The impact of Middle Manager Training on productivity: a test on Italian companies

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ABSTRACT

This paper presents panel evidence on the productivity effects of middle managers' off-the-job formal training in Italy. It is based on a rich and reliable panel dataset covering all sectors of the Italian economy over the period 2006-2011. We employ panel data techniques and self selection models to show that off-the-job formal training for middle management has a significant non-linear exogenous effect on total factor productivity. Moreover, results indicate that middle manager's off-the-job formal training is more effective in larger firms and that different training methods have heterogeneous effects on productivity.

Keywords:

middle manager training, total factor productivity, IV-GMM

1. Introduction

It has been documented widely that human capital investments are essential for firms to maintain high competitiveness levels, face continuing technological changes efficiently, and reap the benefits of such changes. Recently, this observation has been evidenced by the effort that institutions and countries are undertaking to improve and promote human capital investments by giving priority to training activities. Training[i], among various human capital strategies, represents one major activity to improve skills and abilities, which in turn increase one's human capital accumulation (Becker, 1964).

The literature on training outcomes is extensive. Both empirical and theoretical studies can be generally classified into the following three branches on the basis of the level of analysis: individuals, firms, and economies. Evidence for individuals has a strong and coherent background[ii]. Many studies confirm that individuals profit from training because it can positively influence their performance and because it produces better paid, more stable, and more satisfaction-providing jobs (Bloom and Van Reenen 2007; Zwick 2005). In the past two decades, the interest has shifted from the individual level to the organizational level, and the debate has increasingly opened to the study of firms' potential returns on training investments. Although it is difficult to assess and isolate the impact of training on firm performance, a number of empirical results demonstrate that training has a significant positive effect (e.g., Bartel 1994; Bartel 2000; Dearden et al. 2006) and suggest that it directly enhances firm performance by raising the general level of skills. At the national level, the evidence is less clear, but does suggest investment in human capital has a positive effect on productivity growth, propensity to innovate, and success in R&D[iii] (Gospel 2005).

This study considers the literature concerned with the effects of training on direct measures of firm productivity, and it focuses on training for middle management in Italy, conducted as off-the-job formal training.

The uniqueness of the research lies in the distinctive feature of its target, which is the middle manager. This choice is dictated by the importance accorded to this professional role in explaining productivity gaps among firms. Recent cross-sectional studies argue and demonstrate that the way in which a firm is managed strongly influences its performance (Bloom and Van Reenen 2007; 2010).

Several contributions suggest that improving management skills is effective in helping firms outperform their competitors (Bailey et al. 1992). Furthermore, the importance of management quality, as far as the persistence of relative productivity is concerned, appears to be more determinant than worker quality. Contemporary theory argues that organizational performance is heavily influenced by what happens in the middle of the organization, rather than at the top, and that middle managers are positioned as key strategic actors (Currie and Procter 2005). Given adequate support, middle managers can enact substantial strategic changes in mature manufacturing firms (Jones 2005), regularly attempt to influence strategy, and often provide the impetus for new initiatives (Floyd and Wooldridge 1992).

As observed by Floyd and Wooldridge (1997), a substantial amount of theory and research underlines the key role of middle managers on a firm's strategy. First, a key strategic role of middle managers is to implement the top management's strategy (Nutt 1987; Schendel and Hofer 1979). Empirical research has confirmed middle management's upward influence on strategic decisions and shown a positive relationship between middle management's involvement in strategy and organizational performance (Floyd and Wooldridge 1992). Indeed, middle managers link the overall direction provided by the top managers with the day-to-day realities of lower-level managers. They mediate, negotiate, and interpret connections between an organization's institutional (strategic) and technical (operational) levels. Middle managers mediate between the organization, its customers, and suppliers. As administrators, middle managers direct the organization's overall technical tasks. Floyd and Wooldridge (1992) observed that middle managers' upward influence can potentially alter the firm's strategic course by providing the top management with unique interpretations of emerging issues and through the proposal of new initiatives. Indeed, championing alternatives, defined as the persistent and persuasive communication of strategic options to upper management, appears to be an important middle management function. Additionally, middle managers supply information about internal and external events to top management. Synthesizing information, defined as interpretation and evaluation, affects top management perceptions and is the second way in which middle managers influence organizational strategy formulation. By contrast, in terms of downward influence, middle

managers become change agents, foster adaptability, and implement deliberate strategy. Moreover, they can make organizations more flexible and stimulate behaviors that diverge from official expectations.

This study relies on a very detailed dataset containing information on the duration of training, direct costs of training to the firm, and productivity data. It is statistically representative of the population of firms in the Italy in terms of dimension, sector and geographic location. The dataset comprises 10,169 companies and covers the years 2006–2011. The dataset is also representative of every manager within the firm, meaning that we can track the training activity of each manager in the aforementioned six years.

The analysis is concerned with Italy, a country which deserves particular attention for several reasons. First, Italy displays a low incidence of on-the-job training: in 2005 still only about 30% of Italian corporations were investing in training (ISFOL 2013). Even if this share did increase to 56% in 2010 (ISFOL 2013), data are still worrying for the following two reasons: 1) in 2010 the share of training firms was still below the EU27 average (66%) and 2) the improvement between 2005 and 2010 was mainly due to the implementation of training activities required by law such as environmental protection, work health and safety. Furthermore, in 2005 Italy was ranked third from last place, after Greece and Turkey, for what concerns the employees' expectations to be involved in training activities (ISFOL 2012). Given the apparent unsatisfactory Italian performance on this ground, the European Union itself underlines the importance to develop research which demonstrates the potential returns on training in order to encourage firms to boost investments, though this is important to be able to innovate, be competitive and create new jobs (CEDEFOP 2014).

Italy represents an interesting case-study because the context allows us to test the theories (which we collapse into our working hypotheses) in extreme conditions: the low intensity of training provided by Italian firms. In other words, it could be interesting to see if and how much training to middle managers not accompanied by high intensity of workers training eventually generates an impact on TFP.

Finally, only two studies show a positive and significant effect of training of workers on productivity in Italian firms (Conti 2005; Colombo and Stanca 2014) and no evidence is available for what concerns middle manager training practices.

The remainder of this article is structured as follows. Section 2 discusses theoretical and empirical literature related to the organizational effects of training investments. Sections 3, 4, and 5, respectively, introduce the research hypothesis, data, and methodology employed herein. The main findings of this study are discussed in Section 6. Concluding remarks follow in Section 7.

2. Literature

Literature on training and its importance is available widely but there is a substantial lack of literature on the theoretical link between training and organizational performance. Interest in this topic has increased constantly, and a growing number of studies have been trying to capture the effect of employer-provided training on productivity by using firm-level data from several sectors in the economy. Protogerou et al. (2012) observed that the learning capability is one of the factors underlying dynamic capabilities because the former can be conceived as "a principal means of attaining strategic renewal" (Protogerou et al. 2012: p. 619). Learning allows individuals to resolve specific problems in a better and quicker manner through experimentation and repetition. Furthermore, learning involves individuals and organizations at the same time: indeed, learning processes are at an individual level, but individual knowledge is shared at the organizational level; thus, insight and innovative ideas "become institutionalized as organizational artefacts" (Protogerou et al. 2012: p. 619). Then, the impact of training on firm performance can be seen as a part of the more general impact of dynamic capabilities on performance. Eisenhardt and Martin (2000), Winter (2003), Zott (2003), and Protogerou et al. (2012) advanced the indirect link between dynamic capabilities and performance by considering the mediating role of functional competences. Training activities also enhance firms to invest in their absorptive capacity directly by boosting their ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990).

As observed by Thang et al. (2010: p. 29), "the theoretical framework for the relationship between training and firm performance has been subject to considerable debate". As a matter of fact, there are numerous difficulties in measuring the returns on training investment for firms. One major problem is the availability of data on training activities[iv]. In addition, unobserved heterogeneity of training-[v] and endogeneity of training[vi] are likely to affect the econometric estimation of the impact of training on firm productivity. In this respect, the change in the research horizon from cross-sectional to

longitudinal allows researchers to address the two econometric biases properly. Study of the impact of training on productivity is a developing research field, thanks both to increasing interest from employers in terms of understanding the return on investment of training activities and availability of firm-level data.

Empirical investigation of the topic has yielded mixed results. Bartel (1994) estimates the effect of training programs on net sales. No effect of formal training on productivity in the same year is found, and this result is not affected by the inclusion of the variables for measuring three other human resource policies (a formal job design program; formal performance appraisal system; an employee involvement or quality circle program). Secondly, Bartel addresses the endogeneity problem by implementing a model of the determinants of 1983 labor productivity and calculating the residual. For businesses that did not have any training programs as of 1983, a Logit model is estimated, where the dependent variable was the probability of implementing a training program after 1983 and the independent one was the value of the residual from the 1983 labor productivity equation. Results indicate that firms that invest in training programs experience faster productivity growth. Furthermore, businesses operating below their expected labor productivity levels in 1983 are more likely to implement a formal training program and experience larger increases in labor productivity growth in the three following years. Only new training programs, but not formal training, exert a positive effect on firm sales.

Black and Lynch (1996) show that training (defined as the number of workers trained in 1990 and 1993) has no effect on firm performance but the proportion of time spent in formal off-the-job training, i.e., outside working hours, has a positive effect on performance of manufacturing sector firms, and computer training has a positive impact on performance of non-manufacturing sector firms. However, this cross-sectional study is prone to an unobserved heterogeneity bias, and the authors consider training as an exogenous variable in their regression as opposed to endogenous. Black and Lynch (2001) show that the positive relationship between training and productivity observed in the cross-sectional analysis disappears once one correctly considers endogeneity. Nonetheless, Turcotte and Rennison (2004) show that an increase of 10 percentage points in the proportion of employees that received technological training is linked with a 4.5% increase in

productivity.

Ballot et al. (2006) show that returns on training can be shared between the firm and its employees, but it remains higher for the firm itself. They find that the returns on training accumulation are higher for firms than for their employees and that employees share with their employer the returns of physical capital investments, R&D, and training. Dearden et al. (2006) found that an increase of 10% in the proportion of trained employees leads to increases of 3.0% and 6.0% in wages and value added per worker, respectively. Conti (2005) replicates the British study of Dearden et al. (2006) by using data covering all Italian industrial sectors. Accordingly, training appeared to have a positive and strongly significant long-lasting effect on productivity. Thus, in the full-dynamic specification, Conti (2005) finds that an increase of 1% in the stock of trained workers in an industry leads to a 0.4% increase in productivity. Barrett and O'Connell (2001) find that for Irish firms, general training has a positive impact on productivity growth, whereas specific training has no effect.

Starting from individual-level data on training, firm-level data on productivity, and wages for the years 1996-1999, Conti (2005) empirically analyzes an industry panel including all sectors of the Italian economy. Colombo and Stanca (2014) analyze the impact of workers' training on productivity and wages by using a database representative of the population of Italian firms, formed by merging firm-level information on training and company account data between 2002 and 2005. In both the contributions training is demonstrated to have a positive and strongly significant effect on productivity although to a different extent. Conti (2005) suggests that raising the stock of trained workers in an industry by one percentage point leads to a 0.4% increase in productivity and Colombo and Stanca (2014) find that a one per cent increase in training is associated with an increase in value added per worker of about 0.07 per cent. Taking advantage of the detailed dataset, we first analyze the effect of overall training activity on firm performance and then we study the effectiveness of different methods of training activity.

In sum, the vast majority of empirical literature demonstrates the existence of a positive and significant relationship between training activity and firm performance. Nonetheless, the results are not always coherent in the estimation of the magnitude of that relationship (i.e., Ballot et al. 2006; Barrett and O'Connell 2001; Colombo and Stanca 2014; Zwick 2006).

3. Research Hypotheses

Effect of training on firm performance

Many studies demonstrate the role of human resource practices in determining and influencing business results (Becker and Gerhart 1996; Pfeffer 1994; Wright and McMahan 1992). However, the vast majority of empirical studies concerning the effect of training on firm performance do not distinguish between the categories of worker undertaking training. Conversely, our analysis focuses entirely on middle managers, a topic for which the evidence is scant at best. The importance of working on this specific target instead of a broad one is dictated by a number of considerations. As suggested already, middle managers represent a key professional figure for firms for several reasons. They are typically the decision makers with regard to knowledge diffusion and seizing opportunities afforded by information and communication technologies. They can exploit opportunities and neutralize threats, and they could be rich in terms of firm-specific knowledge and build an imperfectly imitable, non-substitutable resource for the firm. Indeed, firm-specific knowledge accumulated by managers in a firm is not completely substitutable because the competitive advantage of a firm is determined in a unique historical, social, and economical context. Other managers would lack the knowledge of these particular circumstances, and they can replace the existing management team only imperfectly (Mahoney 1995). Furthermore, organizational capability at the management level is essential for improving international competitiveness (Castanias and Helfat 1991). Finally, managers are particularly instrumental in creating organizational learning ethos for all employee groups (Martin et al. 1998).

Middle managers have been demonstrated to play a key role in explaining the heterogeneity of business results among firms. More specifically, several studies have demonstrated that training devoted to managers has a positive impact on their practices (Mabey 2004), which, in turn, have a positive and significant impact on firm performance (Bloom and Van Reenen 2007, 2010; Bloom et al. 2012). Bloom and Van Reenen (2007)'s study is based on 732 medium-sized firms in the U.S., France, Germany, and the U.K. Considering 18 individual management practices and taking a score of each practice as an independent variable in the productivity function, they find substantial evidence to support the fact that management measures are positively and significantly correlated with superior

firm performance in terms of productivity, profitability, Tobin's Q, sales growth, and survival. For example, an increase from the lower to the upper quartile of management score among firms (0.972 points) is associated with a 3.2%–7.5% increase in productivity (measured as net sales). In a following study, the same authors extended this type of analysis to 3,380 manufacturing firms in 17 countries (Bloom and Van Reenen 2010). Again, they find that higher management scores were associated with better performance in terms of productivity, profitability, growth rates, survival rates, and market values. Similar results are found in another work by Bloom et al. (2012) as well, confirming that variations in management practices explain the large differences in productivity among firms and countries. The magnitude of the impact of training on a firm's performance is expected to be positive and significant because of its direct effect on the firm's managerial practices.

Moreover, recent contributions to managerial literature recognize non-linearity of effect as a key factor (Wales et al. 2012). In particular, there could be an inverted U shaped relationship between training and performance. This effect is also known as too-much-of a good thing effect (TMGT). In our case, we do not know ex ante if and when the hypothesized positive impact approaches zero or even a negative value. We know that there exist a series of tradeoffs in providing training to middle managers. First, there is the direct cost of training. Then, we have account for the indirect cost in terms of lost production because the fact that middle manager is taken away from her/his typical duties. The point is if and how these costs are offset by the additional returns generated from upgraded managerial competences, which translate into new, more productive managerial practices. In particular, we concentrate on off-the-job formal training for middle managers, and as a result of the above discussion, we propose the following competing hypothesis:

Hypothesis H1.a) the impact of middle management off-the-job formal training on firm performance presents itself as the TMGT effect.

Hypothesis H1.b) the impact of middle management off-the-job formal training on firm performance does not present itself as the TMGT effect.

Effect of firm size on firm performance

The magnitude of training effects seems to be linked to firms' structural characteristics, even though the results are not always significant and coherent (Colombo and Stanca 2014; Dearden et al.

2006; Turcotte and Rennison 2004). In particular, firms' size directly influences the production process and results in more formalized organizations because larger firms use more capital-intensive production processes on average and have more specialized positions, which are occupied by personnel with higher qualifications, and higher positive correlation between training and productivity (de Kok 1999).

The belief that firm size is a key measure of firm performance is widely documented in academic literature. In equilibrium, better-managed firms should be larger (Lucas 1978). This is partly because the market will allocate to these firms a greater share of sales, but also because larger firms have the resources and incentives to employ better management (Bloom and Van Reenen 2010). Empirically, we can find evidence that middle managers perform better practices in large firms. Bloom and Van Reenen (2010) find that the management score (as a measure of the quality of managerial practices) rises steadily with firm size[vii]. Furthermore, middle managers are often expected to play both operating and strategic roles in small–medium firms (Lubatkin et al. 2011), with possible consequences on the manager's qualifications and competences (Floyd and Wooldridge 1994).

In addition to the above considerations, larger firms can more effectively benefit from managers' training because of the different "internal environment" they provide to managers compared with medium or small-sized firms. For instance, in smaller firms, managers can benefit from easier, more direct contact with the owners, thus facilitating higher levels of concern and care for employees (Hodgetts and Kuratko 1998). However, disadvantages could include owner's unwillingness to delegate authority to lower levels. Middle managers who do not receive adequate authority can get frustrated easily, probably seeing their career opportunities as being limited (Hodgetts and Kuratko 1998). In medium–small firms, the middle managers know that they have few hopes of achieving top management positions (Barth et al. 2005). Limited career prospects may function as a disincentive to these middle managers, leading to reduced efforts as a result (Barth et al. 2005). We also opine that in such firms, middle managers can hardly apply what they learn from training, thus compromising the expected outcomes of training on their operations and their firm's productivity. Small firms might not have cushion that the larger firms have to absorb 'mistakes' in resource allocations or to write off bad training decisions and lost opportunities. Smaller firms often have higher training costs per employee

than larger firms because they cannot spread fixed costs of training over a large group of employees. In addition, the loss in production from having one worker in off-site training is probably much higher for a small firm than for a larger firm.

Last but not least, sometimes, large companies can rely on their own internal training providers (e.g., corporate university)[viii]. This could have a number of benefits. For example, with such providers, continuous dialog, higher mutual commitment, deeper knowledge of the business and its workforce contribute toward a higher probability of meeting business needs through the provision of tailored training programs. Furthermore, small firms have much lower training propensity compared with large firms, and, at best, they provide informal on-the-job training (Cosh et al. 2003).

Hence, we state the following:

Hypothesis 2 (H2): the effect of middle managers off-the-job formal training is relevant for larger firms while for smaller firms this effect is not significant.

Effect of different training methods on firm performance

We now exploit the data that allows us to investigate the variety of effects of different off-the-job formal training methods. While the rich literature on this topic debates the effectiveness of on-job *vs* off-job training activities, no evidence is available about the effectiveness of different off-the-job formal training methods.

We argue that some off-the-job formal training methodologies are more suitable and effective for managers than others. The previous literature on this topic does not analyze this aspect, with the exception of Zwick (2005)'s study, which considers the impact of the training method on productivity. He distinguishes training methods as formal external courses, formal internal courses, on-job training, seminars and talks, job rotation, self-induced learning, and quality circles. Furthermore, at the theoretical level, the use of applied methodologies is encouraged by Read and Kleiner (1996), although no single training method can be considered superior to all others. The characteristics of the matter to be presented, number of participants and their background, equipment and time available should be considered when selecting the most appropriate training method. In addition, the effectiveness of a training program is only partially dependent on the training method. The benefits of training, such as increased productivity, should exceed the cost of training for training to be considered effective.

Employees should transfer in their day-to-day work what they have learned. Then, measurement of post-training behavior indicates whether the training is applied and, thus, whether the training is effective from the company's viewpoint. As a consequence, a method encouraging active participation by trainees and providing adequate feedback (e.g., one-on-one instruction, role plays, games/simulation, and case studies) is generally preferred because the use of such a method increases the likelihood that what is taught will be retained and applied later. Nevertheless, methods that are inherently passive can be made active with effort on part of the trainer.

In our study, we categorize off-the-job formal training activities into three groups based on their main features in the following respects: degree of interaction with other colleagues, use of online platforms, and use of virtual situations. In particular, we define three categories: simulations and experience-based methods in which the use of virtual situations is a key feature (*TrM1*); group learning methods based on interaction among activity participants (*TrM2*); traditional and e-based methods that rely on instructors and online platforms (*TrM3*). See Table 1 for details about the taxonomy. For each of these groups, we rely on precise information about the hours of training middle managers were engaged for.

Insert Table 1 about here

Hence, the third hypothesis can be formalized as follows:

Hypothesis 3: Middle managers' training activities performed using simulations and experience-based methods have higher impact on performance than those performed using traditional, e-based, and group learning methods.

4. Data

4.1 Sample and Data Sources

The empirical analysis is based on an original six years panel which has been created by merging two different complementary datasets. The two data sources are Fondirigenti[ix] and the Italian section of Bureau van Dijk. The construction of this novel database was motivated from the fact that to our knowledge, such a dataset containing information on both training and corporate performance measures in the Italian context, which is required for the analysis, had not been prepared thus far.

The dataset from Fondirigenti contains detailed information about the middle management training activity of Italian firms. It is an individual-level dataset that includes the number of managers in training, number of days spent on training, overall number of hours and overall amount of money spent on training, and disaggregated information about different training methodologies and the amount of money that is at the disposal of firms to finance manager training each year, which as we will clarify below, plays a crucial role in our identification strategy. Furthermore, this information has been used to classify those firms which spend just a portion or over the credit balance ('active' firms) and those which do not use the credit ('inactive' firms). This suggests that the availability of money is not a binding constraint in our sample.

From the second data source we collected all accounting data of firms for the corresponding years. It allowed us to build a series of firm-level indicators and variables such as sector of activity, sales, value added, stock value of fixed capital, number of employees, cost of labor, as well as other variables regarding balance sheets, firm demographics, and employment. As a result of the matching, we obtain a firm-level panel dataset containing firms' economic characteristics and training practices covering a six years period from 2006 to 2011[x]. Table 2 lists the variables used in the empirical analysis.

Insert Table 2 about here

The sample size is remarkable in the light of previous studies, which often considered only a few hundred observations. The final clean dataset counts 10,169 firms[xi] and training information about middle management is unusually deep and reliable[xii].

As previously pointed out, the main innovation of our contribution is that it provides evidence about middle managers training. From a methodological perspective, this key strength could be seen as a limitation as it could be argued that not having information on training provided to others in the firms might cause an estimation bias: the effect that is attributed to middle manager training would be overestimated.

This problem would be ideally addressed having available information about training for every workforce category in the firm but unfortunately, to our knowledge, such comprehensive dataset simply does not exist. Therefore, to deal with this limitation at best we have employed appropriate and

consolidated econometric procedures. In the first place, we chose to implement the IV-GMM technique which handles not only unobserved heterogeneity and potential endogeneity of training. It also controls for time-invariant fixed-effects. Because it is reasonable to assume that firm's propensity to train is a time-invariant characteristic of the firm, we are confident that this effect is cleaned out in a first instance by the econometric procedure itself.

Furthermore, in order to be confident that the effect of middle manager training remains when we control for training elsewhere in the firm we have estimate the model on a number of subsamples of firms with a diverse propensity to train.

Finally, when analyzing the determinants of TFP, we have implemented the Heckman correction. The two step model specifically handles the selection biased which could potentially affect our sample.

In the lights of the considerations above, we are confident that our model identification strategy succeeds in overcoming the selection bias issue.

5. Methodology

5.1 Regression Models

Following the approach by Bloom and Van Reenen (2007), TFP estimation is implemented using the Levinsohn and Petrin (2003) method[xiii], which has the advantage of tackling a key issue in the estimation of production function: the correlation between unobservable productivity shocks and input levels. Indeed, firms respond to positive productivity shocks by expanding output, which requires additional inputs. Conversely, negative shocks lead firms to contract output, thus decreasing their inputs. Levinsohn and Petrin have suggested the use of an intermediate input as a proxy for investments to avoid the simultaneity bias related to inputs level[xiv].

The production technology is assumed to be Cobb–Douglas (Levinshon and Petrin 2003)

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + w_t + \eta_t, \qquad [1]$$

where y_t is the logarithm of the firm's output measured as value added; l_t and m_t are the logarithm of the freely variable inputs labor and the intermediate input; and k_t is the logarithm of the state variable capital. The error has two components: the transmitted productivity component given as

w_t and η_t, an error term that is uncorrelated with input choices.

We then investigated on the determinants of TFP implementing the Heckman selection model. As explained in Section 4, the two-step estimation framework helps to control for selection bias (Heckman 1976), while we take into account the issue of endogeneity using a GMM second step regression model.

In general, the two estimated models take the following form:

In the first step we model the probability of giving training for each firm using a probit specification:

$$prob\left\{status_{i,t}=1\right\}=probit\left\{\alpha_i+\beta\cdot training_{i,t-1}+\delta_1^{'}X^1_{i,t-1}+\gamma'Z_{i,t-1}+\tau_t+\varepsilon_{i,t}\right\} \quad [2]$$

In the second step we regress the estimated TFP – through [1] – against a series of variables on the set of firms that provide training. In particular, we add the training variable:

$$TFP_{i,t}=\beta_i+\beta_1 training_{i,t-1}+\beta_2 X^1_{i,t-1}+\beta_3 X^2_{i,t-1}+\beta_4 Z_{i,t-1}+IMR_{i,t}+\tau_t+\varepsilon_{i,t} \quad [3]$$

In both equations the subscript *i* refers to firm and *t* to year. $TFP_{i,t}$ represents the total factor productivity of firm *i* in year *t*.

The crucial variable here is training, denoted $training_{i,t-1}$, which is the logarithm of the intensity of training activity (in turn: the number of hours or the expenditure per year)[xv]; $X^1_{i,t-1}$ is the age of the business; $Z_{i,t-1}$ is a vector of additional independent covariates, namely, sector of activity (SIC 2-digit level) and the geographical area of activity at NUTS 1 level. In Equation [3], $X^2_{i,t-1}$ represents the cost of labor per employee. This term has been added to the regression model in order to control for human capital quality. The term τ_t is a time dummy for controlling the business cycle effect. The term $IMR_{i,t}$ represents the inverse Mills ratio which has been calculated from the regression (Equation [2]) and added to the instrumental variable regression model [Equation [3]) as an independent variable to correct for selection bias. In addition, to test the assumption H1.a *vs* H1.b, we also introduced a quadratic term, denoted $training^2_{i,t-1}$.

All independent variables are lagged one period with respect to the dependent variables to avoid simultaneity bias. The estimation of Equation [3] is performed using the IV-GMM technique, which allows for coping with the endogeneity of training variables: more productive firms can conduct more training because they have more resources to devote to this activity or because they understand better the value they can derive from middle manager training. If this is the situation, a regression analysis without further corrections could signal a correlation between training and productivity that could be wrongly interpreted as the causal effect of training on productivity. Hence, the endogeneity of the training variable can bias the estimations and needs to be addressed.

Moreover, to get rid of heteroskedasticity, we estimated robust standard errors.

5.2 Choice of Instruments

A key aspect of the present work is the availability of an instrument that seems to mimic the characteristic of the theoretical instrument. In the context of our study, endogeneity arises from the fact that we intend to single out the impact of middle manager training on firm performance. Nonetheless, we cannot exclude ex ante that fact that past performance influences the level of training activity in a firm. Under this condition, "standard" regression coefficients are biased (Wooldridge, 2002). The first way to solve the problem is using the GMM-Sys technique, which exploits the longitudinal structure of the data to address the problem by using lagged values of variables as "internal" instruments.

As prescribed in the IV-GMM technique, we introduce in the models variables that are correlated with training but not with productivity. Hence, we introduce the lagged values of the variables into the regression models. Note that an ideal solution would be to individuate a variable related to the training activity but not to firm performance. Consequently, we use an external instrument, i.e., the yearly amount of money that Fondirigenti put together to be used by each firm for training activity, the so called "conto formazione" (amount of money saved annually for financing middle manager training).

This sum of money is generated via administrative legislation related to the Fondirigenti membership. In particular, Fondirigenti saves a percentage of the annual fee due from the firms—0.30% from the overall amount of wages paid each year by a firm—in a reserved fund that is

accessible to the firms only to "buy" training for middle managers. After three years, the fund "expires," meaning that firm cannot use it anymore, and Fondirigenti reallocates the money for other purposes.

This variable appears to be significantly correlated with the number of hours spent in training yearly (0.432; 0.000) and with the amount of money spent on training each year (0.435; 0.000). At the same time, the correlations of this variable with the performance indicators used are not significant and are close to zero. Hence, the number of hours and the amount of money spent in training are contingent on the annual training budget available to each firm, which *ex ante* is correlated with the number of hours of training but not with firm performance. The Hansen test/J-test for overidentifying restrictions and the Kleibergen-Paap Wald underidentification test were applied to every model, and the results show that the specified equations are correct.

6. Results

'Active' firms represent about 30% of the sample. The 34.5% of the total sample is composed of small firms (i.e., less than 50 employees), with about 65% of firms using training services being medium and large (more than 50 employees). The majority of the firms is located in the North of Italy (about 79%) and has been in business for more than 14 years (about 67%). Table 3 lists the descriptive statistics of the variables used in the analysis.

Insert Table 3 about here

All results were obtained using the IV-GMM technique, employed to control the endogeneity of the training variable.

We present in the tables the p-values of the following two tests: the Hansen test/J-test which is a test of overidentifying restrictions and the Kleibergen-Paap Wald underidentification test which is a test of whether the equation is identified. The results of both tests suggest the validity of the IV approach because the instruments are proved to be valid and training can be treated as exogenous. Furthermore, a set of dummy variables for geographic area and sector are included as control variables in all estimated models.

Table 4 summarizes the effect of training expenditure and training hours on TFP. Estimates of the impact of training on TFP (log of) are positive and significant: raising the training expenditure and

training hours by 1% point is associated with an increase of about 0.08% (Column 1) and 0.15% (Column 3) respectively.

Columns 2 and 3, present the results of the model in which we introduced the squared term of cost of training and hours of training respectively. TFP shows the too-much-of-a-good-thing effect: there exists an optimal training expenditure that maximizes the benefit arising from training activity and minimizes its costs for the firm. Conclusions hold using the number of hours or the expenditure as a measure of intensity of training activity.

Insert Table 4 about here

Table 5 lists the results concerning H2 (investigating the link between training and firm size (i.e. firms with less and more than 50 employees)) and H3 (effect of training method), discussed in Section 3.

Training is observed to have a positive effect on TFP for medium and large firms (i.e., with more than 50 employees), while the results for small firms are positive but not significant. In medium and large firms, a 1% point increase in training expenditure leads to a TFP increase of about 0.06% and a 1% point increase in training hours leads to a TFP increase of about 0.12% (see Table 5 section H2).

A formal test of difference between the difference between the two coefficients for the two separate regressions, i.e. small firms and larger firms regressions respectively, is not significant (d=0.20). To interpret the result we have to notice the large standard error of the regression coefficient of small firms which signals a more heterogeneous effect on TFP of small firms. Put it differently, even if the effect is on average positive, as suggested by the positive coefficient b=0.61, the support of the distribution of such effect is rather large and comprises negative values. Our results are consistent with those from previous literature. The link between training and firm characteristics (structure, dimension, etc.) is proved to be positive, even though it is not significant according to Colombo and Stanca (2014) and Dearden et al. (2006). Turcotte and Rennison (2004) and Zwick (2005) presented significant results. Turcotte and Rennison (2004) found that a 1% point increase in the number of workers trained in class corresponds to a 0.478% increase in productivity for firms with more than 20 employees (results are not significant for firms with less than 20 employees)[xvi]. Zwick (2005) finds that the magnitude of the impact of training on productivity growth increases with

increasing firm size (elasticity is equal to 0.616, 1.119, 1.239, and 1.661 for firms with 20–199, 200–499, 500–999, and >1,000 employees, respectively).

Insert Table 5 about here

To conclude, there is strong and coherent evidence that supports hypothesis H2: larger firms, benefit more from middle manager training. Following the discussion in Section 3, our findings should be read keeping in mind that larger firms can often afford to employ better management personnel and that better management practices are more likely to be implemented in larger firms than in smaller ones. In larger firms, middle managers are likely to be more empowered and they probably apply easily what they learn from training.

The empirical test of the last hypothesis (H3) shows how some off-the-job formal training methods for middle managers are more effective from the firm's viewpoint than other methods (Table 5, section H3). This conclusion represents a key contribution of the study because it deals with characteristics of training that to our knowledge have not been analyzed thus far. Results show that the three groups of methods have different impacts on TFP[xvii]. In particular, upon increasing the off-the-job formal training hours by 1% point, the TFP increases by 0.46% if we use simulation and experience methods (*TrM1*), by 0.39% if we use group learning methods (*TrM2*), and by 0.29% if we use 'instructor-lesson' and e-based methods (*TrM3*).

In order to test whether the difference among the estimated coefficients of the three methods categories is statistically significant we performed the statistical test for the equality of regression coefficients (Paternoster et al. 1998) which leads us to reject the null hypothesis of equality of coefficients.

7. Conclusions

Basing on a rich and reliable panel dataset on Italian firms over the period 2006-2011, our contribution in this paper is to advance the literature in at least two ways. First, it integrates literature by providing for the first time evidence about the performance effects of middle manger's training in Italy. Second, it originally broadens existing literature on the returns to training by proving the existence of a too-much-of-a-good-thing (TMGT) effect.

We demonstrate the existence of a positive and significant link between training investment devoted to middle managers and TFP. Our analysis highlights an exogenous and significant effect of training on firm performance, measured in terms of productivity (TFP). Returns on training investments seem to be much higher for large firms (more than 50 employees) and firms that focus on applied methods.

In detail, on the basis of a unique dataset, we test empirically three research hypotheses: (H1) effect of training on productivity; (H2) effect of firm size on productivity; (H3) effect of different training methods on productivity. We find support for the following hypothesis. (H1) Continuing training for middle management has a positive and significant effect on TFP, and the effect is non-linear. Raising training expenditure by 1% point is associated with an increase of about 0.078% in TFP. Moreover, we demonstrate that H1.a should be preferred over the alternative H1.b. The TMGT effect is in place: TFP is affected by training, but the effect is non-linear. Furthermore, after a given threshold training effort, the effect turns negative.

We also state that middle management training is more effective for larger firms (H2) because a positive effect of training on TFP is observed for medium and large firms (i.e., firms with more than 50 employees), whereas the results for small firms are positive but not significant. In medium and large firms, an increase of 1% point in training expenditure leads to an increase of about 0.06% in TFP and increase of 1% point in training hours leads to an increase of about 0.12% in TFP. It appears that management training projects are less successful in the smallest firms which do not probably have the managerial capacity to benefit from them. Findings show that large firms seem to be able to plan for the future while small firms are more likely to miss the boat. Here there is a rich vein of research to be mined.

For what concerns training method, upon increasing off-the-job formal training hours by 1% point, the TFP increases by 0.46% if we use simulation and experience methods, by 0.39% if we use group learning methods, and by 0.29% if we use "instructor-lesson" and e-based methods. Specifically, these results suggest to managers to choose formal training activities that involve to some extent virtual situations mimicking actual problems faced by middle managers. In general, the results suggest that choosing the "right" training method can possibly enhance the firm's competitive ability.

On the basis of the above results, we can conclude that off-the-job formal training investments devoted to middle managers are effective. This finding is consistent with previous literature. Investments in human capital devoted to middle managers constitute a key strategy decision that allows a firm to improve its management and its productivity in the long run. This is true because of the effects such training has on manager practices, which, in turn, influence firm performance. In other words, human capital investments (e.g., training investment) play an important role in driving good and accepted managerial practices, which help explain the productivity gaps among firms. Influential previous studies suggest and prove the existence of the second link (namely manager's practices vs. firm's performance), while very few studies have addressed the first question thus far (human capital investment vs. manager's practices), leaving room for further research on this topic. To this end, more complete data on managerial practices in organizations need to be collected, and an effort by businesses and governments is likely necessary for generate said data.

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Table 1: The taxonomy of training methods.

Method category:	*Type of training:*
TrM1: Simulations and experience based methods	Business games, in-basket, role play, action learning, outdoor
TrM2: Group learning	Training-groups, coaching, learning communities
TrM3: Traditional and e-based methods	Instructor training, e-learning (blended, community on line, knowledge forum)

Table 2: Variables description.

Dependent Variables		
Name:	*Description:*	*Notes and formulas:*
TangibleAssets	Tangible assets	
TFP	Total factor productivity	TFP is estimated using the method of Levisohn and Petrin (2003)
VA	Value added	Gross revenues minus expenses on materials
ΔVA	Annual growth rate of value added	$Log(VA_t)$-$Log(VA_{t-1})$
Independent Variables		
Name:	*Description:*	*Notes and formulas:*
TrHours	Number of hours devoted to training per manager, per year	As measured by the total number of training hours per year, per firm divided by the number of managers involved in training
TrExpenditures	Training expenditures	As measured by the total amount of training costs per year, per firm
TrM	Training method	TrM are grouped in three categories: traditional and e-based lessons (TrM1); group learning methods (TrM2); Simulations and experience based methods (TrM3)
LC	Labor cost per employee	As measured by the labor cost divided by the total number of employees
L	Number of employees	Average number of employees in a year
K	Capital	K is measured by an permanent inventory method based on fixed assets
Age	Age of the firm in years	
Sector	Two-digit SIC codes in manufacturing	
Area	Geographic locations macro-regions level	Italian Regions are grouped into four categories: North-East, North-West, Centre and South
Credit	Yearly amount of money available for training activity	In Euros

Table 3: Variables used in the analysis: descriptive statistics.

	Total sample					Active firms					Inactive firms				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Dependent Variables															
Total factor productivity (TFP)	48,431.00	69,880.10	181,700.30	0.47	2.07E+07	16,542.00	82,783.75	203,690.40	31.31	2.07E+07	31,889.00	63,186.50	168,786.20	0.47	1.83E+07
Value added per employee (VA)	54,985.00	2.57E+07	3.73E+08	-5.13E+08	3.23E+10	17,814.00	6.40E+07	6.53E+08	-5.13E+08	3.23E+10	37,171.00	7.40E+06	2.00E+07	-7.11E+07	9.22E+08
Annual growth rate of value added (**Δ**VA)	41,251.00	0.00	0.69	-19.58	19.63	14,270.00	0.00	0.74	-19.58	19.63	26,981.00	0.00	0.66	-13.80	18.76
Independent Variables															
Training hours	9,523.00	176.30	1,029.16	1.00	59,696.00	9,523.00	176.30	1,029.16	1.00	59,696.00	---	---	---	---	---
Training expenditures	9,019.00	73,528.62	214,819.20	29.14	2.02E+06	9,019.00	73,528.62	214,819.20	29.14	2.02E+06	---	---	---	---	---
Training methods: (hours spent):															
Simulations and experience based methods (TrM1)	2,318.00	79.07	185.50	1.00	4,444.00	2,318.00	79.07	185.50	1.00	4,444.00	---	---	---	---	---
Group learning methods (TrM2)	5,576.00	104.14	438.13	1.00	12,205.00	5,576.00	104.14	438.13	1.00	12,205.00	---	---	---	---	---
Traditional and e-based lessons (TrM3)	7,020.00	130.34	899.32	1.00	46,268.00	7,020.00	130.34	899.32	1.00	46,268.00	---	---	---	---	---
Number of employees (L)	61,014.00	254.57	1,278.61	10.00	65,648.34	18,750.00	565.63	2,238.62	10.00	65,648.34	42,264.00	116.58	273.80	10.00	8,634.33
Capital (K)	54,996.00	4.09E+07	8.96E+08	0.00	7.94E+10	17,825.00	1.06E+08	1.57E+09	0.00	7.94E+10	37,171.00	9.79E+06	7.03E+07	0.00E+00	6.44E+09
Cost of labor per employee (CL)	48,975.00	46.93	14.61	0.00	100.00	16,495.00	49.29	14.95	0.00	100.00	32,480.00	45.72	14.29	0.00	100.00
Age of business (Age)	60,570.00	28.77	18.11	2.00	156.00	18,306.00	29.42	19.40	2.00	156.00	42,264.00	28.48	17.51	2.00	139.00
Region: (hours spent)															
North-West area	4,488.00	196.08	1,372.13	1.00	59,696.00	4,488.00	196.08	1,372.13	1.00	59,696.00	---	---	---	---	---
North-East area	2,901.00	99.62	232.27	1.00	6,456.00	2,901.00	99.62	232.27	1.00	6,456.00	---	---	---	---	---
Center area	1,619.00	271.29	938.99	1.00	15,763.00	1,619.00	271.29	938.99	1.00	15,763.00	---	---	---	---	---
Islands and South area	515.00	137.31	198.45	1.00	1,396.00	515.00	137.31	198.45	1.00	1,396.00	---	---	---	---	---
Credit (Yearly amount of money available for training activity)	20,413.00	3,611.61	13,357.63	500.00	5.93E+05	12,128.00	5,147.64	17,103.18	500.00	5.93E+05	8,285.00	1,363.10	1,707.79	500.01	31,124.29

Table 4: The effect of training expenditures and training hours on TFP.

		Models			
	Dependent variables:	(1) Log(TFP)	(2) Log(TFP)	(3) Log(TFP)	(4) Log(TFP)
H1	$Log(T_{Expenditure})$	0.0776***	0.1039***		
		(0.005)	(0.009)		
	$Log(T_{Expenditure})^2$		-0.0025***		
			(0.000)		
	$Log(T_{Hours})$			0.1528***	0.1672***
				(0.010)	(0.001)
	$Log(T_{Hours})^2$				-0.0082***
					(0.002)
	LC	0.0189***	0.0190***	0.0193***	0.0194***
		(0.001)	(0.001)	(0.001)	(0.001)
	Log(Age)	0.0257	0.0176	0.0409	0.0384
		(0.026)	(0.028)	(0.026)	(0.027)
	Inverse Mills Ratio	0.5461	2.9960	0.4801	1.1951
		(6.578)	(7.148)	(6.876)	(7.101)
	Constant	7.5030	2.3444	7.7246	6.2053
		(13.532)	-14.685	(14.137)	(14.594)
	Year dummies	Y	Y	Y	Y
	Sector controls	Y	Y	Y	Y
	Geographical area controls	Y	Y	Y	Y
	Observations	3,977	3,977	3,977	3,977
	F	62.09	49.14	57.04	51.87
	F P-value	(0.000)	(0.000)	(0.000)	(0.000)
	Kleibergen-Paap rk LM statistic[a]	499.4	234.7	439.4	340.3
	K-P P-value	(0.000)	(0.000)	(0.000)	(0.000)
	Hansen J statistic[b]	0.123	0.0278	0.0284	0.0002
	J P-value	(0.725)	(0.868)	(0.866)	(0.965)

Notes: *[a]: K-P rk test whether the equation is identified when we drop homoschedasticity. The null is that the equation is underidentified.*
[b]: Hansen J: the null is that the instruments are valid instruments.
*Robust standard errors in parentheses. *** p<0.01, **p<0.05, p<0.1.*

Table 5: Impact of training on TFP. Estimated coefficients for training variables of separate regressions. In the case of training methods we report the estimated coefficients of different training categories for the whole sample.

Hypothesis tested			
	Subsample:	*Estimated coefficients:* **(cost of training):**	*Estimated coefficients:* **(hours of training):**
H2[a]:	Small firms (less than 50 employees)	0.0686 (0.043)	0.1987 (0.137)
	Medium and large firms (more than 49 employees)	0.0598*** (0.005)	0.1155*** (0.010)
	Type of training:		*Estimated coefficients:* **(hours of training):**
H3[b]:	TrM1 - Hours spent in simulation and experience based training		0.4589*** (0.012)
	TrM2 - Hours spent in group learning training		0.3865*** (0.037)
	TrM3 - Hours spent in traditional and e-based training methods		0.2938*** (0.028)
	Test of difference between coefficients of regressions:		
		Hypothesis tested:	*Value of the z test*
		H0: TrM1= TrM2	1.8613*
		H0: TrM2= TrM3	5.4196***
		H0: TrM1= TrM3	1.9978***

[a,b]: The statistical test for the equality of regression coefficients leads us to reject the null hypothesis that the coefficients are equal.
*Notes: Robust standard errors in parentheses. *** p<0.01, **p<0.05, p<0.1.*

[i] Training is defined as "a planned initiative taken by the organization to impart the job knowledge and skills and also to modify the attitudes and behaviours of employees in ways consistent with the goal of the organization" (Noe 2002).

[ii] Noe and Wilk (1993) identify three types of individual benefits which can be gained from training: personal benefits (through the improvement of the job performance), career benefits (through the identification of the career objectives, achievement of career objectives and creation of opportunities to purse new career paths) and job-related benefits (through the improvement of their workplace relations). Moreover, Geale (1995) concluded that additional individual benefits from training include career advancement, mobility, job security, pride, job satisfaction and personal fulfilment.

[iii] See for example Jenkins (1995), Mankiw et a.l. (1992), Gemmell (1995), Krueger and Lindhal (2001), Cedefop (2004), Toner (2009), Pianta (2005), Wolf and McNally (2011).

[iv] Indeed, several research studies have to deal with weak indicators such as training index based on a 7 points-Likert scale (Delery and Doty 1996) and training evaluation (García 2005). Furthermore, in all the reviewed studies, training information are drawn from surveys: interviewees are asked to provide information about training activities implemented several years before the survey itself leaving room to measurement errors (Bartel 1994). In the literature analyzed, the preferred and reliable training measures seem to be the length of training (number of training hours and number of days/weeks), training intensity (% of hours and % of participants) and training expenditure.

[v] There are likely to be unobservable factors that are correlated with the regressor. In order to avoid omitted variable bias (and hence overestimate the true returns to training), the estimation framework allows for a proxy of human capital quality (i.e. labor cost per employee). Time dummies are also included to control for time-varying effects, such as the impact of technological progress or some other unobserved factor linked to the business cycle. The presence of these additional variables helps to control for factors affecting productivity and to mitigate the unobserved heterogeneity issue.

[vi] For example, temporary shocks could increase productivity and bring to changes in training activity (and of course in the other inputs, labor and capital). Some studies demonstrate that firms facing a downturn in demand tend to reallocate idle labor to training activities (Black and Lynch 1997; Bartel 1994). A broad empirical debate has developed on the endogeneity of training and several solutions have been advanced. To deal with this problem, a set of instrumental variables correlated with training but not with the productivity shock should be used. The strategy used in this research is to draw on recent advances in GMM techniques in order to deal with these problems (i.e., Blundell and Bond 1999) also thanks to the availability of a longitudinal dataset.

[vii] A high score represents a best practice in the sense that a firm that has adopted the practice will, on average, increase their productivity (Bloom and Van Reenen, 2010).

[viii] Among the Italian firms present in our sample Eni, DeAgostini, Ferrero, Fiat, General Electric Company, Microsoft, Porsche, Robert Bosch, and TUV, among others, do have an internal training institution.

[ix] Fondirigenti is an Italian Inter-professional Fund, founded in 2004, promoted by Confindustria and Federmanager. Its main objective is to fund middle managers' training of the joined Italian firms.

[x] The time period 2006-2011 corresponds to the years for which we had access to data from Fondirigenti.

[xi] The original sample contained 11,857 firms observed over eight years. However, an accurate work of data cleaning has reduced the sample size. In the first place, observations for years before 2006 have been excluded, due to severe reduction in the number of firms with reported information compared to the following years. Preserving those observations would have severely affected the representativeness of the sample, due to the fact that only information for a smaller subset of firms is available for the early years. Secondly, very small firms (with less than 10 employees) and very large firms (with more than 100,000) have been dropped for the same reason.

[xii] That is true for several reasons. First (1), it is quite unusual to have in the same dataset different measures of training activity such as number of hours, number of days, number of participants, number of training activities per manager and training costs as well as methods of training. Second (2), the training variables available are strong indicators. Indeed, according to the most influential studies in the related academic literature the preferred training measures are the length of training (either the number of training hours or days or weeks) and training expenditure. Third (3), as opposed to the vast majority of academic studies in the field of training, training information are not collected from a survey. The dataset is generated by the firm itself once the provision of training activity has been planned. Joining Fondirigenti, a company can submit its training plans at any time of year. All the details concerning the training activities must be recorded by the firm and subsequently confirmed by the organization which provides training. As a consequence, all the information collected is triple- checked: once by the responsible of the training project within the firm, once by the training provider and once by Fondirigenti. Measurement errors are not likely to occur and the reliability and the completeness of data are ensured. It is also true that utilizing a company database avoids the biases that generally result when individual are unable to accurately recall the amount of training they received and/or when definitions of training vary across diverse firms. With a few rare exceptions (E.g., Barron et al. 1989; Bartel 1995; Holzer 1990), in the academic literature training information are usually reported by the individual employee, raising questions about the accuracy of an individual's response regarding duration or costs of training. Fourth (4), information are collected in real time. As soon the training activity is over, all the data process is generated. This is much better than having employee or employer reported information about past training activities and ensure precise and complete about on-the-job training. Fifth (5), the dataset is fully

representative of the managers in the firm. Once the firm decides to join Fondirigenti, the registration involves all the middle managers working in the firm. This means that training activities are recorded by Fondirigenti for every manager in the firm. Sixth (6), the panel nature of the dataset allows the whole training activity provided to each middle managers to be tracked over the six years.

[xiii] We do this for the general model and also separately for each size group and training method.

[xiv] See Levinsohn and Petrin (2003) and Olley and Pakes (1996) for a discussion about the issues arising in estimating a production function and the related econometric solutions.

[xv] In our first estimation attempt we have derived a measure of the manger's human capital stock using 2011 as reference year. Training costs and hours have been cumulated taking into account depreciation (we used the estimates derived in Groot (1998) as a benchmark) and regressed on TFP. Results confirm that middle manager training has a positive and significant effect on productivity. Anyway, in order to ease comparability with previous literature we present the model where training is measured as a flow variable. Results about the cumulated model are available upon request.

[xvi] Turcotte and Rennison (2004) find also that an increase of 1% point in the share of workers trained in class with computer training entails an increase of 0.485% in productivity form firms with less than 20 employees, while the estimation is not significant for firms with more than 20 employees.

[xvii] Information about training costs for each kind of method is not available.