Productivity and wage effects of the Iso9001 certification for leader and laggard companies in Italy

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In this paper I study whether the adoption of the Iso9001 certification in Italy, between 2011 and 2019, has helped small firms to reduce the gap in productivity, profitability and wages paid to the workers, with the leading group of firms operating on the frontier. After a pooled OLS estimation, a *difference-in-difference model with fixed effects* has been applied. I find that Iso9001 certification does support firms below the frontier to partially recover the gap in terms of multifactor productivity incorporating the mark-up and profits, while no robust effect has been detected for the mark-up corrected productivity and wages.

In questo studio ci si chiede se l'adozione della certificazione Iso9001, tra il 2011 e il 2019, abbia aiutato le piccole imprese italiane a recuperare parte del gap, in termini di produttività, profittabilità e salari pagati ai lavoratori, nei confronti delle imprese leader operanti sulla frontiera. Dopo aver applicato un modello Pooled OLS e un modello difference-in-difference con effetti fissi, si è trovato che la certificazione Iso9001 aiuta ad un recupero parziale del gap solo per profitti e produttività totale dei fattori che incorpora il mark-up. Nessun effetto robusto è invece evidente sulla produttività corretta per il mark-up e sui salari.

DOI: 10.53223/Sinappsi_2022-03-6

Citation
Pompei F. (2022), Productivity and wage effects of the Iso9001 certification for leader and laggard companies in Italy, *Sinappsi*, XII, n.3, pp.112-129

Keywords
Labour productivity
Small and medium-sized enterprises
Wage

Parole chiave
Produttività
Piccole e medie imprese
Salario

Introduction

An increasing polarisation between technological laggards and leaders is emerging in the population of firms of OECD countries, causing skewness in growth rate distributions (Foster *et al.* 2021; Corrado *et al.* 2021) and influencing the slowdown in the aggregate productivity growth (Andrews *et al.* 2019).

In the case of the Italian economy, Dosi *et al.* (2012; 2021) formulated a *neo-dualist hypothesis*, where high-performance firms (technological leaders) co-exist with a large population that exhibits modest and stagnant levels of productivity and profits (laggards). Interestingly, Costa *et al.* (2021) proposed a finer-grained taxonomy for Italian firms where two high-level clusters of leaders (*Interdependent* and *Complex firms*) that base their competitive advantage on a combination of practices and capabilities, co-exist with two low-level clusters

This study relates to a project that has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No.101004776 .

Acknowledgements: I wish to thank Alessandro Nisi, from Accredia statistical office, for providing micro-level database on Italian firms that introduced Iso certifications.

mainly made up of small size units (named *Managerial and Essentials firms*) that deploy simpler and defensive strategies to survive specific local markets. These authors observed considerable gaps in terms of labour productivity levels between the *Complex/Interdependent* and the *Managerial/Essential companies*. However, they did not directly test whether there are single managerial practices that might help small-size *Managerial* or *Essential companies* to reduce the performance gap emerging between the leaders and these laggard firms.

The current study is an attempt to answer the question above. The empirical analysis I perform here, partially relies on a broader research project in which a distance to frontier framework (DTF) has been applied to investigate whether the introduction of specific technologies or managerial practices helps the laggards shorten the distance between them and the companies at the frontier (Pompei and Venturini 2022). In the present paper, the leaders are only the Italian medium and large enterprises located in the top 5% of the distribution of productivity, profitability and average wages paid to the workers. The laggards are the rest, made up of 95% of Italian companies from which we single out the very large sub-sample of small units (1-49 employees). The specific managerial practice I focus on is the introduction of quality certification (Iso9001). According to Bourke and Roper (2017), the quality-orientated management change, which may include the implementation of Iso9001 certification, is crucial for firms. The main hypothesis is that this strategy involves organisational changes that somehow compensate the lack of technological innovation within small companies and help to partially bridge the gap between the latter and those medium-large frontier companies. This is because quality certifications may increase firm compliance to standardized procedures, facilitate the conversion from tacit to codified knowledge and the recombination with external knowledge to solve production problems (Nonaka *et al.* 2000) and favour the exploitation of best organisational practices.

Against a background of increasing labour income inequality fuelled by the heterogeneity of firms' productivity and profitability, this study aims to analyse whether Iso9001 certification not only favours better economic performances for small companies but also reduces the large difference between themselves and the medium-large ones, in terms of average wages paid to the workers.

I investigate these aspects by combining information on economic performances and characteristics of the top manager/director of firms from the Orbis Europe database with information on Iso9001 certifications from Accredia. Matching this information at the firm level allowed me to obtain a longitudinal dataset for more than 109,000 Italian companies, that have been analysed across 28 industries over the period 2011-2019.

According to Andrews *et al.* (2019), we apply a DTF approach by means of a pooled OLS; next, we take into account unobserved heterogeneity of firms and potential endogeneity between the Iso9001 certifications and performances, by performing a *difference-in-difference estimation with fixed effects model* (Autor 2003; Pischke 2005; Angrist and Pischke 2009).

The results indicate that the Iso9001 certification helps firms below the frontier to partially recover the gap in terms of multifactor productivity (MFP) with respect to the top 5% of Italian companies. This gain also reflects in higher profits for the laggards, while the gap-reducing effect on wages paid to the workers is not confirmed by the *diff-in-diff estimation.*

The outline of the paper is as follows. Section 1 surveys the most recent literature on managerial practices and capabilities as drivers of productivity performance at the firm level. Section 2 lays down both the analytical framework, based on the DTF approach and the econometric methodology, based on *diff-in-diff estimation*. Section 3 presents the data on the Italian firms covered by the present analysis, reporting a small set of summary statistics. The econometric results based on the strategy discussed in Section 2 are presented in Section 4. The last section concludes.

1. Literature Review

An influential stream of the literature looks at non-technological innovations (*i.e.*, managerial practices and organisational capabilities) as a key source of firms' performance and competitive advantage (Bloom and Van Reenen 2007; 2010; Dosi and Nelson 2010; Helfat and Martin 2015; Teece 2016). Bloom and Van Reenen (2007; 2010) develop a theoretical framework in which *management quality* is seen as a set of practices affecting profitability, multifactor productivity and other dimensions

of firm performance that cannot be explained by *technological innovation.* Management activities are classified as *monitoring*, *target* and *incentive practices.* By conducting a survey across the US and the European Union covering the period 1994-2004, these authors build a composite indicator of management practices across firms which includes, among others, lean manufacturing and process improvements, that is, aspects to which ISO certification can be ascribed. The authors estimate an overall impact of management practices on MFP that ranges between 3.2 and 7.5% and on profits (measured by returns on capital) by 2.45% (Bloom and Van Reenen 2007, table I, 1369).

According to the evolutionary theory (Dosi *et al.* 2000; Dosi and Nelson 2010; Teece 2010) firms can be seen as boundedly rational and non-optimising agents endowed with stocks of idiosyncratic and firm-specific assets that can hardly be transferred. In this context, entrepreneurial management requires complex and specific knowledge to develop a creative vision, discover and create opportunities, sense customer needs and anticipate marketplace responses (Teece 2016).

Helfat and Martin (2015) review the literature on managerial capabilities and identify three core underpinnings: i) managerial cognition, ii) managerial human capital and iii) managerial social capital. Most empirical studies infer managerial cognition from the association between mental models and beliefs of managers and strategic change. The latter include organisational redesign, restructuring and strategic renewal, and redeployment of physical and human capital.

An attempt to make operative the empirical analysis of the concept of dynamic and organisational capabilities has been made by Costa *et al.* (2021). These authors proposed a taxonomy for Italian firms based on a bundle of organisational routines and heuristics that range from human resource management and price setting rules to a large set of strategies involving quality improvements and new products, internationalisation and investments in advanced technologies. Through this classification, they identified two high-level clusters of leader firms (*Interdependent* and *Complex firms*) where large and medium enterprises are over-represented and the competitive advantage resides in organisational capabilities, that is, strong complementarities among different routines and firm-specific actions. The remainder of the population of firms falls in low-level clusters where small-size units are over-represented. These small units (named *Managerial and essential firms*) rely on low- or medium-level organisational capabilities and on single managerial strategies, respectively. Quality improvement methods may belong to these simpler strategies allowing the laggards not only to survive specific local markets but also to partially recover the performance gap emerging between them and the leading companies. Interestingly, the distance in terms of profits between *Essential firms* and *Complex firms* is not as large as that in productivity: from Table 4 of Costa *et al.* (2021), we observe that the labour productivity of *Complex firms* is more than two times higher that of *Essentials firms*, whilst the same ratio is only 1.44 if we look at profits (ratio of gross profit margin on revenues). This could mean that small companies classified as *Essential firms* may rely on profits essentially based on low labour costs, and not on technological efficiency. In any case, this allows them to survive in local markets.

On the other hand, the implementation of quality improvement methods, such as Iso9001 standards[1], is a challenging task involving strategic change and conditioning the whole organisational structure and routines of companies (Pekovic and Galia 2009; Bourke and Roper 2017). According to Diaye *et al.* (2009), the implementation of Iso9001 certifications requires a non-trivial managerial effort, in terms of time implementation may take between six and twelve months. Quality improvement practices can be seen as complementary to product and process innovations, as raising the opportunities to get non-technological innovations (Terziovski and Guerrero 2014). Iso9001 certification spurs a culture of attention to detail and not only a culture of innovation (Manders 2012).

Currently, results concerning the impact of quality management systems, standards and certification on innovation and productivity are rather inconclusive. Standardisation supporting quality management systems should stimulate the development of a common pool of codified knowledge, orienting the innovation path undertaken by the firm, a mechanism however

1 According to ISO (1998), "The ISO 9000 international standards are a set of written guidelines that make up a non-specific quality management system that can be applied to any organisation regardless of the product or service being provided".

which is still far from being well understood (King *et al.* 2017). Bourke and Roper (2017) explore complementarities between *soft* (*quality circles*) and *hard* quality improvement methods (*quality certification*) and their influence on *learning-by-using* and product innovation. They find positive and significant effects of quality certification, such as Iso9001, only when *quality circles* (*i.e.*, small groups of workers who meet regularly on a voluntary basis to discuss problems) are adopted prior to that certification. Terziovski and Guerrero (2014) look at Australian firms, finding that Iso9001 positively affects process innovation but not product innovation.

Diaye *et al.* (2009) study the effect of Iso9001 on the productivity (value added per employee) of French manufacturing firms in the late 1990s. They use propensity score matching estimates and find that in companies completely implementing Iso9001 the labour productivity is about 10% higher than in companies non-adopting this certification.

Based on the literature above, the empirical analysis developed in the remainder of the paper aims to investigate if simple managerial practices, such as the introduction of Iso9001 certification, at least partially contribute to reducing the large dispersion in firm performances and wages paid to workers fuelled by a *dualist structure* of the Italian production system (Costa *et al.* 2021; Dosi *et al.* 2012; 2015; 2021).

2. Empirical Model

In the first step of the econometric analysis, a pooled OLS model for years 2011-2019 has been implemented to study: a) the simple effect of having Iso9001 certification between 2011 and 2019 on productivity, profitability and wages paid by firms; b) the contribution of the Iso9001 certification in helping laggard firms (only small companies) to catch up with the leaders located at the frontier (only large and medium companies). As for point a), we regressed the firm outcomes on a time-invariant version of our binary variable Iso9001, that is, the Iso9001 dummy is always "1" for those firms possessing the certification in the period of interest (2011-2019) and "0" elsewhere[2]. In point b), I follow the distance to the frontier approach of Andrews *et al.* (2019) by identifying differential trends (in productivity, profitability and wages paid) between laggard and frontier firms. Both firms at the frontier and firms introducing Iso9001 certification are identified by means of binary variables (1/0). The difference here is that the Iso9001 dummy is reported only for those firms that introduced the Iso certification for the first time between 2012 and 2017 so this variable takes value 1 that year and zero elsewhere. For firms not introducing Iso certification the Iso9001 dummy always takes a value equal to zero. This allows making the model comparable with the dynamic difference in difference we use in the second step. However, in the first step, the interaction between linear trend, frontier status and Iso9001 dummy allows exploring whether introducing the Iso9001 certification benefits more the leaders or the laggards. Formally, the econometric specification used is the following:

$$\ln Y_{i,s,t} = \alpha_0 + \alpha_1 \, trend + \alpha_2 F_{i,s,t} * trend + \alpha_3 Z_{i,s} * trend + \alpha_4 Z_{i,s} * F_{i,s,t} * trend + \alpha_5 X_{i,st,} + TD_{t,s} + \epsilon_{i,s,t} \quad (1)$$

where *i* denote firms with i= 1, …, N , *s* stands for industries with s= 1, …, 28 and *t* years with t=2011,…,2019. *Y* is the outcome, namely the natural logs of MFP, labour productivity and average wages, and profit indicators. $F_{i,s,t}$ is a binary variable capturing the frontier status (1 at the frontier and 0 below the frontier) for companies in each sector (top 5% medium and large companies in terms of outcomes mentioned above), whilst *trend* is a deterministic (year) trend. $Z_{i,s}$ identifies a company introducing an Iso9001 certification for the first time between 2012 and 2017. $X_{i,st,}$ is a set of control variables that we describe in more detail in the next section. $TD_{t,s}$ are *industry-by-time* dummies that we introduce to control for any shock occurring at industry level over the period under analysis.

The interpretation for the coefficients of interactions reported in equation (1) reads as follows. α_1 describes the growth rate of the outcome variable *Y* (productivity, profitability or wages paid) for those firms below the frontier that do not introduce an Iso9001 certification (that is, small companies not introducing an Iso9001 certification). α_2 captures instead the deviation from this trend for firms at the frontier (medium and large leader firms not introducing Iso9001 certification). Thus, $\alpha_2 > 0$ means

2 The results for this simple specification are reported in columns 1, 3 and 5 of Tables 3 and A1.

that companies at the frontier are growing faster than those below the frontier. α_3 and α_4 describe the role played by the introduction of an Iso9001 certification for firms below (the smaller ones) and at the frontier (the large and medium ones), respectively. On the whole, positive and statistically significant values for α_3 and α_4 indicate that quality certification raises the rate of growth of Y. More in detail, in case $\alpha_3 > 0$ with $\alpha_3 > \alpha_4$ the Iso9001 certification helps companies below the frontier to catch up with the leaders located at the frontier. By contrast, when $\alpha_3 > 0$, $\alpha_4 > 0$ and $\alpha_4 > \alpha_3$ the Iso9001 certification is contributing to the divergence in productivity, profits and wages between leaders and laggards.

Equation (1) may also be seen as a (*triple*) difference in difference model. For example, α_4 captures the difference between the outcomes of leaders and laggards with Iso certification, after and before introducing it, and subtracts the difference between outcomes of leaders and laggards without Iso certification, after and before introducing it. α_3, instead reports the simple difference in differences between laggards with and without Iso certification, after and before introducing it. The problem in this specification is that there is not an exogenous group variable (policy or institutional change) to which the treatment is assigned. We have companies get treated, that is, they introduce Iso9001 certification at a particular point in time and others do not. The treatment is not randomly assigned and may depend on specific characteristics of companies that we do not observe. As we will see in the next section, I may control for the age and experience of the top manager/director of the firm, but not for his education. Likewise, I cannot control for innovative activities or internationalisation of the companies under analysis. It is possible that these omitted variables are simultaneously correlated with the Iso certification and the performance of the firm. It would mean that the high performances may be driven by the education of the top manager, important innovative activities, or export attitude that we do not observe, rather than the Iso certification. Due to the nonrandom assignment of the introduction of Iso9001, endogeneity related to reverse causality is also possible. It means that they are the most performant companies to introduce the Iso certification in order to strengthen their competitive advantages over time, rather than using this managerial practice as the key strategy to improve their performances.

To alleviate these problems, in the second step of the empirical analysis, I follow Pischke (2005) and Angrist and Pischke (2009) and based on the longitudinal structure of the database I set out a dynamic *difference-in-difference with fixed effects model*. According to the authors above, I may identify the unbiased effect of the Iso9001 certification on performances, provided that I control for unobserved heterogeneity at the company level (fixed effects). In order to clearly isolate the treatment effect related to the Iso certification I avoid triple interactions here and split the total sample into two subsamples including firms below and firms at the frontier. In the spirit of Autor (2003), I also exploit the time variant nature of the treatment (Iso certification) by introducing pre- and post-treatment effects.

The equation estimated in the second step reads as follows:

$$\ln Y_{ist} = \alpha_i + \sum_{\tau=0}^{m} \alpha_{-\tau} D_{i,s,t-\tau} + \sum_{\tau=1}^{q} \alpha_{+\tau} D_{i,s,t+\tau} + \beta X_{i,st,} + TD_{t,s} + \varepsilon_{i,s,t} \quad (2)$$

where now D is the key variable Iso9001, which takes value 1 at different points in time between 2012 and 2017 for treated firms and zero otherwise. The sums on the right-hand side, besides the simultaneous effect $\alpha_0 D_{i,s,t}$, allow for m lags ($\alpha_{-1;}\alpha_{-2;}$...) (or *post-treatment effects* and q leads ($\alpha_{+1;}\alpha_{+2;}$...) or *anticipatory effects*[3]. Significant coefficients for the lead variable tell us about an *anticipatory effect* of the Iso certification. It would mean that companies prepare to introduce Iso9001 by increasing in advance the productivity, profitability or wages paid to the employees. Useless to say that in my case this result would signal a questionable causal nexus between Iso9001 and outcomes; this is because the 'consequence' is determining the 'cause'. Therefore, by performing this exercise we allow for a sort of Granger Test for reverse causality. Instead, significant coefficients for

3 The time variant version of the Iso9001 dummy for the period 2012-2017 allows us to introduce lagged and anticipatory effects. More in detail, my case fits an econometric model with one lead (so that it may include anticipatory effects running from 2012 to 2011) and two lagged effects (so that effects from 2017 to 2019 may be included). Since additional leads and lags do not add statistical significance, I opted for the most parsimonious specification to avoid drops in the number of the observations.

lags mean that the introduction of the managerial practice may take time to show its effects on the outcomes. How quickly Iso9001 exerts its effects on firms' outcomes is a result we can obtain by specifying a dynamic structure with lags in our *difference in difference fixed effects model*.

3. Data description and summary statistics

Data sources and variables

The analysis is performed using two main datasets, namely BvD ORBIS Europe (July 2021 release) and Accredia (March 2021 release)[4]. In the construction of MFP, I supplement such data with sector-by-country information extracted from Eurostat.

I use ORBIS balance sheets to derive a measure of productivity as in Gal (2013) and Andrews *et al.* (2019). I consider firms with information on value added, employment, fixed assets, and depreciation. Monetary variables are expressed in constant euro at 2015 prices using an industry deflator from Eurostat and converted into power purchasing parities (PPP) based on OECD PPP for GDP or investment, respectively. The capital stock is derived, with the perpetual inventory method, from the constant price value of the total (non-current) investment that can be extrapolated from annual data on fixed assets and capital depreciation.

Multifactor productivity has been estimated according to Woolridge's method (2009), to ensure that our regression results are not driven by measurement issues. For example, it is well known that the estimation of production function suffers from the endogeneity of inputs, as productivity shocks, unobserved by the econometrician, influence the choice of input quantities at the company level and produce biased coefficients in the estimation of production function (Van Beveren 2012). Wooldridge (2009) refines the method originally developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) and offers a valid solution to address the endogeneity of inputs. Given differences across industry technologies, I apply Wooldridge's method (2009) to estimate 28 industry-specific output elasticities (and calculate firm-level MFPs as follows:

$$\ln \widehat{MFP}_{i,s,t} = \ln Y_{i,s,t} - \hat{\beta}_l^s \ln L_{i,s,t} - \hat{\beta}_k^s \ln K_{i,s,t} \qquad (3)$$

where $\widehat{MFP}_{i,s,t}$ is the multifactor productivity estimated at the company level, $\ln Y_{i,s,t}$ is the value added, $L_{i,s,t}$ and $K_{i,s,t}$ are labour and capital stock, respectively, used at company level, whereas $\hat{\beta}_l^s$ and $\hat{\beta}_k^s$ are the industry level output elasticities obtained from a production function estimated with the Wooldridge's method (2009).

The measure of MFP discussed above might suffer further from measurement errors due to the omitted price bias (Van Beveren 2012). This is because we used industry-level deflators that do not capture the price setting at the company level, so that MFP may incorporate the mark-up and not reflect the pure technological efficiency. The omitted price bias has been alleviated by applying a mark-up correction proposed by Andrews *et al.* (2019) and De Loecker and Warzynski (2012).

$$\ln (MFP\_MU_{i,s,t}) = \ln (MFP_{i,s,t}) - \ln (\mu_{i,s,t}) \qquad (4)$$

where MFP_MU is the mark up corrected multifactor productivity and μ is a measure of mark-up based on production data. This proxy of mark-up is based on the idea that the output elasticity of a variable input (such as labour) is only equal to its expenditure share in total revenue when price equals the marginal cost of production, $\mu_{i,s,t} = P/MC = Output\ Elasticity/Output\ Share$. Therefore, any form of imperfect competition produces a wedge not only between price and marginal costs but also between the output elasticity and the output share of the variable input (De Loecker and Warzynski 2012), so that becomes higher than one. I follow in particular Andrews *et al.* (2019) by empirically approximating the mark-up as $\mu_{i,s,t} = \frac{\hat{\beta}_l^s}{\widetilde{WS}_{i,t}}$, where the numerator is the estimated output elasticity to labour and the denominator is the adjusted wage share (see Andrews *et al.* 2019 for more details).

In this study, however, estimating MFP corrected for mark-up goes beyond the necessity to use something that accounts for omitted price bias. Indeed, we retain and compare both measures of MFP in order to analyse whether Iso9001, which especially entails improvements in product quality and customer satisfaction, shows different influence between performances based more on technical ef-

4 Accredia is the sole national accreditation body appointed by the Italian government in compliance with the application of the European Regulation 765/2008. This organisation collects certifications issued in many sectors by an accredited third-party body in accordance with the standards ISO/IEC 17065, ISO/IEC 17021-1, ISO/IEC 17024.

ficiency (MFP_MU) and performances incorporating the market power of firms (MFP).

As discussed above, I consider additional dependent variables such as labour productivity (value added per employee), average labour costs (labour costs per employee) and profits, as outcome variables. The average labour costs approximate the average wages paid by firms. Since I am especially interested in the trend and annual variation of average labour costs, I assume that wages mainly contribute to the movements and trends of this variable. As for profits, I use two alternative measures, that is, profit margin and return on assets (ROA) [5]. The former is the ratio between profit/losses before tax and operating revenues; the latter is the ratio of profit/losses before tax to total assets. Profit margin informs investors about a firm capacity in turning sales into profits. ROA is instead a measure of management effectiveness in gaining profits with the available assets and it is normally higher in firms with a low capital intensity that employ important intangible assets not reported in the book (Haryanto and Chaeriah 2018).

I measure quality improvement practices by exploiting information on firm-level use of quality certification. The Accredia database provides complete information on the number and years of introduction of Iso9001 certifications. The firm-level merging with ORBIS was possible by using the company tax code.

From the ORBIS database, I also collect data on the characteristics of the highest-ranking authority in charge of the organisation who has executive powers (director of the firm, top manager, chairman). This allows us to approximate the human capital of managers based on experience (age and tenure within the firm). Unfortunately, we do not have information on the formal education of the managers.

However, in the managerial literature, it is quite common to use work experience explicitly as a measure of human capital (Geletkanycz and Boyd 2011; Khanna *et al.* 2014). Since I have information about the age and appointment date of the top manager in the company, two proxies for the manager's human capital can be built. The age of the manager, as a standing alone term, would capture generic skills. Using the appointment date, I also calculate an indicator for the tenure of the manager within the firm. More precisely, I take the ratio *firm-specific tenure of the manager/age of the manager* to capture firm-specific managerial skills.

I include two other controls for managerial characteristics, that is, time invariant dummy variables for the gender of the manager and their involvement in the firm as a shareholder. These controls allow us to take into account the heterogeneity in ruling companies associated with gender diversity (Brewis and Linstead 1999) and with the possibility of managerial ownership to overcome standard agency problems between management and owners (Jensen and Meckling 1976).

Following Gal (2013), to increase estimates representativeness I use resampling weights based on the employees in *industry*size_class*year* cell, extracted from the Eurostat Structural Business Statistics database. The weight associated to each firm is always greater than, or equal to one. More details on calculation of resampling weights for Orbis companies are reported in Pompei and Venturini (2022).

Summary statistics

Table 1 shows the distribution of Italian companies across the 28 industries, besides the share of firms that introduced the Iso9001 certification, and the resampling weights averaged across years and firm-size classes. Overall, this sample covers 109,919 companies. The number of companies with Iso9001 certification is 8,166, that is, 7.43% of the whole sample. Interestingly, the distribution of Iso certifications is not excessively skewed across industries. We observe higher frequencies of these firms in manufacturing industries with different levels of technological intensity and productivity, such as Computer, Electronics and Optical Products; Chemical Products; Basic Metals; Rubber and Plastic Products.

5 Note that to mitigate the bias induced by extreme observations, for all firms' outcomes mentioned above a trimming procedure has been implemented as follows (see Andrews *et al.* 2019): (i) before computing MFP, we remove companies at the top and bottom 0.5th percentiles of input and output distribution (in logs); and (ii) after MFP computation, we delete those companies with productivity levels and growth at the top and bottom 1st percentile. The trimming procedure described in step (i) is also used for the additional outcomes, that is, labour productivity, average labour costs, profit margin and return on assets (ROA). For each sector and year, I define as the frontier level of the outcome variables their median values for the top 5% companies.

Table 1. Italian companies, Iso9001 certifications and resampling weights across industries

Industries	Total	Iso9001	Iso9001_share (%)	Weights
Mining and Quarrying	411	41	9.98	2.34
Food products, beverages and tobacco	4273	247	5.78	6.32
Textiles, wearing apparel, leather and	4071	122	3.00	5.85
Wood&paperproducts;print.&rec.media	2867	208	7.25	5.93
Coke and Ref.Petr.Products	103	5	4.84	1.71
Chemicals Products	1358	217	15.98	1.77
Pharmaceutical Products	184	15	8.15	1.41
Rubber, Plastic and Non Met. Min. Prod	4255	497	11.68	1.88
Basic Metals and Metal Products	9451	1,301	13.77	3.25
Computer, Electronics, Optical Products	963	157	16.30	2.09
Electrical Equipment	1435	211	14.70	2.78
Machinery	4927	475	9.64	2.27
Motorvehicles and Other Transport Equip	882	88	9.98	2.50
Furniture,Other Manuf.and &Repair	3675	307	8.35	6.68
Elettricity	700	38	5.43	3.02
Water Supply&Waste	1718	293	17.06	2.54
Construction	11854	1,677	14.15	11.65
Wholesale & Retail Trade_MotorVehicles	3839	160	4.17	9.44
Wholesale Trade	16481	678	4.11	5.46
Retail Trade	8149	91	1.12	16.21
Transportation&Storage	5547	424	7.64	5.58
Postal&courier Activities	52	2	3.88	7.10
Accomodation&Food Services	6317	57	0.90	19.40
Publishing,Television&Broadcasting	614	10	1.63	4.72
Telecommunications	180	14	7.78	6.55
Computer Programming&Consultancy	1948	151	7.75	7.81
Real Estate	5755	21	0.36	17.54
Professional & Sc. Activities	7911	659	8.33	18.52
Total	**109,919**	**8,166**	**7.43**	**9.64**

Notes: companies result from a merger between ORBIS and Accredia database and they are averages calculated over the 2011-2019 period. The second column reports companies with the Iso9001 certification independently on the time it has been introduced. Weights are averages over time (2011-2019) and classes of the firm size of the resampling weights assigned to each firm and calculated for each *industry*size_class**year cell according to the Gal's procedure (2013).

Source: ORBIS Europe and Accredia

Likewise, among non Manufacturing, Service sectors and Public Utilities we find above-the-mean frequencies in High- and Low knowledge-intensive industries, for example, Computer Programming and Consultancy; Telecommunications; Construction; Water Supply and Waste. Therefore, even in summary statistics not adjusted by industries and reporting the detail Iso/Non-Iso firms, averaged values for firms' performance suffer less from industry composition effects.

These summary statistics are reported in Table 2 where companies are distinguished according to the

Table 2. Firm performance and managerial characteristics

	Below Frontier			At the Frontier		
	Non-Iso9001	Iso9001	Diff	Non-Iso9001	Iso9001	Diff
Panel A. Firm Performances (outcome variables)						
Ln(MFP)	10.61 *(0.98)*	10.91 *(0.82)*	-0.300***	12.10 *(0.95)*	12.25 *(1.11)*	-0.154***
Ln(MFP_MU)	10.45 *(1.32)*	10.87 *(1.03)*	-0.413***	12.65 *(1.08)*	12.74 *(1.17)*	-0.094**
Ln(wage)	10.27 *(0.69)*	10.44 *(0.42)*	-0.176***	11.17 *(0.26)*	11.18 *(0.26)*	-0.008
Ln(Labour Prod.)	10.84 *(0.65)*	10.90 *(0.49)*	-0.065***	12.09 *(0.33)*	12.07 *(0.30)*	0.014
Profit Margin (%)	2.78 *(8.65)*	3.86 *(6.20)*	-1.080***	24.40 *(6.91)*	24.13 *(7.81)*	-0.724*
ROA (%)	1.80 *(4.63)*	2.39 *(4.32)*	-0.592***	18.48 *(5.14)*	18.92 *(5.07)*	-0.445*
Panel B. Managerial and other firm characteristics						
Ln(Manager Age)	3.941 *(0.25)*	3.938 *(0.25)*	0.003**	3.96 *(0.24)*	3.96 *(0.23)*	-0.003
Manager Tenure/Age	0.095 *(0.12)*	0.092 *(0.12)*	0.004***	0.010 *(0.00)*	0.014 *(0.00)*	0.004***
Female Managers (share)	0.17 *(0.37)*	0.14 *(0.35)*	0.027***	0.11 *(0.00)*	0.09 *(0.01)*	0.013
Man_Shareholder (share)	0.74 *(0.44)*	0.73 *(0.44)*	0.006***	0.26 *(0.01)*	0.26 *(0.01)*	0.006
Ln(Age of Firm)	2.85 *(0.76)*	2.87 *(0.69)*	-0.017***	3.03 *(0.82)*	2.94 *(0.80)*	0.087***
Ln(Kap/labour)	10.49 *(1.89)*	10.28 *(1.42)*	0.213***	10.10 *(2.12)*	10.29 *(2.01)*	-0.191***
Ln(Employees)	2.26 *(0.92)*	2.64 *(0.72)*	-0.379***	4.67 *(0.61)*	4.64 *(0.58)*	0.027
Obs.	**692,067**	**75,357**		**7,125**	**1,048**	

Notes: unweighted summary statistics. For the six measures of performance reported in the table, firms at the frontier are medium and large enterprises in the group of top 5% of the performance distributions, while firms below the frontier are small companies in the rest of 95%. The number of observations and statistics for managerial and other firm characteristics only refer to MFP-based frontier definition. All values reported are averages from continuous variables with exception of Female and Shareholder Managers that show the proportions. All these figures have been calculated across firms, 28 industries and years (2011-2019). Diff is the difference between Non-Iso9001 and Iso9001 means reporting the significance level for a t-test where H0: Diff=0 and HA: Diff≠0; *** p<0.01, ** p<0.05.

Source: ORBIS Europe and Accredia

frontier status and the implementation of Iso9001 certification. For each outcome, I first define the group of leaders (top 5%) and the laggards[6]. In order to study whether performances between small and medium-large companies are diverging and how the implementation of Iso9001 certification is changing this pattern, I further refine the group of leaders as including only medium and large enterprises and the group of laggards as made up by only small companies. The six measures of performances reported in Table 2 (Panel A) refer to the average from the medium and large enterprises at the frontier (top 5%) and to the average from the rest, made up of small companies falling in the larger 95% group below the frontier. The frontier status for managerial characteristics (age and firm tenure of the manager, gender, shareholder status) and other firm characteristics (capital intensity, age of firm and number of employees) shown in Table 2 (Panel B), refers to our key indicator of performance, that is MFP. Figures for managerial and other firm characteris-

6 More in detail, I define an industry-level frontier as the top 5% companies I find in the distributions of the outcome variables, that is, MFP, MFP corrected for mark-up, labour productivity, average wages, profit margin and ROA. As expected, on average, medium and large companies are over-represented in the top 5% groups, as 7% of them fall in this group of leaders, while we only find 1.7% of total small companies in the same group. In addition, we refine the two subsamples that refer to the leader and the laggard groups, by singling out only medium and large enterprises in the top 5% group and leaving only small companies in the rest of the 95% (laggard companies).

tics referring to the other five outcome-based frontier definitions are pretty similar to those reported on this Table and are available upon request.

On the whole, besides the larger gaps that 'by construction' emerge between the performances of firms at the frontier and below the frontier, a different pattern emerges between leaders and laggards adopting an Iso9001 certification (Table 2, Panel A). Introducing an Iso9001 certification is associated with better performances in the group of companies below the frontier (small companies), while the differences appear much smaller in both their magnitude and statistical significance for medium and large companies at the frontier. This very preliminary evidence could reveal that quality improvement through certification is an important aspect for the laggard small companies, whereas it could be not so much crucial for the leaders operating at the frontier.

As for managerial and other firm characteristics (Table 2, Panel B), the small companies (below the frontier) introducing an Iso9001 scheme are slightly older and more labour-intensive (lower capital/labour ratio and higher number of employees) than non-adopters. Instead, for the group of leading firms operating at the frontier, the differences in firm characteristics between the Iso9001 adopters/non-adopters are much less pronounced (as many of those are not statistically significant), except for the higher capital intensity and smaller age, that we find among the Iso9001 adopters.

4. Econometric results: Iso9001 certification as a driver of productivity, profitability, and wages

In this section, I present the results of the econometric strategy discussed in Section 2.

First, a distance to frontier framework (DTF) has been applied as in Andrews *et al.* (2019), to infer the role played by managerial practices, such as the implementation of the Iso9001 certification, in driving or reducing the performance gap between the medium-large firms at the frontier and the small firms who make up the larger group of the laggards. As already reported in paragraph *Summary statistics*, our frontier definition relies on leaving only medium and large firms in the group of leaders (top 5%), while small companies only (1-49 employees) make up the group of the laggards (the remainder 95% of firms).

Second, I take into account the unobserved heterogeneity and the potential endogeneity between the introduction of the Iso9001 and performances (especially the endogeneity based on *reverse causality*) by performing a *difference-in-difference fixed effects model*, with the introduction of leads and lags in the spirit of Autor (2003). In order to avoid complex interactions and difficult interpretations, I first apply this strategy for the whole sample and next distinguish between the sub-samples of leader and laggard firms.

I keep in the main text the results for three preferred outcomes: i) productivity, measured by MFP (Wooldridge method); ii) profitability, measured by return on assets (ROA) and iii) average wages paid by firms. Tables A1 and A2 in the Appendix report results for alternative measures of productivity and profitability: iv) MFP calculated with Wooldridge method and corrected for mark-up (MFP_MU); v) labour productivity (that is, the ratio value added/employees) and vi) profit margin.

Distance to frontier framework

Table 3 shows the results of the model in eq. (1) estimated with pooled OLS. We use two versions of the dummy variable indicating the presence of Iso9001 certification. The *time-invariant* dummy takes value 1 for all firms owning a certification independently of the year in which it has been adopted; in this case, we also include companies introducing the quality certification before 2011. These estimates are reported in Cols. (1), (3) and (5). The *time-varying* Iso9001 dummy takes value 1 only in the year in which the certification has been introduced between 2012 and 2017, and zero otherwise. In these estimates (cols. (2), (4) and (6)), we introduce controls for managerial characteristics to capture potential sources of unobserved heterogeneity associated with the CEO or director's capabilities. It should be noted that all specifications include controls for firm age and size and industry-by-time dummies to account for common shocks influencing the outcomes of interest. Standard errors are clustered at the industry level.

Using the time-invariant dummy for Iso9001, we find a positive association between the certification and higher performance in two out of three outcome variables (average wages and ROA, see Table 3). Appendix Table A1 reveals positive associations between Iso9001 and alternative measures of productivity (*i.e.*, MFP corrected for mark-up) and profits (profit margin).

Table 3. Iso9001, MFP, wages, and profits in the Italian companies (Pooled OLS)

	(1) Ln(MFP)	(2) Ln(MFP)	(3) Ln(wage)	(4) Ln(wage)	(5) ROA	(6) ROA
Iso9001	0.041 (0.031)		0.106*** (0.026)		0.489*** (0.096)	
Trend		-0.020*** (0.001)		-0.013*** (0.001)		0.406*** (0.004)
Frontier X trend		0.456*** (0.036)		0.070*** (0.011)		3.070*** (0.171)
Iso9001_12_17 X trend		0.008** (0.003)		0.018*** (0.005)		0.062*** (0.015)
Iso9001_12_17 X trend X frontier		-0.049 (0.041)		-0.011 (0.020)		0.629 (0.302)
Ln(Manager Age)		0.137*** (0.013)		0.075** (0.031)		-0.394*** (0.090)
Manager Tenure/Age		-0.168*** (0.050)		-0.044 (0.038)		0.763*** (0.245)
Female Managers (%)		-0.063*** (0.019)		-0.038*** (0.012)		-0.105*** (0.035)
Man_Shareholder (%)		-0.101*** (0.014)		-0.040** (0.017)		0.498*** (0.140)
Ln(Age of Firm)	0.131*** (0.017)	0.114*** (0.013)	0.112*** (0.017)	0.124*** (0.015)	-0.642*** (0.153)	-0.204* (0.105)
Ln(Labour Prod.)			0.386*** (0.040)	0.292*** (0.030)		
Firm-size	Yes	Yes	Yes	Yes	Yes	Yes
Time*Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	11.239*** (0.054)	10.333*** (0.068)	5.887*** (0.412)	6.594*** (0.332)	2.908*** (0.485)	1.770*** (0.514)
Iso9001 dummy	Time Invariant	Time Variant	Time Invariant	Time Variant	Time Invariant	Time Variant
Observations	840,548	723149	874027	739111	875,385	734897
R-squared	0.520	0.597	0.202	0.168	0.048	0.071

Notes: the dependent variables are MFP, average wages and ROA in levels. *Trend* is a linear trend while *frontier* is a binary variable that takes value 1 for firms at the frontier and zero otherwise. In cols (1), (3), (5) the Iso9001 dummy takes value 1 for all firms that introduced the certification independently on time (time invariant) while in cols. (2), (4), (6) *time variant* means that Iso9001_12_17 takes value 1 only in the year of Iso9001 adoption and zero otherwise. The year of Iso9001 adoption is the sub-period 2012-2017, in order to make comparable the pooled OLS with the diff-in-diff fixed effects model performed in Table 4. In the wage equation a control for labour productivity has been included. Standard errors clustered at industry (NACE 2) level. Year-by-industry fixed effects and controls for firm-size classes are included in all regressions that also use the resampling weights discussed in Section 3. ***,**,* significant at 1, 5 and 10%.

Source: ORBIS Europe and Accredia

As expected, in the growth trend specifications (cols. (2), (4), (6) of Tables 3 and A1), diverging paths are observed between the top 5% medium and large firms (see the coefficients for *Frontier X trend*) and the rest (coefficients for *trend*), with the former growing much faster than the latter in terms of MFP, MFP corrected for mark-up, profits (both ROA and profit margin) and average wages paid. These results are coherent with divergent paths in the MFP found (at least until 2015) by other studies focused on Italian superstar firms (Lotti and Sette, 2019). Likewise, the divergence in productivity is mirrored by a divergence in average wages paid by firms (see column 4 of Table 3), as also found for Italy by Bloise *et al.* (2022).

However, when we turn to the role played by the Iso9001 certification we find that only the coefficient associated to the *Iso9001_12_17 X trend* is positive and significant. By combining results from Table 3 and Table A1 we get a clear picture of the effects of Iso9001 certification, which seems to largely promote the catch-up of small companies towards national leaders. With the exception of labour productivity, the interaction between certification and the trend term has a positive and significant coefficient only for laggards (α_3). It signals that introducing the Iso9001 scheme helps firms bridge the gap and, at least apparently, this managerial practice seems to exert a role in equalising economies where great divergences emerge due to the *winner takes it all* behaviour of a few superstar firms.

Table 4. Iso9001, MFP, wages, and profits in the Italian companies (Diff-in-Diff with Fixed Effects)

Panel A: Ln(MFP)			
	(1) Whole Sample	(2) Frontier	(3) Below Frontier
$Iso9001\_12\_17_{t0}$	0.056*** (0.016)	-0.151 (0.343)	0.063*** (0.015)
$Iso9001\_12\_17_{t+1}$	0.038 (0.041)	-0.202 (0.198)	0.029 (0.028)
$Iso9001\_12\_17_{t-1}$	0.026** (0.013)	0.035 (0.196)	0.032** (0.013)
$Iso9001\_12\_17_{t-2}$	0.023 (0.023)	-0.041 (0.084)	0.023 (0.023)
Observations	567,897	3,458	500418
Control firms	110567	12319	109687
Treated firms	3226	339	3240
Panel B: Ln(Wage)			
	(1) Whole Sample	(2) Frontier	(3) Below Frontier
$Iso9001\_12\_17_{t0}$	-0.020 (0.013)	0.033 (0.063)	-0.009 (0.090)
$Iso9001\_12\_17_{t+1}$	0.054** (0.018)	-0.003 (0.026)	0.043*** (0.015)
$Iso9001\_12\_17_{t-1}$	0.012 (0.013)	-0.071 (0.050)	0.007 (0.080)
$Iso9001\_12\_17_{t-2}$	0.011 (0.014)	0.083 (0.065)	0.009 (0.016)
Observations	478,207	1995	421499
Control firms	131032	1038	121454
Treated firms	3786	33	3498
Panel C: ROA			
	(1) Whole Sample	(2) Frontier	(3) Below Frontier
$Iso9001\_12\_17_{t0}$	0.181* (0.094)	6.869* (3.799)	0.155** (0.075)
$Iso9001\_12\_17_{t+1}$	-0.186 (0.197)	-3.552 (4.519)	0.074 (0.139)
$Iso9001\_12\_17_{t-1}$	-0.318** (0.135)	-2.545 (1.644)	-0.015 (0.092)
$Iso9001\_12\_17_{t-2}$	0.199 (0.168)	-1.790*** (0.471)	0.182 (0.121)
Observations	478,941	1318	419027
Control firms	131516	1049	122315
Treated firms	3792	43	3494

Notes: the dependent variables are MFP, average wages and ROA in levels. The regression model is a Diff-in-Diff with fixed effects and time variant treatment where Iso9001_12_17 takes value 1 only in the year of Iso9001 adoption and zero otherwise. The year of Iso9001 adoption is the sub-period 2012-2017, this allows to introduce leads ($Iso9001\_12\_17_{t+1}$) and lags ($Iso9001\_12\_17_{t-1}$; $Iso9001\_12\_17_{t-2}$) in order to detect anticipatory effects and post-treatment effects for the period 2011-2019. Like a Granger test, statistical significance for the $Iso9001\_12\_17_{t+1}$ coefficient indicates reverse causality. Standard errors clustered at industry (NACE 2) level. In the wage equation a control for labour productivity has been included. Year-by-industry fixed effects and controls for time varying manager and firm characteristics (manager's and firm's age, tenure, firm-size classes) are included in all regressions that also use the resampling weights discussed in Section 3. The group of firms in the whole sample is larger than the sum of firms at- and below the frontier because firms at the frontier only include medium and large enterprises, while firms below the frontier is only made up by small companies.

***,**,* significant at 1, 5 and 10%.

Source: ORBIS Europe and Accredia

Difference-in-difference with fixed effects model

Our baseline pooled OLS estimation exploits only between-units variability to identify the effect of the explanatory variables, neglecting thus some important issues such as heterogeneity across firms, omitted variables, reverse causality and self-selection processes. To partially mitigate these issues, I run a *Diff-in-Diff* estimation with a fixed effects model as in Autor (2003). This means that the econometric model is augmented, in this specific case, with

one lead and two lags of the treatment variable to capture anticipatory and post-treatment effects of the variable of interest. Since we want to test the reliability of results in Table 3 and Table A1, we also distinguish between firms lying at the frontier and firms below the frontier. Should the previous results be confirmed we would observe a significant impact of the Iso9001 certification only for small companies below the frontier.

Estimates in Table 4 (reporting our preferred outcomes MFP, wages, and ROA) include all time-varying control variables used in the pooled OLS regressions, whilst time-invariant individual manager characteristics, such as gender and shareholder status, are absorbed by the firm-level fixed effect.

In Table 4 (Panel A), col. (1) shows the effect on MFP associated with the Iso9001 certification for the whole sample. The introduction of this type of managerial practice produces a simultaneous increase in MFP levels by 5.6% and a lagged positive effect showing up after one year by 2.6%. The impact estimated here for management practices is pretty comparable to that found by Bloom and Van Reenen (2007) using a composite indicator covering a larger array of managerial characteristics; indeed, these authors found total impacts on MFP that depending on managerial practices used range from 3.2 to 7.5%. The total impact exerted by the introduction of Iso9001 certification in our case is the algebraic sum of the simultaneous and lagged coefficients, which is 8.2%. Interestingly, when the *diff-in-diff estimation with fixed effects model* is replicated within the two sub-samples, we find a similar and statistically significant pattern only for small companies below the frontier, whereas effects of the same certification for the medium and large companies operating at the frontier resulted non statistically significant (see Table 4, Panel A, cols 2 and 3). In other words, the introduction of Iso9001 among small companies (that is, the laggards) yields a positive effect on MFP by +6.3% the year of the Iso9001 introduction and an additional +3.2% after one year.

As for other outcomes, we find confirmation of positive effects of the Iso9001 certification in the group of companies below the frontier only in the case of profits (ROA), where this managerial practice yields a positive simultaneous effect by 0.155 percentage points (see Table 4, Panel C, column 3).

In the case of wages paid by firms (Tabel 4, Panel B) and for alternative measures of productivity and profits (that is, MFP_MU, labour productivity and profit margin, respectively, see Table A.2), the influence of Iso9001 is more questionable. Here, the coefficients for the lead variables ($Iso9001\_12\_17_{t+1}$) are significant and detect the potential presence of reverse causality between outcome and treatment variables (Granger test), whereas coefficients attached to simultaneous and lagged effects ($Iso9001\_12\_17_{t0}$, $Iso9001\_12\_17_{t-1}$, $Iso9001\_12\_17_{t-2}$) show weak or no statistical significance.

If we take as more reliable the results coming out from this more robust method, we may observe that the positive MFP and profit effects of the Iso certification tell us about small companies that partially reduce the gap.

Conclusions

In this work, I have explored the role played by managerial practices, such as the introduction of the Iso9001 certification, on reducing the gap between the small companies below the frontier and the medium-large companies at the industry frontier of the Italian economy.

A distance to frontier approach has been applied to study whether this quality improvement method contributes to reducing (or enlarging) the performance gaps observed between the leading firms and the rest. Several outcomes have been taken into account, namely MFP (with and without mark-up correction), labour productivity, wages, and profits. First, I have run a pooled OLS model finding important divergent trends between top performers and the rest of Italian small companies for almost all the measures of performances used. However, those small companies adopting innovative managerial practices such as Iso9001 certification are found to close more easily the gap, not only in terms of MFP (with and without mark-up correction) but also in terms of profits and average wages.

When I account for endogeneity issues, addressed by performing a *Diff-in-Diff fixed effects regression*, results were revealed to be robust for only MFP (without the mark-up correction) and profits. Interestingly, the positive effect of the Iso9001 scheme on MFP shows up slowly, *i.e.* with some lags with respect to the introduction of this

practice. By contrast, no robust and positive effect does emerge whether we use a mark-up corrected MFP. It would suggest that laggard firms exploit the Iso9001 certification to gain some market power that then translates into higher prices and profits. The competitive advantage in these contexts is shaped by a culture of attention to detail, customer satisfaction and quality improvement. All these aspects probably guarantee the low-capital intensity laggards a minimum of profitability, especially when relying on returns on (low-level) capital assets, and this increases their probability to survive the specific market niches. Undoubtedly, future research is needed to confirm the role of Iso9001 certification in exerting a specific influence on the organisational aspects of companies and in improving the quality of their products and customer satisfaction, without necessarily increasing their productivity performances and technical efficiency. This result seems somehow coherent with that based on the persistence of a population of laggard firms underscored by the literature on *neo-dualism* (Dosi *et al.* 2015; 2021; Costa *et al.* 2021). In particular, as already discussed in Section 1, Costa *et al.* (2021) identified large groups of small companies deploying simple managerial strategies (such as product quality and market power in setting selling prices); they probably survive the local markets, not because of their productivity performances but thanks to profits related to their market power. These *Essential* or *Managerial* companies are very similar to our small firms that partially bridge the gap with leaders only in terms of multifactor productivity (incorporating the mark-up) and in terms of profits.

A second result, deserving more attention and additional research, is the weak role of Iso9001 certification in reducing the gap in terms of wages paid to workers. This could be connected to the result discussed above, *i.e.*, the lack of robustness of Iso9001 certification in boosting labour productivity and technical efficiency also reflects on its weak influence on wages paid by firms. Adopting quality improvement methods relying on certification seems to guarantee survival to the laggard firms but exerts no equalising role on the wage inequality driven by firm heterogeneity. For now, my conclusion is that industrial relations and policies centred on fiscal incentives stimulate the adoption of wage bonuses, by reducing the cost to employers of adopting such pay schemes and compensating employees for the risk to which they are exposed in the case of volatile and uncertain bonuses, remains the way to increase productivity and wages (Damiani *et al.* 2022). However, future research may clarify whether complementarities between quality improvement methods and practices related to human resource management (such as incentive pay schemes) are crucial to alleviating the between-firm wage inequality and the more general problem of wage stagnation in Italy.

Appendix
Effects of Iso9001 on Alternative Measures of Productivity and Profits

Table A1. Iso9001, labour productivity, MFP corrected for mark-up and profit margin (Pooled OLS)

	(1) Ln(MFP_MU)	(2) Ln(MFP_MU)	(3) Ln(LabProd.)	(4) Ln(LabProd.)	(5) Profit_marg	(6) Profit_marg
Iso9001	0.201*** (0.019)		0.019 (0.029)		0.579*** (0.115)	
Trend		0.014*** (0.002)		0.034*** (0.002)		0.572*** (0.006)
Frontier X trend		0.362*** (0.055)		0.179*** (0.016)		4.428*** (0.167)
Iso9001_12_17 X trend		0.028*** (0.004)		-0.001 (0.004)		0.163*** (0.039)
Iso9001_12_17 X trend X frontier		-0.058 (0.044)		0.028 (0.030)		0.074 (0.652)
Ln(Manager Age)		0.199*** (0.048)		0.102*** (0.012)		-0.864*** (0.291)
Manager Tenure/Age		-0.217*** (0.066)		-0.081* (0.043)		2.131** (0.807)
Female Managers(%)		-0.140*** (0.042)		-0.049*** (0.015)		-0.340 (0.275)
Man_Shareholder(%)		-0.133*** (0.029)		-0.074*** (0.012)		0.808** (0.356)
Ln(Age of Firm)	0.162*** (0.024)	0.150*** (0.022)	0.079*** (0.016)	0.091*** (0.013)	0.058 (0.276)	-0.132 (0.278)
Ln(Kap/labour)			0.170*** (0.011)	0.120*** (0.012)		
Firm-size	Yes	Yes	Yes	Yes	Yes	Yes
Time*Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	10.506*** (0.071)	9.498*** (0.204)	8.876*** (0.107)	8.946*** (0.094)	2.205** (0.849)	4.225*** (0.814)
Iso9001 dummy	Time Invariant	Time Variant	Time Invariant	Time Variant	Time Invariant	Time Variant
Observations	839,763	721,816	874,046	741,323	869,117	763,642
R-squared	0.309	0.353	0.311	0.322	0.042	0.196

Notes: the dependent variables are multifactor productivity corrected for mark-up (for the definition of MFP_MU see Section 3), labour productivity (value added per employee) and profit margin (the ratio of profits before tax on operating revenue). They are all expressed in levels. *Trend* is a linear trend while *frontier* is a binary variable that takes value 1 for firms at the frontier and zero otherwise. In cols (1), (3), (5) the Iso9001 dummy takes value 1 for all firms that introduced the certification independently on time (time invariant) while in cols. (2), (4), (6) *time variant* means that Iso9001_12_17 dummy takes value 1 only in the year of Iso9001 adoption and zero otherwise. The year of Iso9001 adoption is the sub-period 2012-2017, in order to make comparable the pooled OLS with the diff-in-diff fixed effects model performed in Table 9. Standard errors clustered at industry (NACE 2) level. Year-by-industry fixed effects and controls for firm-size classes are included in all regressions that also use the resampling weights discussed in Section 3. ***,**,* significant at 1, 5 and 10%.

Source: ORBIS Europe and Accredia

Table A2. Iso9001, labour productivity, MFP corrected for mark-up and profit margin (Diff-in-Diff with Fixed Effects)

Panel A: Ln(MFP_MU)			
	(1) Whole Sample	(2) Frontier	(3) Below Frontier
$Iso9001\_12\_17_{t0}$	0.011 (0.030)	0 .008 (0.131)	0.02 (0.030)
$Iso9001\_12\_17_{t+1}$	0.078 (0.051)	-0.183 (0.191)	0.067** (0.032)
$Iso9001\_12\_17_{t-1}$	0.035** (0.016)	-0.050 (0.075)	0.033* (0.018)
$Iso9001\_12\_17_{t-2}$	0.038 (0.030)	0.021 (0.106)	0.031 (0.030)
Observations	478275	2081	430098
Control firms	109742	1316	109119
Treated firms	3249	36	3232
Panel B: Ln(LabProd.)			
	(1) Whole Sample	(2) Frontier	(3) Below Frontier
$Iso9001\_12\_17_{t0}$	-0.007 (0.016)	-0.098*** (0.032)	0.005 (0.011)
$Iso9001\_12\_17_{t+1}$	0.003 (0.012)	-0.106*** (0.019)	0.001 (0.010)
$Iso9001\_12\_17_{t-1}$	0.027** (0.012)	-0.008 (0.042)	0.019** (0.009)
$Iso9001\_12\_17_{t-2}$	0.012 (0.016)	-0.003 (0.015)	0.014 (0.016)
Observations	478,208	977	422,160
Control firms	131045	503	121680
Treated firms	3786	20	3506
Panel C: Profit Margin			
	(1) Whole Sample	(2) Frontier	(3) Below Frontier
$Iso9001\_12\_17_{t0}$	0.040 (0.146)	-2.968 (3.819)	0.078 (0.189)
$Iso9001\_12\_17_{t+1}$	-0.666* (0.325)	4.183* (2.272)	-0.271** (0.132)
$Iso9001\_12\_17_{t-1}$	-0.288 (0.202)	-3.754*** (1.046)	-0.189 (0.265)
$Iso9001\_12\_17_{t-2}$	0.015 (0.239)	5.769*** (0.865)	0.050 (0.202)
Observations	475,315	1,338	416,707
Control firms	130705	757	121598
Treated firms	3784	22	3495

Notes: the dependent variables are MFP, average wages and ROA in levels. The regression model is a Diff-in-Diff with fixed effects and time variant treatment where Iso9001_12_17 takes value 1 only in the year of Iso9001 adoption and zero otherwise. The year of Iso9001 adoption is the sub-period 2012-2017, this allows to introduce leads ($Iso9001\_12\_17_{t+1}$) and lags ($Iso9001\_12\_17_{t-1}$; $Iso9001\_12\_17_{t-2}$) in order to detect anticipatory effects and post-treatment effects for the period 2011-2019. Like a Granger test, statistical significance for the $Iso9001\_12\_17_{t+1}$ coefficient indicates reverse causality. Standard errors clustered at industry (NACE 2) level. Control for capital/labour ratio has been included in the labour productivity equation (second panel). Year-by-industry fixed effects and controls for time varying manager and firm characteristics (manager's and firm's age, tenure, firm-size classes) are included in all regressions that also use the resampling weights discussed in Section 3. The group of firms in the whole sample is larger than the sum of firms at- and below the frontier because firms at the frontier only include medium and large enterprises, while firms below the frontier is only made up by small companies.

***,**,* significant at 1, 5 and 10%.

Source: ORBIS Europe and Accredia

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