational characteristics. Hellerstein et al. (1999) specifically estimate the impact on the productivity of different individual occupation statuses requiring different education levels.

Haltinwanger et al. (1999) show similar results in that productivity significantly differs between individuals with a higher or lower level of education. Of course, some issues may arise when considering the human capital effect. Indeed, one should consider a possible sorting effect, as more skilled (educated) workers choose more efficient firms, thus raising a simultaneity/causality issue in estimating this relation. However, appropriate data sets matching individual and firm information are required to respond to such questions adequately.

Further studies have focused on the role of human capital (Hall et al., 2003; Biagi and Parisi, 2012; Iorio and D'Amore, 2017) in combination with the recent surge in the adoption of information and communication technology (ICT). Of course, human capital measurement is not always easy and cannot be related only to the level of formal education attached to firms' employees. For this reason, additional proxies such as the professional composition of the workforce are considered in conjunction with other firm-specific variables (Kampelmann and Rycx, 2011).

Besides, the workforce characteristics have contributed to verifying the impact of individual features explicitly related to gender, race, and age (Crepon et al, 2003; Hellerstein and Neumark, 2007; Hellerstein et al., 1999; Van Our and Stoeldraijer, 2011).

Workers' age has been widely investigated. Aubert and Crepon (2007) use an extensive data set matching workers' and firms' data in the late 1990s in France. They estimate panel production functions showing increasing productivity until the age of 45 and then stabilizing afterward.

Haltinwanger et al. (1999) and Van Ours and Stoeldraijer (2011) find a more pronounced inverted U-shaped pattern that, in this latter case, implies increasing productivity until the age of 35-39 years and afterward a decreasing profile. However, such a U-shaped result is not confirmed systematically in other international estimations, as patterns showing an increasing and then steady profile are more common (Cardoso et al., 2011; Hellerstein et al., 1999).

According to these findings, we propose panel estimations of sectoral productivity that incorporate both firms, workers, and sectoral characteristics. Therefore, we estimate a model in which productivity derives from a production function in which workers' age, occupational status, and gender may be considered upward or downward productivity shifts.

Conditional on this individual worker information, firm-specific and sectoral characteristics are also considered. Firm age is expected to enter this production function equation positively. It proxies accumulated knowledge that enables a firm to improve efficiency through time (Cucculelli et al., 2014; Huergo and Jaumandreu, 2004).

Firm size is expected to positively impact productivity, although it could be the case that such an effect is non-monotonic. Of course, it could also be the case that smaller firms could be more efficient in specific sectors, i.e., those more related to new technologies (Acs and Audretsch, 1990).

We specifically consider firms' internationalization, i.e., a firm's propensity to export. Although the literature has extensively focused on internationalization attitudes as a crucial driver of a firm's productivity, it still lacks clear-cut results. In particular, the focus has been on the selection or learning effect of the firm’s export choice (Castellani, 2002; Wagner, 2002; Pattanayak and Thangavelu, 2014; Bernard and Jensen, 2004). Their results are conditional on the characteristics of the data set and the export variable used in the test (attitude dummy or intensity).

Our specification considers a firm's persistent exporting behaviour and tests whether its impact on productivity is significant, positive, and quantitively relevant. We explicitly consider the possible bias deriving by taking the export behaviour as exogenous and, therefore, we endogenize this variable thereby introducing an endogenous propensity to internationalize. This instrumental variable estimation provides more realistic estimates of the exporting attitude impact, thus tackling the bias implicit in the standard panel regression.

Finally, as the previous literature review underlines, one should note that physical capital should be considered to avoid misspecification. We take this issue into account, as explained in Section 5, also recalling that it is crucially affected by data availability.

As previously emphasized, the firms' innovative behavior is crucial to understanding the impact on productivity. However, the analysis is limited by data availability on such a large-scale data set in this particular case. One should recall that we present estimates for almost the entire population of businesses. Therefore, incorporating additional information (innovation) into such a huge data set is challenging. For this reason, we considered the impact of technology by looking at the sectoral technological level of the industry in which a firm operates. Thus we expect a positive effect on the productivity of more advanced specialized sectors, which also proxies the individual firm technological level.

3. *Data description and the stylized facts of the Italian productivity stagnation*

We use the *FRAME-SBS*, the main statistical register developed by the Italian National Institute of Statistics (ISTAT) for the production of the Structural Business Statistics (SBS). This database integrates information from (i) the SBS domain, which is the primary data source for the economic variables required by the EU Regulation for the total population of Italian enterprises, and (ii) the Statistical Archive of Active Firms (*ASIA-IMPRESE*), which provide the structural information on the Italian active enterprises operating in the SBS domain.

We derive additional information on job quality by integrating additional variables on the demographic and job-related employment characteristics at the firm level. These variables stem from the ASIA Employment Archive, a matched employer-employee data set developed by ISTAT. We have an unbalanced panel of 7,926,386 firms that may enter or exit their reference industry during the period 2012-2017.

Table 1 Total sample of Italian business sector firms

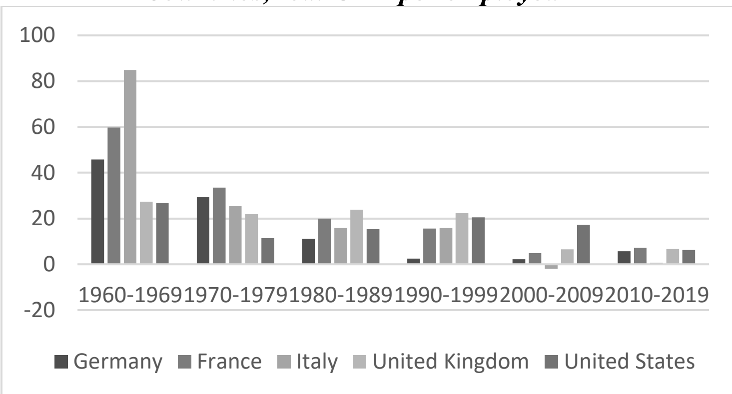
	2012	2013	2014	2015	2016	Total
Firms	1,357,717	1,313,216	1,289,692	1,295,569	1,327,435	7,926,386

Considering the total sample, 84.6% of the firm has less than ten workers, 9.7% between 10 and 19, and only 1.85% have more than 50 workers. Regarding sectors, 17.27% of firms belong to industry, 12.54% to construction, and 70.18% to Services. The distribution of firms by macro-regions (NUTS1) shows that 48,8% of them are localized in the North (27.4% in the North-west, and 21.4% in the North-east (21.4%); 20.28% and 29.8% respectively in the Centre and South.

Despite the short period available, this dataset allows us to ascertain the main drivers of productivity. However, one should point out that a generalized stagnation of productivity growth characterizes this period. This fact, together with the limited availability of time series data, does not allow us to specify a dynamic model and, more specifically, a productivity growth equation and, therefore, its implicit GMM estimation. Indeed, estimates of productivity growth are insignificant - as expected - given the tiny variation in productivity experienced over the whole sample period.

Macroeconomic evidence shows that, after an initial solid increase, the slowdown in labor productivity growth became a stylized fact of advanced industrial countries. The rate of labor productivity growth has drastically fallen since the 70s and has been stagnant for about thirty years (Figure 1). After 2000, a new declining pattern began. In the first decade considered (1960-1969), output per worker almost doubled and was the higher growth rate between the set of considered countries. In the following period (1970-1979), the growth rate declined significantly with a more pronounced pattern in the 2000s.

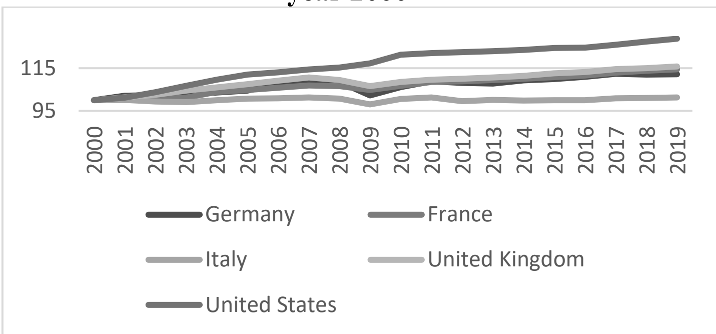
Figure 1- Labor productivity growth for decades in selected Countries, real GDP per employed



Source: European Commission, AMECO database

Since 2000, output per worker in Italy has been more than stagnant (Figure 2). In 2019 the other developed countries showed labor productivity higher than in 2000 between 12% (Germany) and 28% (USA), whereas, in Italy, results only 1% higher than 20 years before.

Figure 2- Real Labor productivity in selected Countries, base year 2000



Source: European Commission, AMECO database

Moving to the microdata evidences on the level of labour productivity during the period under investigation, three main pieces of evidence emerge: a) the level of productivity is higher in the industrial sector than in construction and services, b) on average, the level of productivity is higher in the North-west firms than in the other regions (with some exceptions in the construction); b) the level of productivity, in the same sector and the same region, increases along with firm size. Additional information and descriptive statistics are provided in Appendix 1.

Figure3. Labor productivity – 2012-2017
(log values)

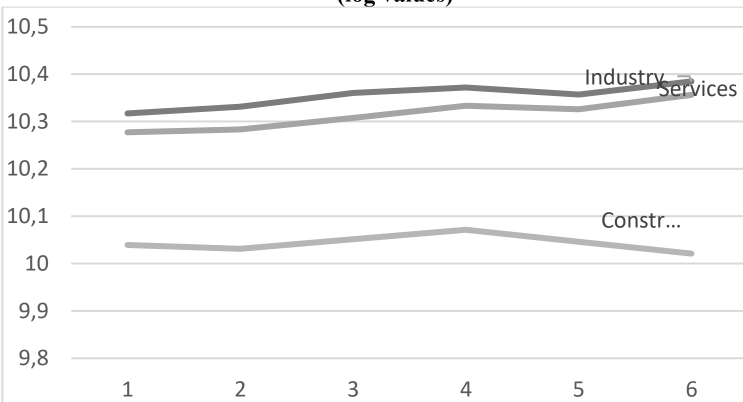


Figure4 . Productivity by areas
(log values)

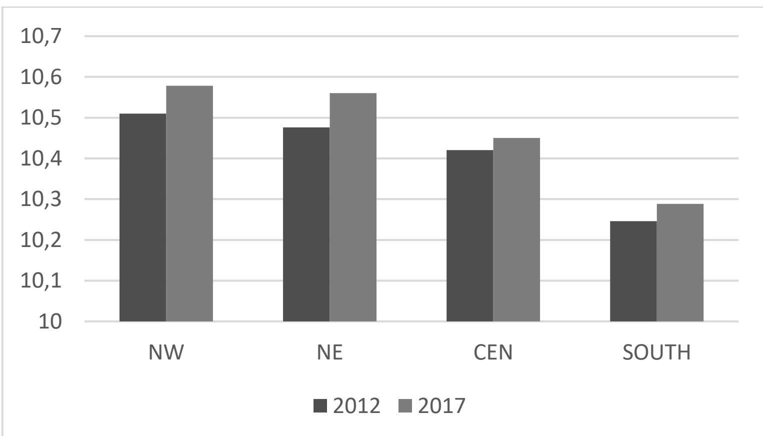
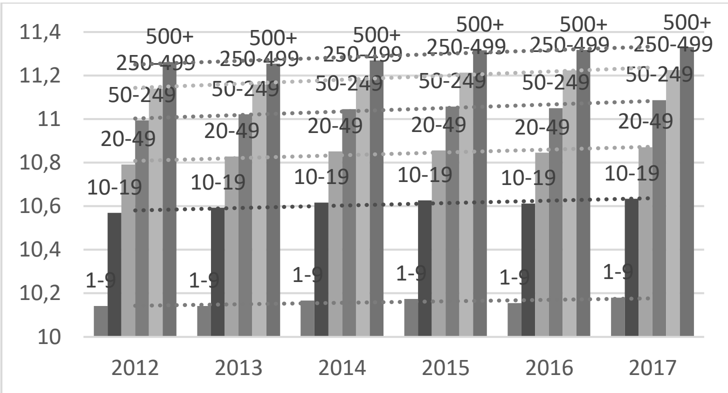
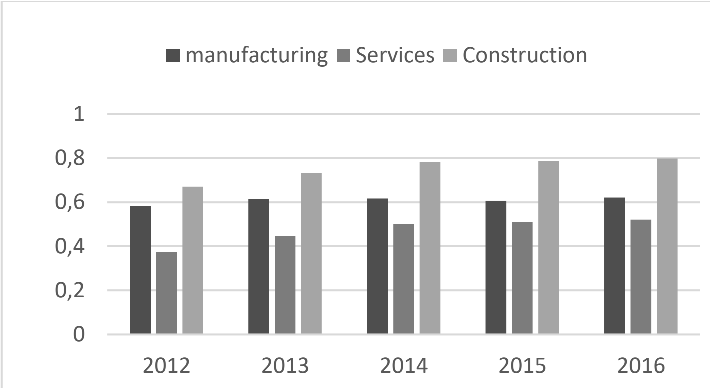


Figure 5. Labor productivity by firm size
(log values)



In addition, the productivity premium for persistent exporting firms (i.e. firms with positive exports in each year under observation) is large and persistent over time.

Figure 6. The productivity premium of the persistent exporters



$$\sum_{j-\{0\}} (\gamma_j N_j)_i = \left(\gamma_0 N_i \left(1 + \sum_{j-\{0\}} \left(\frac{\gamma_j - \gamma_0}{\gamma_0}\right)\left(\frac{N_j}{N}\right)_{it}\right)\right) \qquad III)$$

4 . *Model description*

Given the discussion concerning the determinant of plants or firms' productivity presented in Section 3, we can describe the empirical modeling strategy by considering the following production function:

$$ln\, y_{it} = \alpha\, ln(\gamma_{it} N_{it}) + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it} \qquad 1)$$

where where $u_{it} = \mu_i + e_{it}$. e_{it} is a normal distributed *i.i.d.* error component, μ_i allows for individual firm effects, *i* and *t* identify respectively firms and time.

The RHS represents the log of firm *(i)* labor productivity as measured by the value-added to employment ratio, $\gamma_{it}N_{it}$ is labor input in efficient units, i.e., labor quantity adjusted by its productivity, E_{it}, S_{it} , and Z_{it} capture firms' specific characteristics, sectoral technological level, and location respectively.

The labor input measure may be written as in 2), following Van Ours and Stoeldrajier (2011) and Kamplemann and Rycx (2011):

$$\gamma_i N_i = \sum_{j-\{0\}} (\gamma_j N_j)_i \qquad 2)$$

The right-hand side of (2) may be written as the sum of different labor categories' productivity (e.g., labor by education level):

$$\sum_{j-\{0\}} (\gamma_j\, N_j)_i = \left(\gamma_0 N_i \left(1 + \sum_{j-\{0\}} \left(\frac{\gamma_j - \gamma_0}{\gamma_0}\right)\left(\frac{N_j}{N}\right)_{it}\right)\right) \qquad 3)$$

where γ_0 represents a reference category and γ_j is the productivity of labor's category j.

Substituting into 1), one gets:

$$ln\, y_{it} = \alpha\, ln\left(\gamma_0 N_i \left(1 + \sum_{j-\{0\}} \left(\frac{\gamma_j - \gamma_0}{\gamma_0}\right)\left(\frac{N_j}{N}\right)_{it}\right)\right) + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it} \qquad 4)$$

Taking the approximation of $ln\left(1 + \sum_{j-\{0\}} \left(\frac{\gamma_j-\gamma_0}{\gamma_0}\right)\left(\frac{N_j}{N}\right)_{it}\right)$ i.e., $\sum_{j-\{0\}} \left(\frac{\gamma_j-\gamma_0}{\gamma_0}\right)\left(\frac{N_j}{N}\right)_{it}$

$$ln\, y_{it} = \alpha\, ln\, \gamma_0 + \alpha ln N_{it} + \sum_{j-\{0\}} \alpha \left(\frac{\gamma_j - \gamma_0}{\gamma_0}\right)\left(\frac{N_j}{N}\right)_{it} + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it} \qquad 5)$$

or:

$$ln\, y_{it} = \mathrm{c} + \alpha ln N_{it} + \sum_{j} \alpha_j n_{j,it} + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it} \qquad 6)$$

where:

$$c = \alpha\, ln\, \gamma_0;\ \alpha_j = \alpha\left(\frac{\gamma_j - \gamma_0}{\gamma_0}\right) \text{ and } n_j = \frac{N_j}{N}$$

We are aware that capital input is omitted in this specification and, therefore, parameters' estimates may be biased. However, previous empirical estimates show that the productivity effect is relatively small (Hellerstein et al. 1999; Aubert and Crepon 2003). In any case, we also estimate equation *(I)* by using a proxy for capital as described in Section 5, and we also discuss additional endogeneity issues, thereby presenting instrumental variables estimates (**IV**).

Also, one should note that the production function *I)* includes additional labor characteristics other than *j*. For this reason, one can think of an augmented version of the equation *I)* - we do not report here for the sake of simplicity - in which the summation on the RHS is replicated for the additional number of characteristics taken into consideration. Indeed, we consider education, the type of labor contract, and occupational position.

We first consider the specification in which N_{it} (i.e., a firm's labor input) enters equation *VI)* as the log of full-time equivalent units. We then consider a second specification where the absolute number of labor units is substituted by a set of firm size dummies specified in terms of the number of employees. This specification enables us to provide a more detailed description of the firm size impact of productivity, thus verifying firms' relative heterogeneity and contribution to productivity growth.

This consideration is relevant for the implications, as one may derive the relative advantage/disadvantage of small firms compared to medium-large companies.

5. *Empirical results*

We present the random effect model of firm productivity using the representation corresponding to equation *VI)* and its variant represented by the specification in which firm size, i.e., the number of employees, is substituted by the dummy variable corresponding to the size class to which the firm belongs (Table 2).

This procedure enables us to detail the impact of firm size on productivity, showing the gap in productivity between each size class. Also, we present different estimates for the manufacturing, services, and construction industries.

It is worth noting that the discrete representation is justified by the results implied by the estimation in Table 1. Indeed, the impact of firm size entails decreasing returns until five employees in manufacturing, eleven in services, and four in construction.[1] Therefore, one can conclude that increasing returns prevails since the early steps within the size ladder.

[1] This result is obtained by taking the derivative of *lprod* with respect to *lemp* and then set the first order condition for a minimum.

Productivity increases monotonically with size, implying that companies with more than 500 employees show a productivity level that is 32% higher than the corresponding level of smaller firms (<9 employees). Interestingly, the increase in productivity is constant when moving from the bottom to the top size classes and is about 6%.

Table 2 - Labour productivity by industry - Panel data estimates (re)

	Manufacturing		*Services*		*Construction*	
	(1)	(2)	(3)	(4)	(5)	(6)
lemp	0.0307***	-0.103***	-0.0517***	-0.197***	0.0164***	-0.150***
	[0.00151]	[0.00382]	[0.000840]	[0.00212]	[0.00143]	[0.00409]
lempsq		0.0311***		0.0408***		0.0542***
		[0.000784]		[0.000551]		[0.00124]
area1	0.292***	0.300***	0.233***	0.236***	0.283***	0.286***
	[0.00311]	[0.00313]	[0.00172]	[0.00172]	[0.00261]	[0.00259]
area2	0.287***	0.295***	0.237***	0.242***	0.249***	0.253***
	[0.00317]	[0.00319]	[0.00181]	[0.00182]	[0.00286]	[0.00284]
area3	0.158***	0.166***	0.138***	0.139***	0.172***	0.172***
	[0.00330]	[0.00331]	[0.00180]	[0.00180]	[0.00282]	[0.00280]
lage	0.0486***	0.0517***	0.135***	0.140***	0.0373***	0.0398***
	[0.00113]	[0.00113]	[0.000690]	[0.000692]	[0.00109]	[0.00109]
male	0.244***	0.236***	0.138***	0.136***	0.177***	0.164***
	[0.00379]	[0.00377]	[0.00169]	[0.00169]	[0.00838]	[0.00830]
part_time	-0.425***	-0.427***	-0.355***	-0.353***	-0.382***	-0.382***

	[0.00306]	[0.00305]	[0.00133]	[0.00133]	[0.00359]	[0.00356]
temporary	0.0829***	0.0786***	-0.0364***	-0.0385***	0.0948***	0.0842***
	[0.00453]	[0.00452]	[0.00167]	[0.00167]	[0.00332]	[0.00331]
age_30-49	0.0918***	0.0889***	0.100***	0.0973***	0.123***	0.120***
	[0.00314]	[0.00313]	[0.00137]	[0.00137]	[0.00258]	[0.00256]
age_50+	0.0848***	0.0799***	0.119***	0.114***	0.143***	0.136***
	[0.00411]	[0.00409]	[0.00190]	[0.00190]	[0.00367]	[0.00364]
executives	1.506***	1.284***	1.215***	1.138***	2.433***	1.090***
	[0.0427]	[0.0409]	[0.0156]	[0.0153]	[0.205]	[0.177]
white collars	0.374***	0.367***	0.354***	0.351***	0.368***	0.347***
	[0.00529]	[0.00525]	[0.00177]	[0.00177]	[0.00706]	[0.00702]
edu_secondary	0.144***	0.141***	0.160***	0.160***	0.0490***	0.0463***
	[0.00383]	[0.00383]	[0.00255]	[0.00259]	[0.00310]	[0.00308]
edu_tertiary	0.339***	0.317***	0.356***	0.350***	0.191***	0.173***
	[0.0107]	[0.0106]	[0.00360]	[0.00363]	[0.0104]	[0.0102]
persexp	0.288***	0.262***	0.457***	0.430***	0.217***	0.122***
	[0.00293]	[0.00297]	[0.00354]	[0.00355]	[0.0146]	[0.0157]
dtec_1	0.0489***	0.0399***				
	[0.00513]	[0.00517]				
dtec_2	0.144***	0.144***				
	[0.00280]	[0.00280]				
dtec_3	0.102***	0.103***				
	[0.00258]	[0.00258]				
dtec_5			0.0875***	0.0759***		
			[0.00301]	[0.00300]		
dtec_6			0.196***	0.184***		
			[0.00185]	[0.00185]		
dtec_10			-0.0515***	-0.0603***		
			[0.00181]	[0.00181]		
Constant	9.522***	9.635***	9.360***	9.452***	9.730***	9.837***
	[0.00579]	[0.00661]	[0.00307]	[0.00332]	[0.00932]	[0.00959]
n. obs	1,246,124	1,246,124	4,962,816	4,962,816	838,065	838,065
n. enterprises	261,060	261,060	1,087,555	1,087,555	192,074	192,074
within	0.003	0.006	0.010	0.013	0.005	0.009
between	0.424	0.419	0.328	0.327	0.224	0.235
R^2	0.366	0.363	0.288	0.288	0.173	0.184
s_u	0.493	0.493	0.605	0.606	0.397	0.394
s_e	0.350	0.350	0.386	0.386	0.346	0.345
r_u	0.665	0.665	0.711	0.711	0.568	0.566

Robust standard errors in brackets. Time dummies included

*** p<0.01, ** p<0.05, * p<0.1

Table 3 -Labour productivity by industry - Panel data estimates (re)

	Manufacturing (1)	*Services* (2)	*Construction* (3)
size_10-19	0.0668***	0.0343***	0.0867***
	[0.00206]	[0.00143]	[0.00246]
size_20-49	0.151***	0.0566***	0.173***
	[0.00344]	[0.00262]	[0.00475]
size_50-249	0.217***	0.0476***	0.226***
	[0.00557]	[0.00470]	[0.0105]
size_250-499	0.274***	0.0278**	0.223***
	[0.0145]	[0.0110]	[0.0394]
size_500+	0.318***	0.0199	0.187**
	[0.0227]	[0.0167]	[0.0737]
area1	0.295***	0.223***	0.281***
	[0.00310]	[0.00170]	[0.00259]
area2	0.288***	0.227***	0.247***
	[0.00314]	[0.00179]	[0.00284]
area3	0.161***	0.131***	0.171***
	[0.00328]	[0.00178]	[0.00280]
lage	0.0470***	0.125***	0.0353***
	[0.00110]	[0.000677]	[0.00107]
male	0.241***	0.131***	0.170***
	[0.00377]	[0.00169]	[0.00836]
part_time	-0.420***	-0.347***	-0.379***
	[0.00303]	[0.00133]	[0.00356]
temporary	0.0801***	-0.0411***	0.0906***
	[0.00453]	[0.00167]	[0.00332]
age_30-49	0.0899***	0.100***	0.122***
	[0.00313]	[0.00137]	[0.00257]
age_50+	0.0824***	0.121***	0.140***
	[0.00409]	[0.00191]	[0.00365]
executives	1.378***	1.183***	1.744***
	[0.0413]	[0.0152]	[0.178]
white collars	0.373***	0.364***	0.362***
	[0.00528]	[0.00177]	[0.00705]
edu_secondary	0.144***	0.161***	0.0470***
	[0.00381]	[0.00254]	[0.00309]
edu_tertiary	0.329***	0.349***	0.183***
	[0.0106]	[0.00358]	[0.0103]
persexp	0.258***	0.419***	0.187***
	[0.00284]	[0.00346]	[0.0143]
dtec_1	0.0473***		
	[0.00510]		
dtec_2	0.143***		
	[0.00278]		
dtec_3	0.102***		
	[0.00257]		
dtec_5		0.0833***	

		[0.00297]	
dtec_6		0.202***	
		[0.00185]	
dtec_10		-0.0457***	
		[0.00180]	
Constant	9.558***	9.311***	9.753***
	[0.00544]	[0.00293]	[0.00918]
n. obs	1,246,124	4,962,816	838,065
n. enterprises	261,060	1,087,555	192,074
within	0.004	0.006	0.006
between	0.429	0.346	0.235
R^2	0.372	0.302	0.183
s_u	0.492	0.604	0.395
s_e	0.352	0.390	0.347
r_u	0.662	0.706	0.564

Robust standard errors in brackets. Time dummies included

*** p<0.01, ** p<0.05, * p<0.1

This fact underlines one crucial issue of the Italian industrial structure, i.e., the insufficient firms' ability to grow. In a recent study, Bartoloni et al. (2020) show that, although small firms tend to grow faster than larger ones, they cannot progress over the size ladder. In other words, they eventually grow within their reference size class but fail to jump into higher size classes.

This is a structural feature that negatively affects the ability to compete in the global marketplace and, at the same time, underlines how innovative activity and the overall firms' efficiency may be significantly hindered, thus affecting firms' productivity.

Indeed, technology plays a significant role, as testified by the significant and high impact of the technology industry dummies. This classification is based on the Eurostat H-Tech classification, classifying sectors according to their technological characteristics.[2]

Firms belonging to the high and medium-high technology industries show higher productivity levels (4.7% and 14.3%) than companies in the low technology sector, which is taken as a reference.

Even medium-low technology firms show higher productivity gains (more than 10%) than the low technology ones. In other words, we observe an increase in productivity from the lower to the top technology ladder. However, such an increase is not monotonic, as the gain in the higher technology industry, although significant and still relevant, decreases compared to the two medium technology levels.

Geography matters, as the regional dummies significantly affect productivity, suggesting that companies located in the North (either North-East or North-West) and Centre Italy show productivity levels that are almost 30% and 16% higher than in the South.

This gap testifies how the southern Italian economy lags behind the other areas critically. One should emphasize how this gap impaired even more after the financial crisis.

As we have previously described by specifying the empirical model, we also aim to verify the contribution to labor productivity of specific factors reflecting human capital level, occupational status, and the type of labor contract.

Higher levels of education entail higher productivity. This gain is diversified according to each firm's specific share of education level. It ranges from almost 3.3% relative to a 10 percentage points (p.p) increase in the share of tertiary education to a corresponding 1.4% increase for a secondary degree level. This result is even more magnified by the impact of executives' and managers' shares, implying an even higher impact on a firm's productivity level (more than 13% and about 3.8%, respectively).

The impact of the part-time workers' share is negative and relevant (-4.2%), whereas the share of temporary workers has a mildly positive

[2] High-tech industry and knowledge-intensive services (htec), https://ec.europa.eu/eurostat/cache/metadata/en/htec_esms.htm

effect (+0.8%). This result underlines that this latter component may play a role as a buffer of flexible labor input that may temporarily adjust employment to firms' requirements. Conversely, what matters for the productivity level is the whole amount of worked hours; for this reason, the impact of part-time workers is negative, suggesting that firms cannot efficiently use such a component of the labor force.

Employees' age affects productivity in that workers in their middle age (39-49) or even later age brackets positively affect productivity (+0.8%) compared to the younger component of a firm's labor input. This result is coherent with previous investigations which confirm such a positive effect (Van Ours and Stoeldraijer 2011).

Firm age has a positive and significant effect, as the elasticity corresponding to a 10% increase in firm age is about 0.5%. One should recall that the median age for this sample is about 16 years; thus, this result implies that a five-year increase of the median age brings about a 1.5% increase in productivity.

The positive effect on the proportion of male employment (and therefore the negative impact of the corresponding female one) is mainly related to the negative effect of part-time, which is indeed correlated to female employment.

Although some specific patterns arise, this overall pattern is also confirmed in the services and construction industries. In particular, the firm size effect is not monotonic in services and construction, and it entails an increasing and then decreasing pattern.

Regional characteristics are lined up with those of the manufacturing sector, whereas firm age is higher in services and more aligned with manufacturing in construction.

The gender effect, provided by a firm's share of male employment, is more marked in construction, although its effect is weaker than manufacturing.

By looking at the quality augmented component of employment, i.e., education, professional status, age, and contract characteristics, the results confirm overall the manufacturing findings except for the temporary contract variable, thus suggesting that the buffer effect previously mentioned is not operational in services. Also, the use of such a contractual arrangement might not be efficient.

The education variables shows, as expected, a weaker impact for a higher level of formal education, given the specific characteristics of the construction industry, which is characterized by a low proportion of skilled workers and lower wages.

Competing in international markets has a significant and strong effect on productivity. Export and technological opportunities exert a positive effect. This impact is common to all sectors and is captured by a dummy variable that in every year assumes value one if a firm has always exported. One should recall that the number of exporting firms is relatively small: in manufacturing, this share is about 22% whereas in services and construction it is almost 3% and less than 1%.

In addition, it is worth noting that this attitude is strongly related to firm size. Thus one can identify a possible channel by which productivity may increase, starting from firm size, export propensity, and then managerial and workers' capabilities.[3]

6. Omitted variable and endogeneity issues

This section presents estimates for the manufacturing sector, which incorporate a proxy for the capital stock, as this variable is not available in the original dataset. We assign each firm the fixed capital to employee ratio (*k*) computed in the reference domain, defined by the joint consideration of the NACE division of activity, class size, and macro-region[4].

Additionally, we present IV estimates that endogenize the export variable, i.e., the dummy variable reflecting a firm's exporting attitude. This variable is indeed endogenous as it reflects a firm's behavior and

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[3] One should note that the export variable is significant even when the strict persistent definition is partially relaxed, thus allowing for occasional exporting behavior.

[4] The computation is made using a different source of data at the firm level, i.e., *the panel data on the balance sheets of corporations with employees (ISTAT)*, years 2001-2014. The same panel has also been used under the same project for other topics of analysis aimed at investigating the survival patterns and the size growth over a longer period of time. The ratio *K* assigned to each manufacturing firm is the average value during the period 2012-2014

attitude that crucially depends on its intrinsic characteristics and sectoral features.

For this reason, we decided to estimate equation *V)* by 2SLS using a probit estimation, thus enabling us to derive predicted exporting probabilities then used as instruments for the final estimation.

Including the proxy for the capital stock in the manufacturing equation enables us to consider the OMV issue, at least in the manufacturing sector. This issue was also faced by international studies that only partially find appropriate solutions, as the inclusion of capital is driven by data availability. For this reason, Van Ours and Stoeldraijer (2011) use depreciation on fixed assets as a proxy for capital input. Their baseline results remain, however, unchanged when this proxy is introduced. Kampelmann and Rycx (2012) use, instead, sector dummy variables which are indeed a poor proxy, although fixed capital assets are correlated with industry characteristics.

It is worth noting that microeconometric estimations that use capital input (Hellerstein et al., 1999; Aubert and Crepon, 2003; Dostie, 2011) show a relatively low elasticity attached to it.

The inclusion of the proxy for the capital stock suggests that the magnitude of the impact on productivity is generally confirmed. However, the inclusion of the capital stock reduces, as expected, the firm's size effect, which is indeed captured by the adopted capital stock proxy. The technological dummies are also affected by the inclusion of the capital stock in that their impact increases significantly.

As concern the endogeneity of firms' export attitude, we present IV estimates that enable us to endogenize the dichotomous export dummy variable using the predicted values derived from a *probit* regression of the export dummy on all exogenous variables. This is in fact a 2SLS estimation in which the first stage is represented by such a *probit* regression and the second stage is an IV estimation that uses the prediction of the first stage as an instrument for the endogenous export dummy.[5]

[5] We do not report the results of the first stage, as the emphasis here is on productivity. However, they show, as expected the positive and significant impact of firm size and those variables reflecting firms' human capital and managerial capabilities. Also, technological

Looking at the instrumental variable estimation, the impact of the firm and sectoral characteristics are overall confirmed. The positive and significant impact of internationalization is confirmed in manufacturing and services, whereas in construction the effect is not anymore significant. This result may be explained considering that the ratio of exporting companies in construction is, overall, negligible; the proportion of persistent exporting firms is relatively small, particularly in services (about 3%) and construction (0.5%), whereas the corresponding value for manufacturing is 22%. Also, one should note that the correlation between the predicted exporting probabilities and the exporting dummy decreases from 0.56 in manufacturing, to 0.34 in services and 0.25 in construction.

Thus, endogenizing the export probabilities using a *probit* specification to discriminate between exporting and non-exporting firms provide better results in manufacturing where the probit specification is more effective in discriminating between persistent exporting and non exporting firms. In the other sectors, because of the relative small number of persistent exporting firms, the prediction from the *probit* specification is relatively poor and therefore such predictions are less suitable for representing a good instrument in the IV estimation.

opportunities proxied by sectoral technological levels, entail a positive and significant impact on export propensity.

Table 4 - Labour productivity by industry – IV Panel data estimates (re)

	Manufacturing		*Services*	*Construction*
	(1)	(2)	(3)	(4)
size_10-19	0.0860***	0.0612***	0.0354***	0.0952***
	[0.00321]	[0.00332]	[0.00147]	[0.00250]
size_20-49	0.194***	0.147***	0.0513***	0.186***
	[0.00721]	[0.00747]	[0.00274]	[0.00499]
size_50-249	0.284***	0.209***	0.0333***	0.249***
	[0.0121]	[0.0127]	[0.00479]	[0.0119]
size_250-499	0.354***	0.242***	-0.000405	0.261***
	[0.0191]	[0.0203]	[0.0109]	[0.0434]
size_500+	0.404***	0.268***	-0.0296*	0.271***
	[0.0261]	[0.0258]	[0.0166]	[0.0892]
k		0.0523***		
		[0.00194]		
area1	0.311***	0.298***	0.205***	0.282***
	[0.00428]	[0.00412]	[0.00187]	[0.00278]
area2	0.301***	0.301***	0.212***	0.247***
	[0.00402]	[0.00382]	[0.00191]	[0.00290]
area3	0.171***	0.193***	0.123***	0.171***
	[0.00376]	[0.00370]	[0.00181]	[0.00278]
lage	0.0499***	0.0458***	0.123***	0.0349***
	[0.00127]	[0.00123]	[0.000671]	[0.00106]
male	0.240***	0.188***	0.129***	0.174***
	[0.00376]	[0.00357]	[0.00168]	[0.00833]
part_time	-0.436***	-0.431***	-0.351***	-0.388***
	[0.00331]	[0.00330]	[0.00137]	[0.00353]
temporary	0.0799***	0.0744***	-0.0382***	0.0906***
	[0.00453]	[0.00446]	[0.00167]	[0.00331]
age_30-49	0.0950***	0.0930***	0.105***	0.126***
	[0.00319]	[0.00313]	[0.00137]	[0.00256]
age_50+	0.0911***	0.0793***	0.130***	0.146***
	[0.00424]	[0.00417]	[0.00190]	[0.00362]
executives	1.447***	1.209***	1.165***	1.887***
	[0.0427]	[0.0389]	[0.0150]	[0.226]
white collars	0.404***	0.334***	0.363***	0.381***
	[0.00671]	[0.00702]	[0.00195]	[0.00739]
edu_secondary	0.151***	0.122***	0.155***	0.0465***
	[0.00405]	[0.00393]	[0.00237]	[0.00310]
edu_tertiary	0.353***	0.241***	0.337***	0.182***
	[0.0115]	[0.0109]	[0.00345]	[0.0104]
persexp	0.1003***	0.162***	0.889***	-0.0501
	[0.0275]	[0.0267]	[0.0259]	[0.162]
dtec_1	0.0445***	0.148***		
	[0.00510]	[0.00510]		
dtec_2	0.149***	0.244***		
	[0.00316]	[0.00293]		

dtec_3	0.100***	0.159***		
	[0.00256]	[0.00253]		
dtec_5			0.101***	
			[0.00322]	
dtec_6			0.223***	
			[0.00222]	
dtec_10			-0.0281***	
			[0.00205]	
Constant	9.558***	9.085***	9.323***	9.755***
	[0.00554]	[0.0179]	[0.00286]	[0.00918]
n. obs	1,246,124	1,192,506	4,962,816	838,065
n. enterprises	261,060	249,516	1,087,555	192,074
within	0.004	0.004	0.006	0.005
between	0.433	0.462	0.330	0.237
R^2	0.375	0.399	0.289	0.185
s_u	0.469	0.437	0.558	0.364
s_e	0.352	0.345	0.390	0.347
r_u	0.640	0.616	0.672	0.524

Robust standard errors in brackets. Time dummies included

*** p<0.01, ** p<0.05, * p<0.1

7. Conclusion

Understanding productivity growth and its main determinants are crucial to shaping industries' future evolution and the whole economy. We use a unique data set for the Italian manufacturing, services, and construction sectors that has enabled us to provide a more precise picture of the mechanisms and interactions that crucially affect productivity.

It is worth recalling that the Italian economy is experiencing, like other advanced economies, an unsatisfactory productivity growth rate. Although shared with many developed countries, such a pattern is nevertheless more specific and pronounced in the Italian economy. Our findings suggest that firm size is significant in affecting productivity. Its impact implies increasing returns in a specification in which firm's size is described using dummy variables reflecting a firm's reference size class. This effect is robust to different specifications that consider omitted variables and endogeneity bias. However, one should note that the ability of Italian firms to pass through on the size ladder is significantly low (Bartoloni et al., 2020). Therefore, the poor performance concerning productivity at the industry and economy-wide level may be justified on these grounds.

By looking at firms' characteristics other than size, one can argue that employees' human capital and age structure positively affect productivity. This result confirms international estimates (Van Ours and Stoeldraijer; 2011; Hellerstein et al., 1999) that show how employees' age is a positive driver of productivity, with a declining impact (although positive) from the age of 50. This pattern prevails in manufacturing, whereas productivity increases after this age threshold in services and construction.

In general, age is a more general proxy for describing the specific human capital required by a firm's production process. However, the fact that older ages may still account for a significant and relatively high impact may shed light on a controversial issue regarding firms' ability to attract younger (or at least middle-aged) workforce. Alternatively, this fact may suggest that there is still a mismatch between the supply and demand of competencies.

Occupational profiles positively affect productivity, although this pattern may be related, as in the case of export propensity, to the existence of a relatively low number of companies with a structured functional internal organization in which professionals, technicians, and managers play a significant role. Given that the average firm's size is significantly small, although the individual effect of these variables is significant, the overall impact at the macro-level (industry) results moderate.

Firm age as a proxy of accumulated knowledge play a significant role in affecting productivity, and this is in line with other international findings based on plants' productivity estimation.

Technology matters as testified by the corresponding technology dummies used in manufacturing and services to derive the diversified productivity levels prevailing according to different technological classifications.

Internationalization is a crucial driver of productivity that is nevertheless related to firm size. Therefore, although quite relevant, it cannot exert an overall strong impact on aggregate productivity given Italian companies' inability to grow. Also, structural factors related to regional areas differences matter, which may represent an even stronger hamper to productivity growth. This evidence suggests that, ultimately, the critical policy prescription is to create the conditions that enable firms to grow.

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Appendix 1 – Data description by sectors

Industry

In 2012, the average level of labor productivity in the industrial sector was 44,2k EUR in the North-west, 41,4K EUR in North-east, 33,9k EUR in the Centre, and 28,6k EUR in the South. If it's true that more significant industries have higher productivity in each region than small ones, this is not always true between areas. For example, the labor productivity of the upper firm size classes (250-499; 500+) in Center Italy is equal respectively to 101% and 143,9% that of the North. These evidence is confirmed in 2017 when the average level of labor productivity is 47,5K EUR, 45,8K, 35,3 K, and 28,7K in the four macro-regions, respectively. Also, in this year, the productivity inter-region increases when firms' size increases. Moreover, firms with 250-449 workers of the Centre and South improved their position.

Table A1 Labor Productivity by regions and firm size, 2012

Firm size	Productivity Level				Range intra-regions				Range inter-regions (NW reference)		
	NW	NE	CEN	SOU	NW	NE	CE	SOU	NE	CE	SOU
1-9	37,43	35,43	29,55	25,40	100	100.0	100.0	100.0	94.7	79.0	67.9
10-19	49,69	44,59	39,04	37,16	133	125.9	132.1	146.3	89.7	78.6	74.8
20-49	60,00	55,50	50,92	44,71	160	156.7	172.3	176.0	92.5	84.9	74.5
50-249	70,93	67,45	61,65	56,32	189	190.4	208.6	221.7	95.1	86.9	79.4
250-499	83,32	73,33	84,40	57,78	223	207.0	285.6	227.5	88.0	101.3	69.3
500+	89,84	85,89	129,26	84,81	240	242.4	437.4	333.8	95.6	143.9	94.4
Total	44,20	41,42	33,99	28,67					93.7	76.9	64.9

Legend: NW refers to North-West; NE refers to North-East; CEN refers to Center; SOU refers to South

Table A2 Labor productivity by region and firm size, 2017

Firm size	Productivity Level				Range intra-regions				Range inter-regions (NW reference)		
	NW	NE	CEN	SOU	NW	NE	CEN	SOU	NE	CEN	SOU
1-9	39,27	38,33	30,25	25,14	100.0	100.0	100.0	100.0	97.6	77.1	64.0
10-19	53,70	49,86	40,52	36,48	136.8	130.1	133.9	145.1	92.9	75.5	67.9
20-49	65,46	61,47	53,40	45,35	166.7	160.4	176.5	180.3	93.9	81.6	69.3
50-249	77,66	73,59	66,46	59,45	197.8	192.0	219.6	236.4	94.8	85.6	76.6
250-499	88,30	79,35	95,63	66,04	224.9	207.0	316.1	262.6	89.9	108.3	74.8
500+	94,82	94,43	118,26	68,14	241.5	246.4	390.8	271.0	99.6	124.7	71.9
Total	47,49	45,77	35,29	28,70					96.4	74.3	60.4

Legend: NW refers to North-West; NE refers to North-East; CEN refers to Center; SOU refers to South

Considering all firms, the dynamics of labor productivity between 2012 and 2017 has been stronger in the Northeast (+10,5%) and Nordwest (7,4%) with respect to the Centre (+3,8%) and the South (0,10%). This result is largely explained by the negative trend of productivity in the largest size (500+) that shows a fall of about 8.5% in Center Italy and 19,6% in the South.

Construction

In construction, the average level of labor productivity in 2012 is higher in the North-west (36,77 k EUR) than in the rest of Italy, being equal to 35.45k EUR in the Northeast, 33,55K in the Centre and 28.7k in the Southern regions. Therefore, the distance from the more productive regions increases from the Northeast to the South, where productivity is only 76,8% that of the North-west. Some exceptions exist as the size class 250-499 has higher productivity in the Northeast and the Centre (139,9% and 138,6% respectively, being 100 the North-west). Considering each region, also in the construction sector, productivity increases along with firm size. Indeed, the higher class size (500+), more than double the productivity in the smallest class. In 2017, while the average gap of Northeast construction firms was reduced, the gap between the Centre and the Southern regions increased. Indeed, the average productivity in the Centre in 2017 is equal to 88% (from 91,5%) with respect to which of the North-west firms, and to 74,9% (from the 76,8%) in Southern firms. In the considered timespan (2012-2017), the rate of growth is lower in the

Centre (2,97%) than in the rest of the country (4,37%; 8,81%, 7,1% in the South, in the North-east and in the North-west, respectively).

Table A3 Labor productivity by region and firm size, 2012

Firm size	Productivity Level				Range intra-regions				Range inter-regions (NW reference)		
	NW	NE	CEN	SOU	NW	NE	CEN	SOU	NE	CEN	SOU
1-9	34,99	33,72	32,24	27,28	100.0	100.0	100.0	100.0	96.4	92.2	78.0
10-19	44,66	41,58	40,88	36,07	127.6	123.3	126.8	132.2	93.1	91.5	80.8
20-49	49,82	48,71	46,39	41,17	142.4	144.4	143.9	150.9	97.8	93.1	82.6
50-249	57,15	60,89	57,25	47,85	163.3	180.5	177.5	175.4	106.5	100.2	83.7
250-499	53,72	75,16	74,47	41,64	153.5	222.9	231.0	152.6	139.9	138.6	77.5
500+	77,85	75,59	91,22	58,64	222.5	224.1	282.9	214.9	97.1	117.2	75.3
Total	36,67	35,45	33,55	28,17					96.7	91.5	76.8

Legend: NW refers to North-West; NE refers to North-East; CEN refers to Center; SOU refers to South

Table A4 Labor productivity by region and firm size, 2017

Firm size	Level				Range intra-regions				Range inter-regions (NW reference)		
	NW	NE	CEN	SOU	NW	NE	CEN	SOU	NE	CEN	SOU
1-9	37,55	36,56	33,20	28,48	100.0	100.0	100.0	100.0	97.4	88.4	75.9
10-19	47,22	46,45	41,87	36,95	125.7	127.0	126.1	129.7	98.4	88.7	78.3
20-49	52,74	53,72	49,27	42,18	140.4	146.9	148.4	148.1	101.9	93.4	80.0
50-249	60,07	65,00	55,88	47,91	159.9	177.8	168.3	168.2	108.2	93.0	79.8
250-499	65,06	62,08	61,17	51,36	173.2	169.8	184.2	180.3	95.4	94.0	79.0
500+	73,06	64,17	91,14	69,97	194.6	175.5	274.5	245.6	87.8	124.7	95.8
Total	39,28	38,58	34,55	29,40					98.2	88.0	74.9

Legend: NW refers to North-West; NE refers to North-East; CEN refers to Center; SOU refers to South

Services

In 2012, the level of productivity in the North-west was 35,3 k EUR; 329K in the North-east, 30,35K in the Centre and 24.56k in the South, while in 2017 it was, respectively equal to EUR 35.86K, 33,24K, 29,48K and 24.18k. This means that the percentage change has been positive in the two Northern regions (+1,6%, and+3.79%, respectively) and negative in the Centre and the South (-2,84% and -1.53%, respectively). The result is an increasing gap with the North-west for these latter two regions and relative convergence of the North-east. In addition, productivity increases with firm size in the services in the other two sectors. However, the differences between classes are less relevant than in Industry and Construction and become progressively smaller when size increases.

Table A6 Labor productivity by region and firm size, 2017

Firm size	Level				Range intra-region				Range inter-regions (NW reference)		
	NW	NE	CEN	SOU	NW	NE	CEN	SOU	NE	CEN	SOU
1-9	33.81	31.55	28.27	23.44	100	100	100	100	93,32	83,62	69,33
10-19	45.13	40.84	36.29	30.05	133,49	129,44	128,34	128,21	90,49	80,39	66,58
20-49	51.86	46.97	39.58	32.38	153,37	148,85	140,00	138,15	90,57	76,33	62,45
50-249	54.4	48.97	42.53	33.56	161,05	155,18	150,44	143,18	89,92	78,11	61,64
250-499	54.69	43.85	44.65	38.27	161,78	138,97	157,93	163,28	80,16	81,63	69,97
500+	55.01	47.31	52.58	35.91	162,71	149,93	185,96	153,21	85,99	95,57	65,28
Total	35.87	33.24	29.49	24.19					98,31	87,22	71,53

Legend: NW refers to North-West; NE refers to North-East; CEN refers to Center ; SOU refers to South

Appendix 2. Descriptive statistics and legend

Descriptive statistics

Variable	Mean	S.D
lemp	1.44	0.89
lemp_squred	2.88	4.00
area1	0.27	0.45
area2	0.21	0.41
area3	0.21	0.41
lage	2.49	0.92
male	0.52	0.41
temporary	0.13	0.25
part_time	0.44	0.42
age_30-49	0.56	0.35
age_50+	0.20	0.28
executives	0.00	0.04
white collars	0.32	0.40
edu_secondary	0.47	0.36
edu_tertiary	0.09	0.21
persexp	0.06	0.23
dtec_1	0.01	0.08
dtec_2	0.03	0.18
dtec_3	0.05	0.21
dtec_5	0.03	0.16
dtec_6	0.13	0.34
dtec_10	0.12	0.33
size_10-19	0.10	0.30
size_20-49	0.04	0.19
size_50-249	0.02	0.13
size_250-499	0.00	0.04
size_500+	0.00	0.04

Legend

lemp = the logarithm of employment

lemp_squared = square lemp

area1 = dummy variable equal to 1 if the firm is located in the North-West of Italy and 0 otherwise

area2 = dummy variable equal to 1 if the firm is located in the North-East of Italy and 0 otherwise

area3 = dummy variable equal to 1 if the firm is located in the Centre of Italy and 0 otherwise

lage = logarithm of the firm's age that is the number of years between its foundation and the date of observation

male = share of male workers in a firm on total employees

temporary =share of employees with a fixed-term contract in a firm

part_time = share of workers with a part-time contract on total employees (full-time and part-time contracts)

age_30-49 = share of employed aged between 30 and 49 years old on total employees, by firm

age_50+ = share of employed with more than 50 years old on total employed, by firm

executives = share of employees with managerial or middle management roles on total employees *white* collars =share of white-collar employees (office workers) on total employees

edu_secondary is the share of employees with at least secondary education (level 2-3 of ISCED)

edu_tertiary = share of employees with at least secondary education (level 4 of ISCED)

persexp = dummy variable referred to the persistence of exports. It assumes value 1 if the firm has had a positive value of export for all the period considered and 0 otherwise

dtec_1 = dummy variable assuming value 1 if firm belongs to high-technological manufacturing sector and 0 otherwise

dtec_2 = dummy variable assuming value 1 if the firm belongs to Medium-High technological manufacturing sector

dtec_3 = dummy variable assuming value 1 if the firm belongs to Medium-Low technological manufacturing sector

dtec_5 = dummy variable assuming value 1 if the firm belongs to Knowledge-intensive services

dtec_6 = dummy variable assuming value 1 if the firm belongs to High technology services

dtec_10 = dummy variable assuming value 1 if the firm belongs to the Household services sector

size_10-19 = dummy variable assuming value 1 if the firm has a number of workers between 10 and 19.

size_20-49 = dummy variable assuming value 1 if the firm has a number of workers (between 20 and 49.

Size 50-249 = dummy variable assuming value 1 if the firm has a number of workers between 50 and 249

Size 250-499 = dummy variable assuming value 1 if the firm has a number of workers between 250 and 449

Size 500+ = dummy variable assuming value 1 if the firm has more than 500 workers

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