The Driving Factors of Firm Training Activities
Empirical Evidence from two Italian Provinces

Giovanni Guidetti and Massimiliano Mazzanti

Department of Economics Institutions and Territory
University of Ferrara
Italy

Abstract

The paper studies the driving factors of different firm training activities using two unique cross-sectional datasets at provincial level. Since the empirical literature on training at firm level is scarce, due to the costs and the intrinsic difficulty of collecting high-quality and extensive data, the paper value added is that it adds knowledge on the issue in providing new empirical evidence on the relationships between firm training decisions and firm characteristics at local Italian level. Data derive from two structured questionnaires administered to the management of 243 firms in the Province of Ferrara in 2003 and to the management of 166 firms in the Province of Reggio-Emilia in 2002. Both Provinces are located in the Emilia-Romagna Region. The two surveys, based on diversified questionnaires, provide extensive information mainly focussing on the following key elements: existence and typology of formal and on the job training, firm performances, HRM practices, skill content of the workforce, tenure, labour flexibility. The surveys also covered the main structural features of firms.

The applied analysis uses different econometric models to explore the linkages between firm decisions over training activities and the possible explanatory factors of training, at firm level. Training is thus specified as the dependent variable in a single equation reduced-form econometric model. Different proxies for training investment decisions are used: binomial indexes assessing whether a firm has invested in formal and/or informal training; indexes of coverage representing the percentage of workers involved in training; indexes of training adoption, capturing the variety of training typologies on which firms are involved; indexes capturing the degree of generality/specificity associated to training investments.

The potential driving factors of training here analysed compounds structural characteristics, labour demand dynamics, human resource management practices, workforce features, and firm performances. The availability of an extended dataset on firm characteristics allows controlling for many relevant factors, which may explain training decisions, reducing the possible distortions arising in a cross-sectional environment.

Econometric analysis is structured as it follows. A binomial probit model is first used to preliminary analyse what elements drives the decision of investing in formal and informal/on the job training. A bivariate probit model is then specified in order to analyse whether the decisions of investing in different forms of training are independent or correlated. The literature nevertheless highlights that more important than investing or not in training is the amount of training firms effectively pursue. The core of the empirical analysis thus revolves around the investigation of what the most significant driving forces of training coverage, variety of training activities adopted and training generality content are. Given a large percentage of firms declaring not to invest in training are present in our dataset, both OLS, Tobit and two-stage Heckman models are implemented and compared. The need of focussing the attention on different training proxies and different econometric models strongly emerges.

Summarising results, we conclude that training activities emerges positively associated with productivity, high-performance practices, innovative labour demand features, workforce skill level, firm size, and affected by labour and plant flexibility in various directions. The analysis suggests that a widening gap, between innovatively evolving and more stagnant firms, could characterise the future dynamics of those local areas. This is a key concern for the current debate on local systems in the European and Italian environment.

Jel: J24, C21, C24

Keywords: firm training, general training, labour demand, human resource management, firm performance

1. The theoretical framework: High-performance practices, training and human capital

1.1 Complementarities in production

Modern economic theory (Milgrom and Roberts, 1990) has developed a formal model that refines Edgeworth's approach to complementarity among productive factors. Complementarity among productive factors can be observed when the level of a given productive factor affects positively marginal productivity of other productive factors. In technical terms that means that the second mixed derivative of the production function with respect to two productive inputs is always positive. However, if one abandons the standard approach of the production function and adopts a Leontief-style analysis of production, the definition of complementarity among productive factors changes drastically. In this circumstance, productive factors are perfect complements and can be combined according to fixed coefficients. Therefore, complementarity entails that an increase in the level of production only results from an increase in the level of all productive factors ceteris paribus, according strictly defined proportions. An increase in the amount of a unique productive input does not give rise to production augment, unless one assumes that the increase in the level of that input causes a change of the fixed coefficients. In either way of analysing production, complementarity among productive factors can be understood as a positive externality effect that each input has either on marginal productivity, if production is described according to the standard neoclassical assumptions, or on fixed coefficients of production, assuming the Leontief production function.

In their contributions Milgrom and Roberts never define specific units of analysis. It is not really clear which factors can be complements. They refer to either characteristic features of production (Milgrom and Roberts, 1990, 1995) or to "elements of the firm's strategy" (Milgrom and Roberts, 1990, p. 513) or in a broader sense to "groups of activities (Milgrom and Roberts, 1990, p. 514). From a labour economics' perspective, complementarities among productive factors can be discussed with reference to four units of analysis:

a) employees' individual skills. In that case complementarity refers to both employees' knowledge and tasks carried out in productive activities;

b) division, shop floor, teams or, generically, autonomous sub-units of the productive unit;

c) organisational practices referring both to organisation of work in a broad sense (i.e.: teamwork, task rotation, training practices) and to other defining features of production (i.e.: management of inventories, degree of vertical integration);

d) capital equipment such as hardware (i.e.: lathe, computers), software (i.e.; computer-aided design, word processing program).

Each of these four categories is a set of single complex productive factors and can give rise to complementarity relationships. It is important to notice that these relationships can be set up not only within each of the four categories among two or more of the elements that compose every single category, but also among different elements associated to different categories. For instance, a complementarity relationship can be noticed and, actually, promoted among an employee's skill endowment, some specified organisational practices and given capital equipment.

In the human resource management literature (Baron and Kreps, 1999) the relevance of complementarity among productive factors has always been recognized. This subject is based on a holistic perspective of the firm and its related issue; HRM scholars have always been aware and have often dealt with problems related to complementarity (Legge, 1995). Baron and Kreps (1999) refers to problems of consistency among human resource practices and claim the need to analyse the comprehensive structure of human resource practices, if one wants to understand whether one or more given practices can be successful or sources of potential bottlenecks in a firm. In this literature not only positive complementarities among inputs are strongly emphasised, but also problems of inconsistencies are widely addressed and empirically assessed through the analysis of case studies. HRM scholars realize that the fit among the diverse HRM practices determines the success of the practices, not simply the decision to adopt or not a single practice.

Complementarity among inputs gives rise to three important interconnected consequences:

1. Relevance of the coordination function. The return of the single inputs depends tightly on the match among them. Hence, coordination of inputs becomes a crucial function in the determination of the firm's performance. As implied in the theoretical framework developed by Foss K. (2001), if one assumes bounded rational agents and technological uncertainty, coordination is an inherent dynamic activity, based on learning-by-doing and different stages of experimenting. Of course, these activities originate production costs in the broad sense of the terms. Indeed, these costs present a dual nature. From the one hand, they are production costs in the strict sense of the expression; on the other hand this expression includes some transaction costs arising from coordination activities. In the former case production costs linked to coordination can be wage costs and direct costs originating from the activity of supervisors and in general of employees in charge of coordinating complementary activities and

inputs. In the latter case these include costs such as costs of setting up the organisational structure for coordination of inputs, monitoring costs other than supervisors' wage, training cost.[1]

It seems disputable to assert that these coordination costs arise only because of bounded rationality and technological uncertainty; it is much more reasonable to state that coordination costs exist regardless of those restrictions but, of course, their level is affected by them. In the capabilities perspective these costs have been called "dynamic transaction costs" (Langlois, 1992, Langlois and Foss, 1999), namely, "costs that arise in real time in the process of acquiring and coordinating productive knowledge" (Langlois and Foss, 1999, p. 18). More precisely in this context, a more extensive definition of dynamic transaction costs, including coordination of productive tasks and skills as well as of knowledge, apply. Basically, these costs stem from the complex processes of integration of different assets and, as it will be shown in the following sections, depend on both structural and short-term factors.

2. Factors' productivity is path-dependent. When there is complementarity among inputs the calculations needed to solve problems of optimal allocation of resources become more and more complicated; not only one has to find the optimal level of every single input, but also the optimal balance among productive factors. Accordingly, the marginal product curve of a single factor, ceteris paribus, is not so smooth and negatively sloped as in standard production functions. Complementarity can produce discontinuities in marginal product curve, even though Leontief production functions are not assumed.

The return of a certain input (asset) also depends on the level of other inputs and the way inputs are coordinated among them. Complications in calculation of marginal productivity, combined with bounded rationality of agents emphasizes, as stated in the previous point, the role played by the coordination function and the related learning processes. Path-dependence is an obvious consequence of the importance of the coordination function and of the hypothesis of bounded rationality. Marginal product of factors develops and grows (or diminishes) in time, according to how the coordination function and the dynamics of learning processes evolve. However, even assuming perfectly rational agents marginal productivity can be path-dependent, when there is complementarity among inputs. Bounded rationality of agents is a sufficient condition for path dependence but it is not a necessary one. As a matter of fact, complementarity implies that adjustments in either the level of other resources or in the coordination of inputs match any marginal increase in a given factor (such as skill…). Hence, marginal increase in any asset increases coordination activities and costs; instantaneous adjustments cannot always take place, unless one assumes an unlimited amount of resources at disposal.

The rationale for path-dependence developed with respect to complementarity diverges for two different reasons from Arrow's explanation of path-dependence in production through learning-by-doing. First of all, Arrow's process of learning –by doing seems to refer especially to automatic and unaware process of learning, taking place in the course of productive activities. Differently, in this case learning is also

[1] Sometimes the distinction between production and training costs is subtle and can give place to ambiguities. However, for the purpose of this paper, it is sufficient to say that coordination activities affect the level of both production and transaction costs.

associated to organisational design and, in general, to improvements in production strategies. Secondly, Arrow's analysis does not explicitly emphasise how learning is linked to process of adjustment in the match of complementary inputs.

3. Factors' productivity and production costs are highly idiosyncratic. The importance of the coordination function in the implementation of the complementarity relationships among inputs and the consequent path dependence of factors' productivity results into highly firm-specific level of factors' productivity and production costs. Internal mechanisms governing the coordination function become a central factor of competitiveness. This third consequence of complementarity is specially connected to tacit knowledge whose role will be analysed in the following section.

1. 2 Tacit knowledge and complementarity in production

The notion of tacit knowledge was firstly introduced by Polanyi (1967), explicitly. Polanyi claims that "we know more than we can tell", referring to that set of knowledge that we are not aware of and that we cannot easily define or transmit. Any human activity is based on a given amount of tacit knowledge and production is no exception. Tacit knowledge is inherently contextual and can be acquired only through a process of systematic interaction between the learner and the organisation within which this kind of knowledge has been developed. Two properties of tacit knowledge deserve special attention: a) uniqueness; and b) difficulty of transmission and reproduction. The first property derives from the role played by the productive context in developing this form of knowledge. The single firm is conceived as a learning organisation (Nelson, 1982). In this perspective, learning in a firm is not a mere individual experience. The firm's knowledge endowment goes beyond the sum of the individual knowledge of its members. Individual tacit knowledge is transformed into explicit knowledge through a process of socialization and then is internalised in individuals (Nonaka and Takeuchi, 1995). In this way, acquisition of knowledge also depends on the social context and, therefore, has always a firm-specific component. Conclusively, each firm develops its unique stock of specific and distinctive knowledge. Uniqueness of knowledge and the conception of firm as learning organisation give rise to the second property of tacit knowledge. If the firm's knowledge does not coincide with the sum of individual knowledge of agents working in the firm, then it cannot be easily transferred and transmitted outwards from the firm's boundaries. Of course, this does not mean that transmission of knowledge and information out of the firm has to be ruled out, but that both of them can flow out mainly through informal and not codified channels.

Tacit knowledge and complementarities are tightly entwined. As a matter of fact, tacit knowledge implies a high degree of complementarity among inputs. Complementarity is a necessary but not sufficient condition for the existence of tacit knowledge. Tacit knowledge requires interactions among productive factors, even though the latter do not always cause tacit knowledge to grow up to significant level. When employees' skills have a high degree of complementarity, then the potential room for tacit knowledge becomes wider and

wider. When two or more skills are complements then it becomes more and more likely that this relationship turns out to be highly firm and/or context- specific.

Conclusively, tacit knowledge accentuate idiosyncrasy of both factors' productivity and production costs. This effect can be strengthened by complementarity among inputs.

1.3 Asset specificity

The third pillar needed for the analysis of production is asset specificity. The relevance of asset specificity in transaction costs' economics has been widely investigated by neo-institutionalist economists. A brief survey can be found in Williamson (1981). Williamson refers to three different sources of asset specificity: site specificity, physical asset specificity and human asset specificity. The notions of ex-ante and ex-post competition play a pivotal role for the definition and the understanding of asset specificity. Ex-ante competition can be observed before any contractual relationship starts and involves a large number of bidders who qualify to match the demand's requirement. However, after the contract has been signed and the winning bidder has carried out tasks and/or services in fulfilment of the contract, its renewal does not replicate the first bidding procedure. As a matter of fact, the first winning bidder has invested in durable specific assets during contract execution. Therefore, he/she has advantages with respect to non-winners for the renewal of the same contract, because investments made favour the smooth and efficient performance of contractual obligations; ex-post competition characterises the relation between the winning bidder and other bidders. The efficiency of institutions governing these contractual relations depends on the degree of asset specificity, which develops during contractual execution. If investments in specific assets is nil or negligible, then the classical market governs efficiently these transactions. As this type of investment rises, classical market's mechanisms erode since the agent who invested in specific assets fits in with the characteristics demanded in the contractual obligations better than other potential competitors. The classical market contracting collapses into bilateral market contracting, when investments in assets is "semi-specific". Investments in specific assets impair the traditional mechanisms of competition. If assets specificity becomes high, then contracting through any market mechanism fades and is superseded by internal organization.

For the understanding of how investments in specific assets affect the mechanisms of governance of transactions, let us consider an entrepreneur who has just started her business. It is reasonable to expect that this employer needs some legal advice. The problem that the employers face is the determination of the most efficient contractual relation to establish with a law expert. To start with, the employer can monitor the market and then sign with the "best" bidder a contract for professional advice (classical market and ex-ante competition). After the execution of the contract if the employer needs some more legal advice, the winning bidder has some advantages over non-winners because, in the course of contract execution, she has invested in specific assets (bilateral market contracting and ex-post competition). Of course, that does not imply that the winning bidder is going to sign the contract renewal for sure; many external factors affect this transaction. However, the mechanisms of classical market are not at work. After a while the employer can

realize that legal expertise is needed frequently and can decide to establish an employment relations with the legal expert. With Williamson's words "internal organisation will displace market as assets take on a highly specific character" (Williamson, 1981). Hence, the employer can find it efficient to substitute an employment relation for a market one. Asset specificity needed for the execution of contractual obligations is so high that the establishment of an incomplete contract, such as the employment relation, is required. Regardless the contractual form that the employment relation can take (i.e.: either open-ended or fixed-term labour contract), it is important to underscore that the higher asset specificity, the more likely is the adoption of internal organisation for the governance of transactions involving labour services. As Williamson states effectively: "«the normal presumption that recurring transactions for technologically separable goods and services will be efficiently mediated by autonomous market contracting is progressively weakened as asset specificity increases» (Williamson, 1981).

It should be clear that both complementarity and tacit knowledge increase the degree of asset specificity. Complementarity implies that the return of inputs depends on the productive context, as well on inputs themselves. As claimed in the previous sections, complementarity has three diverse effects on production in firms. First of all, it increases the importance of the coordination function; secondly it causes factors' productivity to be path dependent and, finally, it generates highly idiosyncratic factors' productivity and production costs.

The first element implies some investment in specific asset for the execution of contractual obligations. The winning bidder, whose asset is coordinated in the course of production, has to invest a minimum amount of resources if she wants to match the requirements of production. The execution of one's contractual obligations has to fit into a cobweb of complementary contractual nexus and hence need adjusting through experience and learning-by-doing. Costs arising from adjustment and refining activities have been called in previous sections «dynamic transaction costs». Of course, the amount of resources to meet these costs varies considerably, according to the characteristics of production and of the inputs referable to the contractual obligations.

Path dependence in factors' productivity makes explicit Williamson's analysis of asset specificity as a dynamic process. Since factors' productivity changes in time, then investments in specific assets by agents occurs in time and is not a one-off event; asset specificity increases as the matching process of assets stemming from the previously referred cobweb of contractual obligations proceeds. Therefore, the advancement of this process of matching and dynamic refinement among inputs and activities, aimed at achieving productivity gains, augments asset specificity. Of course this is not a linear and evolutionary process in which any single stage (adjustment) gives rise to productivity improvements with respect to the previous ones. Adjustments are based on a process of trial and error and the amount of resources (not only financial ones) sets the pace of this process. Conclusively, also due to complementarity among productive factors, the development of asset specificity is a time consuming, non-linear and non-spontaneous process requiring the deployment of both agents' and firm's resources.

The third feature outlined previously is the idiosyncratic nature of both factors' productivity and production costs, as a consequence of complementarity among inputs. Use and return of resources and complementary relations among them, as well as the correlated production and transaction costs, depend on the productive context in which they develop. Asset specificity derives from the coordination among inputs and the nature of the complementary relations established. This characteristic of production causes asset specificity to be idiosyncratic and firm specific. Since asset specificity evolves as the matching of inputs and activities progresses, then the idiosyncrasy of this process results in asset specificity itself being highly idiosyncratic and firm specific. As a matter of fact, one can claim that factors' productivity gains are also due to increase in asset specificity and that path-dependence of factors' productivity parallels path-dependence in asset specificity. If complementarity were not an inherent feature of production in firms, then it would be easy to explain neither productivity nor asset specificity growth, except as phenomena of learning-by-doing.

To conclude this section, there remains to analyse the role of tacit knowledge on asset specificity. It should be clear enough that tacit knowledge increases asset specificity. Both uniqueness and difficult of transmission of this form of knowledge determine increases in asset specificity. The development of tacit knowledge by agents affects positively the degree of asset specificity. In addition to that, the view of the firm as a learning organisation, which implies the idea itself of tacit knowledge, presuppose investments by agents in assets, whose specificity evolves in time, coherently with the organisational knowledge. The continuous process of transformation of tacit knowledge into explicit one and, especially, the individual internalisation of knowledge can be conceived as a tool to facilitate investments in specific asset.

Conclusively, when confronted with complementarity among inputs and tacit knowledge, asset specificity emerges as a process of adjustment and matching of different factors. Accordingly, asset specificity derives from a dynamic process, pushed by trial and error and, therefore, characterized by non-strictly linear dynamics. The development of this process is costly and depends on both the amount of resources available for this purpose and, more generally, on the distinctive characteristics of production in firm.

2. Training, skills and production

2.1 Training in firms: the Human Capital approach

The seminal contribution in modern economic theory about training in firms is the classical treatment by Becker (1964). Becker draws the crucial distinction between specific and general training and analyses its consequences. Assuming perfect competition in both the labour and the product market, perfect information and perfect mobility of productive factors, Becker shows that no employer is available to fund training of employees for the acquisition of skills/ knowledge that affect positively employees' productivity in the firm financing training, as well as in other comparable firms; namely no employer funds general training. On the contrary, employer's financing is available for specific training, namely the acquisition of knowledge/skill that affect positively employees' productivity solely in the firm providing the financial means supporting this training programme. In the case of specific training the burden of financing is sustained not only by the

employer, but also by the employees benefiting from training support, who share with the employer direct training expenses and opportunity costs.

Departing from Becker's treatment of human capital, the economic literature has focused on three different approaches. The first one is strictly theoretical and is aimed at investigating the consequences of relaxing some of the assumptions on which Becker's model is set up. The other approaches are mainly empirical and are devoted to investigate three different issues related to provision of training and acumulation of human capital in firms, namely: a) the propensity of employers to fund general training of employees; b) the structural determinants of firms associable to provision of any form of training; c) the effect of training on the level of both absolute and relative wages[2].

In this approach both employers and employees are regarded as rational agents, maximising an objective function, given a set of constraints. Training activities push up employees' productivity and the target for both employees and employers is to maximise the remuneration arising from their activities of rent seeking. For the employer, the rent she can appropriate is given by: $R= MgPL – W_{MAX}$, where MgPL is the individual productivity after training and w_{MAX} is the maximum wage level the employer can afford to pay, taking into account the percentage of training costs borne. As far as the single employee is concerned, her goal is the maximisation of a quasi-rent given by: $QR= W- W_{MIN}$, where W is the actual wage rate after training and w_{MIN} is the minimum wage acceptable, given the level of the employee's investment in training and the condition of the labour market for comparable job positions[3]. In the case analysed by Becker, with perfect competition and general training provided, the rent (R) the employer can appropriate negative, since the employer is forced to pay a wage rate equal to individual productivity, if she does not want the trainee to quit the firm, since other firms would be available to pay a wage rate equal to w= MgPL. Unfortunately, the employer providing training cannot afford to pay the same level of wage as other employers, if she wants her investment in employees' training is paid off, because she has borne a percentage of training costs. Therefore, as Becker stated in his seminal paper, employees are not available to support employees for general training expenses. Things change, if one considers specific training. In this case, the employer's rent can be positive, as individual productivity has increased in the specific firm where training was provided, only. Of course, specific training is feasible if the employee finds it convenient, too, namely, if the level of quasi-rent the employee manages to extract is positive. Conclusively, a necessary and sufficient condition for the provision of training in firms is that both the employer's rent and the employee's quasi-rent are positive.

Basically, this straightforward analytical framework highlights two underlying mechanism regulating the provision of training in firms, namely promotion of asset specificity and the operation of the so-called "hold up problem". Asset specificity is favoured by employers and its pursue is carried out through the provision of firm specific training. In this way, since skills are poorly transferable, employers can manage to fix a positive

[2] Since this important topic does not deal directly with provision of training in firms, this strand of the literature will not be discussed further on.

[3] A rent is the portion of earnings in excess of the minimum amount needed to attract a firm to finance a training programme. A quasi-rent is the portion of earnings in excess of the minimum amount needed to prevent a worker from quitting her job (Milgrom and Roberts, 1992).

level of rent. Hence, asset specificity push up the level of individual productivity and causes wage to increase at a slower pace than individual productivity. As to the hold up problem, this form of ex-post opportunism can be associated to the behaviour of trainees, once they have benefited from general training programme. Ceteris paribus, the level of wage in alternative firms (w_{MIN}) increases, due to the increase in individual productivity and if an increase in the level of remuneration paid by the firm providing training does not offset this increase, then the employee can be tempted to resign and to apply for a job in other firms[4]. The necessary condition for resignation is QR<0, which, obviously hold if the wage increase acknowledged is below the augment observed in individual productivity.

Using this simple framework of analysis, one can interpret and highlight recent developments in the economic literature. The standard strategy followed by economists working in this strand of the literature is to draw the consequences deriving from the violation of one or more of the standard hypotheses of perfect competition in both the labour and the product market on which, as stated previously, Becker's model is founded.

In their survey of the literature on human capital, Acemoglu and Pischke (1999) show this strategy quite well. They stress three different deviations from the model of perfect competition in the labour market. First of all, they show how the presence of turnover costs for both employees and employers limits employees' mobility and, hence, makes room for the two types of rents to raise. Secondly, they focus on two different sources of imperfect information, which are related to classical problems of adverse selection and moral hazard. In the case of adverse selection the problem arise, because potential employers, who did not pay for training, cannot appraise perfectly the individual productivity of potential employees. Since the effect of training on individual employees depends on their individual characteristics, and is not the same for all trainees, then potential employers can monitor imperfectly individual productivity ex-ante. Accordingly, employers financing general training programme are not forced to equal marginal productivity to wage rate and can enjoy benefits from their rent seeking activity. As to moral hazard, the problems of asymmetric information arising ex post can persuade the employer to set a minimum threshold on the level of wage. When the value of individual productivity is below this threshold, then the employer can push up its level through provision of general training, without increasing wages. In this way, a positive level of employer's rent can arise. Of course, in this case some mechanisms restraining employees' mobility needs to be at work.

In the same spirit as Acemoglu et al., Stevens (1994, 1999) develops a model based on a imperfectly competitive market for skills. In Stevens' model, employees' mobility is limited by the demand side, which is made up of a small amount of firms. Competition for transferable skills among firms is cut down and the level of wage is not driven up to the value of marginal product; competition does not compress completely the employer's rent and the incentive to sponsor general training, either.

[4] Of course, this reasoning also holds in presence of problems of uncertainty and adverse selection. However analysis becomes more and more complicated.

On the theoretical ground, other scholars have pursued a different strategy (Lazear, 2003, Acemoglu, Pischke, 1999). In these contributions general training is a specific case of specific training and, therefore, its effects on individual productivity are maximised in the firm sponsoring training. Acemoglu and Pischke claim that general and specific training are complements; an increase in the level of general skills increase the returns from specific training/skills. Consequently, even though general skills can also be used in different firms, its effect on individual productivity is firm specific and the employer can benefit from positive rent. Lazear maintains that employees' skills derive from a bundle of both firm-specific and general knowledge. The composition of this bundle and the mix among specific and general knowledge distinguishes each employees' endowment of knowledge. Training can be conceived as a bundle of learning practices. Even though training is general, two or more general training programmes can compose the bundle of learning activities. The composition of the bundle determines the firm specificity. From the employer's perspective, Lazear shows that the higher the expected tenure, the higher the propensity to provide general training. This raises an interesting point, because it confirms the claim that tenure has a positive effect on training.

Economists have carried out a lot of empirical analysis in the human capital approach. A detailed survey of this literature goes beyond the scope of this paper. However, it should be mentioned that several of these papers deal with the propensity of employees to provide training, neglecting its degree of specificity and focusing on the distinction between formal and informal training. This bias is caused by poor availability of appropriate data and by difficulties in measuring empirically the degree of firm specificity of training programmes. In addition to that, almost all empirical literature on human capital includes some structural features of the firm among the determinants of the propensity to adopt training programmes such as firm's size and sector, composition of the workforce. The relevance of these variables stems from casual empiricism and is not explicitly rooted in any theoretical framework. As a matter of fact, the theoretical human capital literature addresses especially the effects of deviations from standard assumptions of perfect competition on the behaviour of maximising agents, ignoring the influence of structural variables.

2.2 The content of training: skills acquired vs. skills used

In the human capital literature the distinction between general and specific training is crucial and overlaps the one between general and specific skill. However, if one introduces the distinction between skill acquired and skill used, then the notions of training and skill do not coincide any longer. Skill acquired refers to the content of education, training and, in general, to the knowledge content transmitted to the employee. Acquisition of skills occurs through both formal and informal procedure of transmission and refers to the broadest concept of knowledge[5]. On the other hand, skill used applies to the skills actually used by the employee in his working activities and define the set of tasks to perform.

[5] Following both Loasby (1996) and Lundvall (1998), this broad notion of knowledge point out four different categories: a) know-what; b) know-why; c) know-how; d) know-who.

This distinction between skills acquired and used is consistent with the classification of skills introduced by Stasz (2001). The Authors points out four broad skills area: a) cognitive skills, i.e.: school background; b) generic skills such as problem solving, communications and teamwork, whose meaning varies with the context; c) technical skills, i.e.: academic skills and knowledge of specific machinery or productive processes; d) work-related attitudes or soft-skills such as motivation, volition and disposition. Skills under a) and c) can be viewed as acquired skills, whereas b) and d) refer to firm-specific skills actually used.

The relationship between skills acquired and skills used is complex. The set of skills acquired does not overlap necessarily with the one of skills used. Moreover, skills used are not simply a sub-set of a static endowment of skills acquired. Indeed, skills used can have a completely different nature from skills acquired. From the one hand one employee can have acquired very general skills in a training programme, although the skills used in the production process, and the tasks associated to those skills, can be highly firm specific. From the other hand, firm specific training, aimed at developing specific skills used, can entail the acquisition of general skills, because learning of general skills can be a prerequisite for acquiring highly firm specific skills[6].

The relation between skills acquired and skills used is not necessarily unidirectional. As a matter of fact, skills acquired and skills used give rise to a feedback loop. From an endowment of skills acquired, one can develop a set of skills used through for instance on-the-job training, learning by doing, specific off-the-job training and other interactions with the domain of production. However, the relation also works in the opposite direction. In other words, after a series of skills acquired has developed into skills used, the process of conversion can continue in reverse and proceed towards the acquisition of new skills and the consequent growth of the endowment of skills acquired. Of course, the notion of learning also applies when the relation runs from skills used to skills acquired.

The conversion of a given endowment of skills acquired into skills used is not a simple process of extraction or selection of some relevant skills for productive requirements, but it is a process of learning based on the selection, transformation, adjustment and refinement of a set of skills, acquired in either the educational or the vocational system, into skills interacting with other inputs and promptly usable for the performance of productive tasks.

This process is not neutral with respect to the range of skills acquired. Actually, an increase in the endowment of skills used can feed back on the skills acquired, changing, transforming and also widening their domain. The conversion of skills used into skills acquired focuses on the behaviour of employees and point to their ability to turn working experience into a set of skills acquired. If this ability is poor, then this learning process does not give rise to a set of skills acquired which is significantly different, in nature, from the skills used. Hence, these skills newly acquired cannot be easily adapted to a different context for the

[6] A suitable example of firm specific skill encompassed in general skill is given by the skills needed by a bank cashier to record each transaction. She needs to learn a firm specific software (specific skill used), however to manage this software, she needs to learn some basics of standard operating system, possibly either Windows or Linux (general skill).

development of skills used. On the contrary, if this ability is high, the employee can transform the skills newly acquired and adapt to new context for the development of skills used.

Learning complexity determines the degree of similarity between skills acquired and skills used. The simpler learning, the higher the similarity in nature between skills acquired and skills used and, conversely, the more complicated learning, the lower similarity.

Without doubt, the notion of learning complexity is quite intuitive, but it is hardly definable in scientific and unbiased terms. First of all, this process consists in the conversion of skills acquired into skills used and is basically driven by labour demand's requirement. If this process of conversion is long and complicated and cannot be limited to a simple process of learning-by-doing, then, presumably, the nature of skills acquired and skills used, as measured by their degree of specificity/generality, is different. Contrarily, if this process of conversion (learning) is short and easy, and can be limited to a span of learning-by-doing, then the nature of skills acquired, is close to the one of skills used. A brief conversion process implies that both skills acquired and skills used are either general or specific. In conclusion, on the one hand one can state that learning is complex, when a significant conversion of specific/general skills acquired into general/specific skills used takes place, on the other hand a simple learning entails an irrelevant process of conversion.

In second place, the relationship also runs from skills used to skills acquired. This process of conversion is substantially carried out by labour supply, namely by the employees' ability to enrich the personal endowments of knowledge through the conversion of skills used into skills acquired. As in the previous case, the nature of learning which underlies this process of conversion can be either complex or simple. Complex learning indicates that accumulation of skills used has generated a set of skills acquired which is partially independent from skills used and self-contained, therefore it implies different nature in terms of specificity/generality between skills used and acquired. Conversely, simple learning process implies that the bundle of skills used does not lead to a set of autonomous skills acquired.

This analysis of the relationship between training and skill differ from that developed in Acemoglu, and Pischke (1999), mentioned in the previous section. The two Authors refer to potential complementary relationship between specific and general training. They refer to complementarities arising from two diverse training practices. Differently, in the approach developed in this section, the idea is that the same training initiative has often a double-sided nature. From the one hand, specific training aimed at developing firm specific skills can require learning of general skills. From the other hand, general training has to be always converted into skills used so that marginal productivity is actually reinforced.

In conclusion, general training implies the acquisition of general skills, but it does not cause skills used to be necessarily and solely general. Similarly, specific training can also entail the acquisition of general skill used. A simple one-to-one functional relation between, from the one side nature of training and of skills acquired and, from the other side, nature of skill used cannot be established. Hence, not only one has to take into account the distinction between general and specific training, but also the one between general and specific skills used.

2.3 Skills and production.

In the first place it can be interesting to focus the attention on the interaction of this analysis of skills with the features of firm's production, outlined in the first section of this paper, i.e.: complementarity among inputs and activities, asset specificity and tacit knowledge. In second place, it is important to discuss the consequences of this framework of analysis on both the labour market and some structural characteristics of the firm.

As mentioned in previous sections, three important consequences arise from complementarity: a) relevance of the coordination function; b) path-dependence of factors' productivity; c) idiosyncrasy of both factors' productivity and production costs. It is interesting to discuss the interaction between each of these factors and the processes of skill accumulation and human capital development in firms.

Relevance of the coordination function. One of the most relevant properties stemming from complementarity is the effect of the match among inputs on individual productivity. This interaction should be interpreted not only in terms of team production, with the problems of monitoring of individual performance widely discussed in the seminal paper by Alchian and Demsetz (1972), but also as a simple problem of match among interacting skills, as implied in Adam Smith's classical example of work organisation in a pin factory.

Since skills can be considered as productive inputs, then one can state that the nature and the return of skills used is affected by the way these skills are coordinated with other inputs such as other skills, firm's equipment… The execution of the coordination function establishes the complementary relationships among all sorts of inputs and, accordingly, defines the actual set of skills used[7] and their nature. Accordingly, the coordination function manages the process of conversion of a given endowment of skills acquired into skills used and, therefore, the learning processes implied, as stated in paragraph 5. The coordination function governs this process; the interaction with other skills, inputs and the productive processes define and limit the domain of skills used.

Training can be conceived as process of definition and specification of skills used and includes a wide range of various activities such as apprenticeship, formal specific courses, informal on-the-job training and, in general, all the forms of learning enabling the employee to carry out the tasks associated to her job position. Using the typical terminology of the management literature, the coordination function creates the environment for the productive exploitation of the skills acquired, through their conversion in skills used, and the setting up of consistent relationships among diverse skills associable to either the same individual or to different employees. Failure or not optimisation in the performance of this function cannot be ruled out

[7] An example can clarify this assertion. Let us consider a bank cashier who was trained in the basics of informatics in order to acquire the minimum set of skills required for the performance of his job. During this stage of apprenticeship it is unlikely that she will learn just the basic skills needed, but she will acquire skills which will never be used in the performance of the job. That seems correct especially if training is not tailored on the specific requirement of a specific job position, but is devoted to a set of workers covering comparable job position.

and can impair and limit drastically the positive effects of training. In conclusion, as far as skills are concerned, coordination refers to the process of extraction of skills used from skills acquired through the implementation and establishment of complementary relations among skills and other productive inputs.

This function of coordination of skills is one of the sources of dynamic transaction costs, discussed previously. These costs play a crucial role in the definition of the rent enjoyed by the employer, because they are a crucial component of training costs. In traditional human capital theory, training costs are either direct or opportunity costs. In this framework of analysis the standard typology of costs considered in the human capital approach do not encompass all expenses arising from the organisation and coordination of skills used and their development through the implementation of training activities in firms. Variables affecting the level of such costs are manifold and cannot be easily singled out; nevertheless it seems reasonable to mention variables such as the ability of personnel in charge of the coordination function, the complexity of both training and productive activities and the possibility to monitor them, the individual characteristics of trainees…

Path-dependence of factors' productivity. Path dependence in factors' productivity results into path dependence of skills used. If the evolution of skills used is tightly linked to the coordination function and, in this way, to processes of learning and trial and error, then it is also reasonable to maintain that, not only this process is time consuming, but also that the accumulation in time of skills used constrains and steers their evolution.

Consequences of path-dependence are not simply that employees' skills change over time because of physiological mechanisms of learning. The notion of path dependence carries the idea of not perfect reversibility and not-uniqueness of the process of evolution of skills used. It is important to stress the joint effect of these two factors. The endowment of skills used results from the choice made by the staff in charge of the coordination function of inputs. The process of conversion of skills acquired into skills used is oriented by these choices and can give rise to either "optimal" (satisfactory) setting up of consistent relations between skills and other factors or to an inconsistent configuration of relations. Not perfect reversibility implies that sub-satisfactory configuration of relations cannot be adjusted at no costs and, hence, can originate persistent inefficiencies.

When analysing path-dependence and not perfect reversibility, it is important to observe that both affect the profile of dynamic transaction costs. These expenses are not limited one-off costs, distributed within a clearly predefined span. Path dependence results into time variability and unpredictability of such costs. Bounded rationality and limitedness of resources available to plan in details the process of conversion of skills acquired into skills used do not enable to predict not only the exact level of the correlated costs, but also their timing. Of course, this dynamic process of cost-bearing binds, and sometimes can hamper, the development of skills used.

With the important exception of Arrow's analysis of learning-by-doing, the time dimension has always been neglected in standard analysis of skill development and in human capital literature. Anyway,

considering skill development as a simple dynamic process would change neither the spirit of human capital analysis nor its main conclusions. However, the hypothesis of path dependence, as well as that of skill development as dynamic process, change conclusions quite radically. Path dependence is hardly consistent with the idea of optimal development of skills used from an endowment of skills acquired. In a standard human capital perspective, the match with other skills and factors of production determines the optimal combination of skills used, conversely in a dynamic and path-dependent world the dynamics of the complementary relations established constrains the process of development of skills used. Skills used evolve in accordance with the way the coordination function among inputs operates.

Idiosyncrasy of both factors' productivity and production costs. Finally, from the analysis developed under points I and II, idiosyncrasy of the process of conversion of skills acquired into skills used emerges neatly. Development of skills used is highly contextual and depends on the choices made, as far as the complementary relations among inputs are concerned. Idiosyncrasy unfolds in three different ways. First of all, the nature itself of skills used is highly idiosyncratic; given the same endowment of skills acquired the set of skills used varies according the productive context in which the process of conversion occurs. Secondly, the process of conversion is idiosyncratic because it is strictly linked to highly firm-specific complementary relations among assets. In the end, dynamic transaction costs arising from this process are quite idiosyncratic, for the same reasons as the two other elements.

The fundamental distinction between skills acquired and skills used has to be analysed in comparison with the idea of asset specificity, outlined in previous sections. This distinction does not parallel the one identifiable by the degree of training generality/specificity; skills acquired do not point out solely general training, as much as the idea of skills used does not overlap the concept of specific training. One can conceive highly specific skills acquired, so much as highly general skills used.

As far as skills are concerned, the notion of asset specificity is twofold. Each stage of the feedback loop that characterizes learning process points out a specific meaning of asset specificity. Firstly, when the relation runs from skills acquired to skills used, asset specificity depends on both the complementary relations established and the nature of the skills used; asset specificity is set through the operation of the coordination function (Asset specificity type 1). Secondly, asset specificity can be defined with respect to the process of conversion of skills used into skills acquired (Asset specificity type 2). The former notion of asset specificity depends on skills used and orientates the behaviour of labour demand; the latter focuses on skills acquired and affects the behaviour of employees (labour supply). The two interpretations of asset specificity need not coincide; one can observe a high degree of asset specificity type 1 and a low degree of asset specificity type 2, and vice versa.

Learning affects both types of asset specificity differently. The effects of learning depend on the direction of the relationship between skills acquired and used. When the link runs from skills acquired to skills used, the degree of asset specificity (AS1) is proportional to the complexity of learning processes; the more complex learning processes the higher asset specificity. When the relation runs in the opposite direction,

things change. In this case the more complex learning processes, the lower the degree of asset specificity (AS2). In the former case complex learning processes imply that the development of skills used requires an elaborated process of conversion, whereas in the latter complex learning processes indicate that acumulation of skills used has generated a set of skills acquired which are partially independent, self-contained and different in nature. Thus, as learning processes become more and more articulated, the former carries the development of asset specificity, whereas the latter results into more general assets.

Conclusively, asset specificity has a double nature depending on this feedback loop, outlining the effect of the coordination function on the skills acquired which originates the skills used (AS1), and the feedback effect of the skills used on the endowment of the skills acquired (AS2). Learning connecting these two types of skills is crucial for the determination of asset specificity, intended as skill specificity. As asset specificity stems from this feedback loop, one has to take into consideration the learning processes between skills acquired and used, appraised in both directions. Since the global feedback loop matters for the determination of asset specificity, the same set of skills used can be associated to different level of asset specificity according to the process of development of skills used[8].

Complementarity among assets plays a pivotal role for the determination of both complexity of learning process and, especially, the return of the skills used. As a matter of fact, the complementarity among skills and productive factors specifies the process of conversion of skills acquired into skills used. Asset specificity (AS1) highlights the complementary relationship among skills used and other inputs involved in the production process. The cobweb of relations determines the productive return of skills used, which is never independent from the way the diverse skills observable in a firm fit together and are coordinated. This view of skills used, whose return depends substantially on asset specificity, and the idiosyncratic complementarity relations implied,

It is important to stress that skills used specificity and asset specificity are two distinct concepts. The former refers to the features of skills in themselves, neglecting complementary relationships with other inputs; the latter points to the complementary relations established between the skill content and other inputs. Consequently, one can observe highly general skills used which give rise to high degree of asset specificity (AS1), when the complementary relations among these skills and other inputs are highly firm specific. Specificity of asset derives from the specific and idiosyncratic relations established with other inputs. The reverse can hold and specific skills used can originate a low degree of asset specificity. As it will be analysed in the following section, the distinction between skills used and asset specificity is quite important in the definition of both employer's rent and employee's quasi-rent. As to skills acquired, these define the degree asset specificity (AS2). Skills used and acquired are bound together through the feedback loop described previously. Technology, work organisation and the consequent learning processes establishing the set and the

[8] Let us consider the case of the bank cashier, again. We can assume that there are two ways to learn how to register every single transaction. In the first way, the cashier is trained off-the job. In the second way he is trained on-the-job by one of her colleagues. Assume that after the spell of training, the cashier has developed the same series of skills used, so that she can perform her job with the same efficiency, regardless the form of training. However, the degree of asset specificity can be different, since the underlying feedback loops are not inevitably the same.

characteristics of skills used affect the endowment and the nature of skills acquired. Nevertheless, employees' individual ability also has an important role in the determination of the degree of generality of the skills acquired; the higher ability, the more general the set of newly skills acquired and vice versa.

The role of tacit knowledge on the development of skills in firms is similar to the one played by complementarity, since these two elements are tightly entangled. Tacit knowledge augments the degree of asset specificity of skills used.

The relevance of the distinction between skill used and skill acquired stands out neatly, when one discusses problems of marketability of skills, by using the simple framework developed previously for the analysis of rent seeking activities of both employers and employees. As far as the employer's rent is concerned, marginal product depends on skills used. The value of the trained employee for the firm in which the worker was employed at the period of training is determined mainly by skills used and asset specificity type 1, because, obviously, those define the range of tasks that the employee can carry out and, in this way, her actual and potential productivity.

If one takes into consideration the level of quasi-rent for employees, things change. In the definition of quasi-rent, W_{MIN} depends on the wage attainable in comparable job position. Accordingly, the marketability of individual skills results from skills acquired, as product of previous working experience, training and school background, and the match between those and the features of potential labour demand. Labour demand constrains the marketability of skills acquired, given its role in the conversion of skills acquired into skills used. This match between skills acquired and labour demand is an indicator of potential skills used, extractable in different workplace from that to which the employee is currently linked. W_{MIN} depends, ceteris paribus, on this potential match between the demand side of the labour market and skills acquired. Therefore, an increase in the endowment of skills acquired does not entail by itself an increase in the level of W_{MIN}, as stated in standard Becker's story. W_{MIN} increases only if the increase in the endowment of skills fits into the features of potential labour demand.

Conclusively, the distinction between skills acquired and skills used points out a differentiated dynamics between the employer's rent and the employee's quasi-rent, in presence of training. The accumulation of skills acquired affects positively the width of the potential range of skills used, if and only if potential labour demand manages to extract newly skills used from the process of accumulation of skills acquired. To the extent that the process of acquisition of skills diverges from that of skills used, the impact of any form of training on the employer's rent and on the employee's quasi-rent is different. In Becker's classical treatment of human capital in firms, general and perfectly transferable training has the same effect on the rent and the quasi-rent and, as a consequence of that, the employer cannot finance it and its costs are entirely borne by employees. For opposite reasons, the employer's financing of specific training programme is feasible. The discrimination between skills acquired and skills used enables to catch the possible differentiated effects on both the rent and the quasi-rent, not only of specific but also of general training. Conclusions are less sharp-cut than in Becker's seminal analysis of training in firms. Both specific and general training can yield

differentiated levels of rent and quasi-rent, which is the condition required for the financing of training by employers; not only financing of specific training but also general training programmes can be supported by employers. Though, if the dynamics of rent is not differentiated, provision of training by employers is not feasible, irrespective of whether it is general or specific.

An interesting and extremely relevant consequence of the way both types of asset specificity develop is given by the effect of general training and, also, the availability of employers to finance it. From the analysis developed in the previous sections, it should be clear that general training influence the endowment of skills acquired of employees. The idiosyncratic process of conversion of skills acquired into skills used specifies the effect of general training on labour productivity. That means that general training is always coupled with some form of specific training.

The basic idea is that "the feedback loop of skills" described above, and not the nature of training, determines the degree of asset specificity type 2 and, hence, the marketability of the skills acquired, which however also depend on the characteristics of labour demand. When general training is imparted to employees, idiosyncratic complementary relations specify the nature and the return of the skills used. Even though the set of skills acquired can be highly general and transferable, skills used can be extremely firm specific and, therefore, can give rise to positive level of employer's rent. Accordingly, the employer can find it convenient to finance general training. The reverse can hold for specific training. Even though the set of skills used can be highly firm specific, the process of conversion of skills used into skills acquired can result into a highly general set of skills acquired. Thus, the employer can be quite reluctant to provide this kind of training.

To conclude with, it can be interesting to provide few hints about the interaction of some firm's structural variables and the process of skills development, discussed in the previous sections. Attention will be focused on three different elements, featuring the firm's structure such as: a) firm's size; b) firm's technology; c) tenure, internal labour market and the employment relation.

a) It is reasonable to believe than in small firms fewer complementary relationships among inputs can be coordinated than in big firms. This seems to have a negative impact on small firms' productivity. If fewer complementary relationships can be established, then the same set of skills acquired can produce a lower level of returns of the skills used. Furthermore, a small size can have the possible effect to decrease the degree of asset specificity arising from the creation of skills used, either through conversion of skills acquired or directly on-the-job. Of course, in small firms this limits the value for the employer to provide training for employees. Furthermore, this characteristic of organisation of production in small firms can explain why downsizing strategies are consistent with promotion of functional flexibility. Basically, downsizing implies both a decrease in the level of employees and outsourcing of peripheral productive activities. Increase in employees' productivity is reached through the establishment of newly complementary relationships. This strategy is pursued by means of an extensive use of the workforce. Basically, a decrease in the range of productive activities brings about the pursuit of job enlargement strategies aimed at

engineering new complementary relationships. As the scale of production augments, this strategy is more and more carried out implementing complementary relationships among sub-units of the firm (divisions, departments…) and less and less the pursuit of employees' functional flexibility.

b) Technology constrains the process of conversion of skills acquired into skills used. Capital equipment, machineries and, in general productive processes characterize technology. These factors constitute productive inputs with which skills used have to establish complementary relationship. The process of conversion depends on how one coordinates and manages the match between the elements characterizing technology and the development of skills used. Of course, the relationship between technology and skills used also runs in the opposite, i.e.: from skills used to technological development.

c) Internal labour market provides the suitable environment for the process of development of skills, as it implies employees' long-run attachment to firm. However, some caveats apply to this general statement. Job description in internal labour market can be so rigid to restrain the process of development of skills used, which requires a considerable degree of internal labour market flexibility. When, for any reason, internal labour market flexibility is poor, then the process of development of skills used can be strengthened by procedures easing the hiring of new employees and the firing of incumbents. On the other hand, if internal labour market flexibility is high, skill development can be compatible with fairly rigid procedure of hiring and, especially, firing. Conclusively, in order to meet the conditions for skill development, internal labour market flexibility/rigidity is always matched by external labour market rigidity/flexibility.

This framework of analysis can be a useful basis to understand possible effects of short-term labour contracts. This typology of contracts has a twofold interpretation. First of all, in the short-run contracts can be a tool to meet product demand fluctuation; when demand is highly uncertain and variable, short-run labour contract can act as a buffer to control wage costs. Secondly, short-term labour contracts can be adopted in order to increase external labour market flexibility, as they ease the procedures and the costs of hiring and firing.

In the former notion of short-term labour contracts, those restrict the expected temporal horizon for the process of conversion of skills acquired into skills used. This implies that the process has to be quite simple and little costly and, hence, that no significant asset (skill) specificity is needed for the performance of the tasks attached to the job positions associated to short-term labour contracts. For short-term employees, employers are not available to finance complex general training programme, as employees' attachment to the firm is expected to be short. The latter case is more complicated. As short-term labour contracts increase external labour market flexibility, they favour the process of substitution of obsolete (rigid) workforce with trainable (functionally flexible) newly employees. On the other hand, if the process of skill development extends in the long-run, a short expected duration of employment relation can be a problem, as it loosens the employee's attachment to the firm. The time profile of skills development and the associated costs, as well as the processes of both rent and quasi-rent extraction, play a pivotal role in the specification of the most suitable labour contract's length and can also persuade the employer to set up open-ended labour contract.

Therefore, when rigid internal labour market prevails, external labour market flexibility can be a necessary but not sufficient condition for the development of skills used.

3. The Empirical literature on firm-level training

The empirical evidence on training determinants is overwhelmed by contributions stemming from a micro-based approach, which takes as unit of reference the worker. While a rich array of data on training is provided by cross sectional and longitudinal individual based surveys, data on the nature and extent of training investments and training typologies provided by private establishments and firms are scarcer (Frazis et al., 1995). Data are usually gathered from National firm or household surveys that elicit information on worker characteristics, contract features and position within the firm.

Our approach is specifically focussing, as already stressed, on micro-based data at firm/establishment level. Within this field of applied analysis, empirical evidence is scarcer, presumably given the higher cost and difficulty of collecting high quality data at firm level by direct surveys using structured questionnaires. The approach is nevertheless more interesting since by directly interviewing firms one has the possibility of collecting extensive data on firm performance, organisational structure and dynamics, structure of labour force and other key issues at firm level. One drawback is that the analysis is usually constrained within a specific regional territory. Good sample representativeness is therefore important for rooting a robust statistical analysis on firm training and its determinants.

We now summarise the more recent and relevant contributions that empirically analyse the relationship between training and various determinants. This survey of the literature is aimed at highlighting (i) the different training indexes used in the literature, (ii) the econometric modelling, in terms of statistical specifications used, (iii) the empirical evidence arising from the studies. The critical analysis of those factors is crucial to introduce our empirical analysis on the two above described datasets next.

Whitfield (2000) is one of the recent studies that are of major interest to our analysis. He uses a dataset based on a nationally representative sample of British establishments[9], and analyses the core relationship between training decisions and high-performance work practices, finding that firms implementing a set or bundle of such practices exhibit stronger intensity in training. The main hypothesis tested is the (joint) effect of high-performance practices on training intensity. Another hypothesis tested is that the link between training and new work practices is stronger for those at the upper end of the occupational scale, following a bimodal distribution of training across occupations. The dataset is estimated by a single equation model having as dependant variable a proxy for training coverage/intensity. Training is measured by the number of days a worker in a work place receives training in a given year (Incidence), by a coverage index and by an intensity index (time spent in training). New practices included as covariates are quality circle, flexible working, teamwork, and briefing group. The joint variable obtained multiplying the four elements (dummies)

[9] Obtained matching the third British Industrial relations survey and the employer manpower skills practices survey.

is included as well to capture the joint effect. Then a set of control variables, like union presence, age of establishment, level of technology, market openness, sectors, is also added. The analysis of the cross sectional dataset based on 1991 data is limited to the trading sector (647 firms considered in the final analysis). Econometric analysis is based on a standard Tobit model. Main results are that there is strong evidence of a correlation between the adoption of new practices and training. The relationship is especially strong for intensity of training, rather than for coverage[10]. Thus, size effects are present, new practices are positively associated to training but on a joint basis, not in isolation, and the effect of new practices is significant for the intensity of training, not for coverage (HRM do not seem to extend the number of workers involved).

Black et al. (1999) use the 1992 UK Small Business Administration Survey for testing two main hypotheses linked to firm size. The first is related to formal training: do economies of scale provide an incentive towards more intensity in training, given the decreasing cost of investing in formal training for large organizations? The second refers to informal training: large organization may experiment more informal training due to the higher opportunity costs of co-workers (managers in that case) in small businesses, with respect to large firms, where multiple workers perform the same job or co-workers are used instead of managers for this type of training. Econometrically speaking, three measures of training are considered as dependant variable: hours per week that training is offered (intensity), duration of each type of training per week, and a mix of training (fraction of training provided by each type of training[11]). For covariates, they use the size of the establishment, the size of the firm, a union presence proxy, and other control variables. The analysis is carried out by using a Tobit model for intensity, an ordered logit for duration and a double limit Tobit[12] for the mix of training. Main results are the following. Regardless the

[10] The author correctly underlines some main methodological issues, like the necessity to develop a shared set of training measures, the need to be clearer and more accurate in measuring HRM practices and, finally, the need to use either longitudinal dataset or hybrid cross sectional dataset with lagged variables, in order to disentangle the causal relationship between training and its determinants.

As far as the latter point is concerned, Caroli et al. (2001) analyse both theoretically and empirically, on French establishment-level data, the relationship between workforce skill and new work practices. Since both training, as kill accumulation, and new work practices may be considered as innovative factors related to organizational change, it is difficult to assess the eventual causal relationship. As an example of the possible different research perspective on the link between new work practices and skill accumulation (training), they estimate a probit model with dependant variable equal to one if net employment has increased in establishment I for skill group s, a test on the link between skill accumulation and organizational change is performed. It appears that organizational change leads to downsizing for all categories of workers, but it is more detrimental for the least skilled workers. Other empirical studies have tested such a reduction: OECD (1999) investigates the link skill of the workforce-organizational change, with a result that establishment with flatter hierarchical structures and those that use teamwork are less likely to have low skill requirements for the workforce. Caroli et al present evidence from some French empirical studies that confirm that the introduction of innovative work practices has important implications on the reshaping of the workforce at the expense of the least skilled workers.

A choice made by other author (Huselid, 1995) is to include training among the new work practices, as an eventual explanatory factor of performance (although the objective of the paper is more general and focused on HRM and firm performance). All the different lines of analysis are useful to add new pieces of information on the complex links between new work practices, training, innovation and performance.

For the sake of transparency, this paper aims at investigating the force which lie behind the adoption and investment in training. As a second step, it will be possible to assess the impact of training and other determinants on future performance. We are thus aware that each paper studies a specific part of the puzzle.

[11] In other words, the proportion of each type of training as a fraction of total training. In this manner, they see a firm's method of training response to different firm features.

[12] It is worth noting that the use of a two limit Tobit when fractional variable are analysed, limited but continuous over the range 0-1, is justified if censoring occurs at both tails. Following Long (1997, p.212), a common application of this model is when the outcome is a probability or a percentage, but upper censoring is present only if the latent phenomenon is higher or more positive

typo of model of training measure implemented, intensity, duration or mix of the two, it emerges that larger establishment and firms provide training that is more formal. Then, larger firms are more likely to train elsewhere in the firm or purchase outside training course. In addition, larger firms tend to provide more informal training by both increasing intensity and duration.

The link between firm size and training performance was also the focus of Black and Lynch (1995), who use unique nationally representative survey of establishments and find that the smallest employers are less likely to provide formal training programs than larger employers are. In addition, regardless of size, the adoption of high performance work systems is correlated to the presence of more intense formal training. Finally, they also find that more investments in physical capital and higher educated workforce are elements that show to be positively correlated with formal training activities, especially in the manufacturing sector. The survey considered private establishments with more than 20 employees, interviewed in 1994. The cross section dataset consists of 1621 establishments in the manufacturing sector and 1324 in the non-manufacturing sector. Overall, 71% of establishments offered some formal training programs, although the coverage is 40% on average. The above results stem from a binary logit analysis based on a sub-sample of firms, respectively 890 and 624, due to missing values of many explanatory variables. The most relevant explanatory variables taken as determinants of the probability of investing in formal training are the book value of capital stock, human resource management practices, firm size, and worker characteristics such as education level, tenure, unionisation, skills, etc… although the analysis is a simple binary logit type, the focus of the author is on the analysis of diverse dimensions of formal training, as computer training, teamwork training, basic education, sales and customer service. Results previously described refer to the logit analysis. As far as the analysis of coverage is concerned, they use a Tobit model. The authors note that the determinants of the proportion of workers trained look somewhat similar to the determinants of the probability of offering formal training, especially in the manufacturing sector, besides the size effect, which seems less significant. Smaller establishments so not seem less likely to train a higher proportion their workers, condition on training at all. It remains confirmed the main result of the contribution, that is that investments in training are complementary to investments in physical and human capital[13]. This result, which is difficult to assess and generalise given the nature and quality of accounting data about capital, is not always supported by new evidence. Hempell (2003) explores whether investments in ICT and firms sponsored training are complementary, using a German panel data over 1994-1998. He finds that training is a complement to ICT investment but not to other capital good.

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than indicated by the limit 1 or 100%. This is not always true and it is often an ambiguous matter to assess. The point will be addressed also in the part devoted to econometric analysis.

[13] The same authors (Black and Lynch, 1996) then provide evidence on the effect of training and other determinants of innovation on firm productivity, finding a relevant role played by human capital and certain types of employer provided training. As we said this is another piece of the puzzle, we will study in the future whenever data on future firm performances are available. The availability on data concerning past and future performance allows to move towards hybrid cross section environment, incorporating also lagged explanatory variables as well as two stage instrumental values approaches, with the aim of mitigating the well known simultaneity bias (Huselid and Becker, 1996; Huselid, 1995).

A study which also refers to the US environment is by Frazis et al., (1995), who examines the results of a survey conducted by the Bureau of Labour Statistics on formal training and on the job training. The dataset is of 8467 establishments, of which 71% is involved in any type of formal training (although about 97-98% of establishments over 50 employees provide training), with significant difefernce by sectors. In addition to gathering information on six major categories of training, from basic skill training to workplace training and apprenticeship training, the survey collected detailed information on diverse types of formal job skills training (management skills, computer skills, technical skills, etc..). The primary aim is to obtain detailed information on various typologies of formal training and formal job training[14]. Empirical analysis is carried out by a binary probit model, using as dependant variable the adoption of some specific forms of formal training (any formal training, formal job skills training, training in basic skills) and as explanatory variables factors tenure, new workplace practices, union coverage, worker skills, and establishment size. Findings are that the provision of formal training generally increases with the size of establishments, with the provision of some employer benefits (assistance plans), with the adoption of new work practices and with tenure.

Boheim and Booth (2003) presents an empirical study which grounds on a hybrid dataset, partly deriving from a survey on employees and partly from the 1998 UK Workplace employee relations survey targeted on the private sector. The paper analyses the link between workplace union recognition and private sector employer provided training. By using a probit model taking as dependant variable a variable which takes the value of one if a worker received formal training over the last year, the determinants of the probability that worker participated in employer-provided formal training over the last year are investigated. Results show that union recognition (measure of union presence) is overall positively correlated with the individual training probability for non-manual men and women, but not for manual women. The interpretation is that the presence of a recognised union at the workplace is likely to be associated with features that are leading to training, such as labour turnover, and reduced wage dispersion.

Among the more recent contributions, Beckmann (2002) is one of the main interesting works and it is next to our line of applied analysis, although he focuses on apprentices training only. The author investigates firm-sponsored Apprenticeship training in Germany, using establishment data. Data comes from the largest firm-level data set (Establishment German panel) in Germany, covering both west and east Germany and containing information on business policies and developments, innovations, personnel structures, recruitment, wages, working times, training schemes, industrial relations. The panel for the wave 2000 includes 13931 firms of all sizes and industries. For the applied analysis, the author uses only data for 2000, thus opting for a cross sectional like model. The firm training decision is described as a two-stage process: first, the firm decides whether or not to invest in training then it decides the amount of training. In the paper training intensity is specified as the ratio between apprentices to total employees, which is defined as the

[14] It is worth noting that nearly 2/3 of establishments that did not provide formal job skill training in 1993 reported that on the job training satisfied needs.

dependant variable[15]. The explanatory factors are: some variables proxing capital investments, like indexes of modern and obsolete technologies, firm investment per employee, the number of quits after apprenticeship, the relevancy of short-term contracts among the workforce, the rate of qualified workers, firm profitability (proxied by dummies excellent/deficient, not by real accounting figures[16]). On the econometric ground, he applies probit and Tobit models in order to analyse both the binary choice and the censored phenomenon about training decisions. In addition, he estimates a truncated model accounting only for firms associated to positive training levels. Using a single regression model, the determinants of training probability and intensity are investigated for both west and East Germany. Main overall results are that, on the one hand, modern technologies, union presence, firm size are significant with positive sign on the coefficient, while short term duration contracts and quits after apprenticeship is significant but with negative sign. It is to remark that performance dummies are not significant, as well as investment per employee. The study also highlights that structural regional differences concerning the economy, in this case west and East Germany, are associated to often striking different results concerning training explanatory factors[17].

Summing up, we may now underline the critical points of the literature which help us figuring out what the more value added research lines are. Critical points refer both to methodological/econometric issues and to data/measurement issues.

On a methodological ground, it is worth noting that the variety of training proxies/indexes used should be compatible with the model specified for the applied investigation. Many of these critical points have already been discussed.

The literature presents two main deficient points concerning econometric methodology which will be addressed below using the information contained in the two datasets: first, most authors cope with the intrinsic censored (at zero) training variable by using a Tobit model. Nevertheless, it relies on specific assumptions and it brings together in one choice two diverse decisions: whether or not to train and how much to invest in training. The exploration of two stage selection models and the comparison with the Tobit model are necessary and worthwhile. The second point is that the literature has left unexplored the eventual correlation between different forms of training. Thus, it is worth exploring such issue by specifying bivariate probit models.

On a quantitative and measurement level, the studies surveyed often possess low quality or not exhaustive information for the vector of explanatory variables. Some studies are deficient with respect to some key

[15] The author correctly stresses, " The choice of econometric model depends on whether the analysis should be based on all firms in the sample or whether it should concentrate on the training firms. In the first case, the training intensity is censored at zero, as non-training firms are excluded from the analysis. A suitable method to deal with this problem is to use a truncated regression model (p.298)".

[16] The availability of high quality data is a crucial problem in all analysis concerning the relationship between innovation and firm performance (Huselid, 1995; Antonioli et al., 2004).

[17] Another study dealing with apprentices training is Wolter (2003). The study is methodologically interesting since it exploits the two-stage selection heckman model for analysing the firm training decision. The data used derived from two surveys conducted in Swiss firms in 2001, embracing 2352 training firms and 2230 non-training firms. The final sample consisting of only private firms is composed of 3632 firms: the percentage of training firms after deletion and selection is 29%. Rooting on an empirical cost benefit model for apprentices training, the first stage estimate a probit model with the binomial variable of training, while the second stage estimates an OLS model where the dependant variable is net costs or gross costs of training.

independent variables (i.e. performance indexes), other present detailed good quality information, but only for a limited set of explanatory variables. Measurement errors and heterogeneity bias thus may undermine estimates. We believe that our two datasets present partially different, but high quality and comprehensive information about most, if not all, the key explanatory variables highlighted by the theoretical and empirical literature.

As far as this contribution is concerned, the empirical value therefore revolves around the use of different econometric specifications, the investigation of a full set of training indexes and the introduction of a comprehensive set of covariates. This allows a detailed and robust analysis on the most significant determinant variables for firm training.

Comparatively speaking, those two point maybe represent the two main weaknesses we have found in the literature: if one the one hand the use of different training indexes, in order to capture different dimensions of the problem, is more or less widespread, on the other hand the econometric specifications used are often not very consistent with the available data, and, more important, the quality and quantity of such available data is seldom very satisfactorily, increasing the probability of exacerbating both heterogeneity biases (given the limited set of independent and control variables, thus omitting relevant ones) and measurement errors given the imperfect measure concerning key determinants variables. A particularly rich set of key explanatory variables and simple controls, that should mitigate the selectivity bias, is an important asset for the estimation stage (Boheim and Booth, 2003). We possess good measures of a number of establishment control variables and, for Reggio Emilia; we can use good quality past performance data stemming from official accounting data.

It is also true that poor measures of training plague this literature (Fairris and Pedace,). As far as this work is concerned, we start (i) from the analysis of binary choices for (ia) formal and (ib) informal training, then (ii) specific indexes of (iia) formal training coverage and (iib) formal training intensity (here defined not in terms of training hours only, but derived from various collected information referring to the intensity of the investment in training) are investigated. Finally, we study the determinants of general/specific training, using an index derived from various sources of training information purposefully elicited by detailed questions.

4. Empirical analysis: survey-based datasets and Econometric investigation

4.1 Case studies

The applied analysis is based on two studies, one concerning the Province of Ferrara and the other the Province of Reggio Emilia, both located in the Emilia-Romagna Region. Emilia Romagna is an area of Italy characterised by a high density of industrial districts (more than 20 given official statistics), a value added per capita (22.738€ per capita in 2000) higher than the Italian average level (17.952€)18, and it represents

[18] The Region ranks third concerning value added per capita in Italy. As far as the two Provinces are concerned, Reggio Emilia ranks at the seventh place in Italy while Ferrara is at the 48th place. The former is above the regional average while the latter is below, slightly higher than the national average.

the 7% of the Italian population with four millions residents. Thus, the Region is highly representative of the North-Central industrialised economic system.

Two independent surveys were administered respectively in 2003 and 2002, with the aim of collecting detailed and extensive data. As said, the two surveys differed with respect to the typology of issues addressed. While both questionnaires dealt extensively with training decisions issues (type of training, coverage, etc.), the survey administered to firms in the Ferrara province was biased toward investigating workforce features like skills, tenure, competencies and labour demand characteristics. HRM and industrial relations issues were not addressed. On the other hand, the survey administered in the Province of Reggio Emilia focused on HRM and industrial relations. As far as performance indicators are concerned, original balance sheets are available for Reggio Emilia, while only qualitative trend indicators are elicited in the other case study. The following paragraphs describe the two surveys and dataset in details.

4.1.1 The Province of Reggio Emilia

The firms included in the universe are drawn from national[19] and local databases and are classified on the basis of the codex ISTAT-ATECO 91. They are all the manufacturing firms (257) with at least 50 employees and establishments located in the province of Reggio Emilia in the year 2001. The survey is made up of a questionnaire addressed to the management, on five main topics: (a) firm's characteristics; b) employment structure and internal labour markets; c) organisational innovations and human resources management practices, including training decisions[20]; (b) industrial relations; (c) payment systems. The firms responding to the survey are 199, with a reply ratio of 77,4% of the entire population. Firm distribution by sector and dimension is characterised by limited bias. Interviewees are generally top managers and human resources directors. Balance sheet data are available for 166 firms out of the 199 interviewed, for the period 1996-2001.

The industrial local system of Reggio Emilia is a complex one, primarily characterised by a high degree of dynamics of the system, with important variations and exceptions to this general feature. Innovation intensity is high and mainly driven by managerial initiatives, but with an important role played by union delegates and workers in the field of innovative labour organisation. Just the organisational realm is likely to constitute the most suitable field for further fruitful experimentation in the field of worker participation. The role of industrial relations, together with worker training and other relevant features of the workforce, do have a relevant impact on the organisational structure of the firm, the intensity of its innovative efforts, its ability to benefit from the flexibility of labour services and labour contracts, and, eventually, to accomplish better economic performance.

[19] Intermediate census 1996 of the National Institute of Statistics (ISTAT, 1999).

[20] The shortcoming of the definition of a set of best practices in an aprioristic way is the insufficient degree of analysis of the process steering organizational evolution. Our database on industrial firms in Reggio Emilia does not suffer from such limitations since it cover a high number of items connected with new work practices, training processes, firm hierarchical structure, internal labour markets, and industrial relations. Investigation concerning the determinant of organisational innovation and the diffusion of best work practices gains relevance when the process of organisation evolution receives closer inspection.

4.1.2 The Province of Ferrara

The survey has been carried out on industrial and market-service firms, thus excluding agriculture and public administration, with at least 20 employees and one establishment in the territory of the Province. The main source of information for setting up the universe of firm was the dataset acquired from the Local Chamber of Commerce, which was integrated with information derived from other regional and provincial level datasets. We identified 436 firms, which were disaggregated by sectors (metalwork, market services and other industries: textile-wearing articles, food products, chemical products, engineering and energy and other manufacturing products) and size (20-49, 50-99 and more than 99 employees, corresponding to small, medium and large size firms as far as this paper is concerned[21]). Building on those 436 firms (the universe), a random sample of 250 firms was selected (57% of the universe). As far as size is concerned, we decided to determine it by firm and not by local units, for two reasons. First, it is plausible to assume that human resource management practices reflect the organisational complexity of the firm and are more top down driven: from the firm to local units; secondly, the adoption of local units as statistical unit would have implied a bias towards firms with more than one local unit in the territory, although occupational strategies are often, if not always, centralized at firm level. Data were collected during February and March 2003 by direct interviews (one hour long) at either the central offices or local establishment offices of the firm; other units of the same sector-size "cell" replaced those firms refusing to participate in the survey. Given that some cell were small, we ended up with 243 filled questionnaires, which constitutes the final information database used for the applied analysis. The questionnaire referred only to local units in the Province; thus, data on occupational and training strategies are quantitatively at the level of local unit, although the firm often decides strategies. It was divided into 5 sections: firm structural characteristics; the stock of occupation, disaggregated by education level, contract typology, tenure, positions within the firm; occupational flows; training strategies, occupation and labour market forecasts for 2003-2004. Stock data refer to 31.12.02, flow data to the 3 years period 2000-2002.

The primary aim of the applied investigation is to assess the relationship between training in firm and its determinants using different synthetic index of the main forms of training activities as dependent variables. Tables 1 and 2 sketch the training-related dependant variables used for thee econometric analysis. It is worth noting that the dataset mainly concerns cross-sectional data. Thus, the causality links between variables are to be intended generally as "weak links": the objective is not to test cause-effect relationships between performance, innovation and industrial relations, but to assess the significance and intensity of relationships between those variables. Only for Reggio Emilia, we may exploit lagged information concerning firm performances (data for the period 1995-2001) and other organizational innovation (trend data for 1998-2001), as potential determinants of training indexes calculated on 2001 related data. As far as the analysis on Ferrara Province is concerned, data are cross-sectional[22].

[21] We excluded seasonal employees from the analysis.

[22] We here remark that although a panel setting is often a fruitful framework for investigating dynamic relationships (even a 2 years panel which allows a study on differences), also an "adjusted" cross section dataset, that is cross section frameworks integrated with

The potential determinants of training here analysed compounds firm structural characteristics, labour demand dynamics, human resource management practices, workforce features, industrial relations and firm performances[23]. The full set of explanatory variables used is presented for the two datasets in tables 3 and 4.

The availability of an extended dataset on firm characteristics allows controlling for many relevant factors that may explain training decisions, reducing the possible distortions arising in a cross-sectional environment. As we said, the two surveys were aimed at collecting a partially different set of information: for Reggio Emilia, the focus is biased towards Human resource management practices, industrial relations and innovation dynamics; in addition yearly accounting data for most firms are available since 1995. The Ferrara case study is instead more focused on labour demand features and dynamics and on workforce characteristics[24].

We use as dependant variables in both cases different proxies for training: we use indexes of (i) total coverage, (ii) general/specific training content[25] and (iii) indexes of training activities adoption[26]. We focus

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lagged variables, may lead to clean and robust estimates (Huselid, 1995). The pros and cons of using panel in such settings are then well described by Huselid and Becker (1996), who point out: "the problem is that although panel data offer an opportunity to mitigate the heterogeneity bias in the OLS estimates, this approach may exacerbate the effects of measurement error" (p.403), and "panel data offer an opportunity for a cleaner estimate of the true effects of HR strategies", but "the risk is that panel estimates may be subject to even greater attenuation from measurement error than cross sectional estimates, and one is actually worse off using the panel estimates" (p.404), finally "Rather than relying on such assumptions, future research should devote more attention to the identification and measurement of these other management practices so that they can be explicitly controlled in the estimation method" [..] We believe that much progress can be made by well-executed industry studies that utilize both conventional measures of firm performance and new work on the economic contribution of business units to overall firm performance" (p.420). According to this, we agree that it exists a trade off between the collection of detailed panel data and the collection of good qualitative data on most HRM practices, most of which do not present strong observed variability over time. Thus, our effort was mainly devoted to collecting high-quality and detailed cross sectional data, integrating HRM data with balance accounts data as far as possible.

[23] Among firm performance, the literature underlines the pivotal role of productivity. We are aware that the main target of the analysis on training, HRM and performance is to assess the impact of all relevant inputs (man made and human capital, HRM, training activities) on different performance indexes. As far as our work is concerned, the focus is on the impact of past performances on current training decisions. A further step is certainly to study the effect of training decisions on performances like profitability and productivity. As pointed out by Storey (2004), empirical evidence is still scarce and ambiguous for both nodes of the training-performance link. It would have been possible to investigate the training → productivity (performance) link. Nevertheless, we decided to avoid such estimation in a pure cross section environment with only spatial heterogeneity and without temporal lags, postponing the analysis when new data on performances are available.

As a reference, Zwick (2002) presents evidence on the productivity effect of training investments (training intensity and different forms of training), exploiting the information of an establishment panel for the year 1997-2000 and adopting a production function approach. He finds that higher training coverage is a significant explanatory factor of productivity even with a limited 2 years lag (the paper concentrates with the influence of training in 1997 on productivity in the years 1998 and 1999. findings are that formal internal and external courses have the highest positive impact on productivity, quality circles have a smaller impact, while training on the job and job rotation do not affect productivity. Technically, the author first estimates the 1997 cross section regressions for training by means of a binary probit and in another case by a Tobit model when training coverage is analysed. Firm size, workforce skill, union presence, ICT and technical investments are detected as explanatory factors. Then, two analyses are carried out to investigate the training → productivity link: an OLS model with lagged impact of 1997 training on productivity in 1998 and 1999, and a fixed effect panel model (1997-1999), adopted in order to correct for time invariant heterogeneity, leading to the result described above. The panel estimation is two-stage type since the focus is on estimating the residuals of the production function as in Black and Lynch (2001).

Another interesting work is by O'Connell (1999) who studies the impact on productivity growth of both general and specific training. This is of interest to us given our focus on training indexes related to "specificity". The author finds out that while general training has a positive significant effect on productivity, no effect is observable for specific training. The positive impact remains significant when additional control variables concerning work organisational are introduced, although that impact varies with the level of capital investment. The analysis grounds on 654 firm level survey questionnaires dated back to 1993, eliciting information on training coverage, training spending and training typology. In order to study the effect of training on productivity growth, a follow up survey was carried out in 1997. The finals sample of firms is 215: taking variables in differences, OLS estimation is then applied within a production function approach (where training indexes are included as explanatory factors directly into the production function together with usual inputs and controls).

[24] The diversity between the two datasets concerns more the realm of explanatory variables than the set of training indexes. Coverage, adoption and general/specificity training indexes for training are obtained in both cases.

[25] Assigning a specific training weight to each training activity adopted.

both on formal and informal training, also analysing the eventual correlation between the two forms of training investment. In the case of proved correlation, the use of a single equation model is in fact not justified.

For the Reggio Emilia analysis, we use different training indexes at year 2001 as dependant variables, explanatory factors referring to the period 1998-2001and average performance indexes for the period 1995-2001. Thus, while the analysis is of a cross section type, we set into the model some temporal distances between variables with the aim of mitigating the simultaneity bias typical of dataset strongly affected by endogeneity of crucial explanatory factors.

For the Province of Ferrara, the analysis is instead a typical cross section exercise, based on average data for the period 2000-2002 in case of flow measures and at the date 31.12.2002 for stock measures. More information is available nevertheless for factors like tenure, skills, and other labour demand characteristics and labour demand motivations[27]. Given the structural difference in terms of data, the two analyses are not *directly* comparable: different determinants and implications are then derived for the two provincial cases. Nevertheless, carefully considering the structural difference concerning the two economic and industrial frameworks, we may attempt to bring together the main results, with the purpose of sketching what similarities and differences emerge in terms of training determinants.

Two different sets of hypotheses are tested by the statistical exploration. Each set specifies a cluster of interrelated hypotheses, which emerge from the theoretical and empirical literature presented in sections one and two.

Hypotheses (1): This first set of hypotheses leads to the notion and the relevance of complementarity among productive inputs, introduced in the theoretical sections. As stated in the outline of Milgrom and Roberts analysis, complementarity in production involves different units of analysis. For the interest of this paper, the relevant are the following:

a) Training practices. Data used in this paper allow singling out two diverse classifications of training. The first one ranks training according to the distinction between formal and informal. The second one ranks training according to its degree of generality/specificity;

b) Practices of work organization. The data consider innovative organizational practices such as: job rotation, total quality management, team working and quality circle. The correlation between training and the innovative content of labour demand, where innovation is proxied by the "new competences"[28] and "innovation oriented" features of employment creation, compared to less innovative elements (i.e. market expansion, turnover);

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[26] Thus synthesising all the relevant information concerning the different typologies of formal and informal training adopted. In a certain sense, our index captures how widespread training is (by type); the index takes the value of one if a firm adopts all formal and informal activities.

[27] The questionnaire was not set for collecting information on organisational and technological innovations.

[28] See Ashton et al. (1999), Boyatzis (1982), Spencer and Spencer (1993) and Green et al. (2001) for some contributions concerning the competence approach to firm's issues on theoretical and applied grounds.

c) Different occupational groups. As discussed in the theoretical sections, complementarity relationships can be set up not only within factors included in each unit of analysis, but also among them. The establishment of complementary relations is a tool to convert skills acquired into skills used and to specify the operative tasks.

Hypotheses (2): As discussed in the theoretical sections of this paper, the likelihood to adopt training practices is affected by firm's structural variables, referable, broadly speaking, to both internal labour markets and variables which proxy the organization of work and the style of management. Due to data availability the hypotheses tested vary according to the dataset used.

In the empirical sections of the paper, we are going to stress the importance of three different variables: a) firm's size; b) percentage of short-term labour contracts (atypical employees) measured in both terms of flows in and out of the firm and stock; c) labour productivity and, in general, measures of firm performance.

a) If actual and potential complementary relationships are scarce, as in small size firms, the return of training practices is lower. Hence, the larger firms, the higher the probability to adopt all sort of both organisational and training practices and, accordingly, the higher the probability to set up complementary relationships (see also, Storey, 2004).

b) The need to establish complementary relationships among skills and inputs provides a convincing explanation to understand why employers train short-term employees, somehow. In this respect, short-term employees are not different from workers with a longer expected attachment to the firm. This is quite counterintuitive, because, based on the standard Becker's model of human capital, one would expect that the provision of training. However, the model developed in this paper implies that a minimum amount of adjustment, needed to convert acquired skills into skills used, is always required for newly hired employees, regardless the expected duration of the employment relation. On the other hand, one expects the link between the stock of short-term (atypical) employees and provision of training to be negative, which is consistent with a traditional interpretation of development of human capital in firm, but does not contradict our theoretical analysis. Of course, since tenure is negatively associated to the flows of short-term employees, one expects tenure and provision of training to be negatively linked.

c) As to the relation between training and any indicator of economic performance, things can be rather complicated. Provision of training gives rise to increase in both the level of labour productivity and firm's profitability. In its turn, the increase in profitability favours the accumulation of resources aimed at financing training for employees. For this reason, it is difficult to point out a causal link between any measure of provision of training and any indicator of performance of the firm. Anyway, a positive association between these two variables is firmly rooted in any approach to the analysis of training in firms. Problems arise when, from empirical evidence, this association turns out to be weak or, even worse, nil. In that case, the only sensible conclusion is that firms do not benefit from training, i.e.: training is irrelevant to their economic performance. This would mean that, if training is actually provided, then it is basically used as a tool to

favour the match between the characteristics of the workforce and the organisation of work and not to strengthen and to widen the range of the skills used in production.

Failure to find a meaningful association between training and performance might emphasize a poor quality of labour demand. Of course, this is a quite strong conclusion, which should be also supported by further empirical evidence, concerning the quality of labour demand. In this circumstance, the datasets used for this paper provide a measure of the propensity of the firm to produce for the market, and not as subcontractor, and to compete on international product markets. Therefore, for testing the importance of training for a firm, it can be useful to study the degree of association between training and the propensity of the firm to produce for both the domestic and the international market.

We now move to the statistical and econometric analysis. Before starting the regression analysis, a preliminary selection is carried out by studying the full correlation matrix concerning covariates. A threshold was fixed at 0.35: above this value of correlation, variables were discarded, keeping the one with the least serious correlation problem overall. The first selection is aimed at reducing the collinearity problem. Then, variables showing a coefficient with associated a t ratio below the value of 1.282 (20%) are dropped at each stage of the econometric analysis. The backward stepwise method may result more consistent with the different biases arising when variables relevant variables are omitted or irrelevant ones are included: in the former case coefficient are biased, in the second case variances are inflated by using too much information and estimates are less efficient. Thus, the second problem, which we may encounter here in over fitting specifications starting from a conceptual model, is less severe and can be resolved by deleting non-significant variables.

Econometrically speaking, we use different specifications. Since indexes of training range between zero and one, we deal with the well-known issue of *fractional variables* (Papke and Woolridge, 1996). It is possible to affirm, building up on the empirical contributions which have dealt with such index variables (see, among the others, Antonioli et al., 2004; Mazzanti et al., 2004; Cellini et al., 2000; Fronstin and Holtmann, 1994), and on the empirical application concerning training which we have discussed above, that there is not an "optimal" econometric model for studying fractional variables. Although OLS estimates may suffer from the same distortions characterising binary variables, the often used one limit or two-limits Tobit models (Rosett and Nelson, 1975; Tobin, 1958) are not a panacea, and often it is possible to verify that estimates deriving from OLS and Tobits[29] do not differ significantly as far as coefficient absolute and relative significances are concerned[30].

[29] It was noted that the set of explanatory variables presented in tables 3 and 4 derives from the analysis of a full correlation matrix concerning all explanatory variables initially considered as potential determinants. This preliminary selection is relevant since the aim is to analyse the determinants of training by exploiting a rich *but* selected vector of explanatory and control factors, mitigating eventual multi-collinearity problems deriving from too high correlations. This problem is often not considered or made explicit in most papers found in the literature.

[30] In the present case, since training indexes present many observations at zero and one, we are prevented from tackling the problem by transforming the dependant variable (y) using a log-function (log[y/1-y]), achieving a new variable which clearly varies over a non limited space (Papke-Woolridge, 1996). Data losses would be substantial if we dropped limit observations. When fractional variables are used and limit observations do not constitute a large share of observations, the above transformation is nevertheless a useful method for comparing and checking different specifications.

We then decided to use different specifications, consequently comparing estimates deriving from OLS regressions, corrected for heteroskedasticity, and Tobit maximum likelihood models[31]. Furthermore, given the large number of firms not involved in both formal and informal training, we check the presence of sample selection by moving from a Tobit to a two-stage Heckman model[32] (probit plus OLS). The correlation between formal and informal training, as said, is also tested by means of a bivariate probit model[33]. A single equation regression model is used in all cases for the estimation of a reduced form for firm investment/effort in training.

Summing up, we proceed as follows in the analysis of the two case studies. We first carry out simple probit regressions for formal and informal training, and for employee and new hired workers, as a preliminary analysis. We nevertheless also investigate the hypothesis of correlation between different training forms by using a bivariate probit model. Secondly, the determinants of both training adoption and training coverage indexes are analysed. Finally, regressions using an index of general/specific training are studied. The next two paragraphs present and discuss econometric results for the two datasets. Tables 1 and 2 presents dependant variables for the two case studies; tables 3 and 4 the set of independent variables considered after filtering by correlation analysis. Finally tables 5 and 6 presents econometric results for the main significant specifications.

4.2.1 The Province of Ferrara: training, workforce features and labour demand

As a preliminary analysis, we investigate training decisions by using formal and informal training binary indexes. The related probit analysis for any training, formal training and informal training leads to the following results. It shows a positive coefficient associated to larger firms and the service sector. Size and sectoral dummies are highly significant. Further, the share of foreign market revenue is also positively associated to training activities. As far as the labour demand features are concerned, the employment creation driven by new product and processes and new workers competencies is associated to a higher probability of

[31] Both one limit and two limits Tobit are considered. Given the limited but continuous nature of index variables, a two limits Tobit is justified only if double censoring is deemed to characterise data (Long, 1997). A 2 limit Tobit requires censoring in both tails, not just finite limits. The point is often not well addressed in the literature. As a rule, the correct model is generally dictated by the theory and the specific application.
In any case, strong differences between the two Tobit specifications did not arise in all cases analysed. We stress again that a general rule of thumb, when facing fractional variables without a clear model dictated by economic theory, is to compare outcomes and performances of different econometric models –OLS, tobits, two-stages- and different specifications, rather than relying on a single model.

[32] For a useful discussion on the Heckman selection corrected estimation see Kluve and Schmidt (2002), who, though dealing with the issue of ex post program evaluation, stress another useful point: "Most of the evaluation literature has focussed on advances in methodology, but even the most sophisticated estimators will fail if applied to poor data, and one should not forget that good informative data are essential for meaningful evaluation" (p.430). This is crucial for the empirical literature on performance, innovation, and training, where both methodological and data issues are key factors for achieving robust results from the specified empirical models. As far as training empirical analysis is concerned, we also refer to Storey (2004), who stresses in his conclusion the need to take into account selection biases.

[33] Two recent applications of the model within the field of labour economics are Battu et al. (2002) and Xiao-Tsiang (2001), which study the correlation between informal training and adult education, for applications of the bivariate model. In brief, the bivariate probit is employed when one wants to tests the hypothesis of inter-relationship between two key variables. In other words, under the null hypothesis that the covariance between the error terms of the two distinct regressions is zero, the bivariate probit consists of two independent regressions. If the null hypothesis is rejected, we face a joint co-determination of the two investigated variables. In statistical terms, the errors of the two equations are related (a part of the errors term is common to both).
For example, formal and informal training may have interdependent impact one each other in terms of firm investment decisions.

adopting training practices. Training is thus linked to innovative decisions in employment dynamics. Finally, the variable capturing the flow of atypical workers is positively associated to training, while the stock of atypical workers is not.

Independent probit regressions do not take into account the eventual correlation between, for instance, formal and informal training. Therefore, a bivariate probit analysis is attempted, in order to test the above-mentioned hypothesis of correlation. The important result is that the null hypothesis of no correlation between the two training practices is highly rejected by data[34]. A joint distribution is therefore more robust. The point is often not underlined in the literature, though it is extremely relevant for analysing firm training decisions, wherein joint investments and complementarities between different practices are a key issue. Table 5 presents the results, which mainly confirm what previously said. Nevertheless, the bundle of training determinants is not the same for formal and informal training[35]. Private and larger firms, and service sector firms are more likely to provide informal training, but only size and sectoral factors arise for formal training. Foreign revenue is quiet significant for informal but not for formal training, while the opposite emerges for tenure, which appears linked to a significant negative coefficient in the informal training regression. The firms hiring workers with motivations associated to new competencies are more likely to provide both forms of training. We stress the non-significant role of performance variables; only past productivity trends are positively linked to training but do not overcome the minimum significance threshold.

In order to provide a more significant analysis of training determinants we move to present and discuss results for other indexes of training we derived from the information collected. We remark that all indexes vary between zero and one.

First, an index of training "intensity" in terms of typologies of training activities adopted by firms is specified as dependant variable. The index takes the value of one when a firm adopts all informal and formal training activities. Results are shown in table 5 and we may sum up as it follows. Highly significant and positive coefficients emerge associated to large and service sector firms. Other positive significant effects are associated to "new competencies" and new product/processes oriented labour demand, skill labour force intensity and the flow of atypical workers. On the other hand, the stock of atypical workers emerges with a less significant but negative coefficient. This outcome may be consistent with the conceptual framework developed in the theoretical sections.

It is also worth noting that, while past mean performance indexes confirm to be not significant explanatory factors the trend concerning productivity emerges as a driving force for firm training: firms experiencing higher productivity trends over 2000-2002 are more likely to adopt a wider range of training practices[36].

[34] As the joint log-likelihood is the sum of the two likelihood, we can compare the independent probit and the bivariate probit likelihood using a simple LR test. All regressions are estimated by using LIMDEP 7.0.
[35] The model is identified if the same variables are included in both regressions.
[36] For this index, a Tobit analysis lead to similar results; estimates are OLS corrected for heteroskedasticity. A two stage heckman-like regression proves that a sample selection is may be present but weak. In fact, the inverted mill ratio coefficient does not overcome the 90% significance level (t ratio= 1,258).

Secondly, we focus on two indexes capturing only formal training activities. Results are always presented in the final column of table 5.

A first index captures various dynamics of formal training over the 2000-2002 period, from financial resources invested to coverage and hours devoted to training. We decided to summarise those information in a synthetic index since the elicited information is of qualitative nature (trends). The key role of size and sectoral factors is confirmed. The message is very clear: large and service sector firms do invest more resources in formal training. Weaker but still significant factors emerging from this regression are the skill intensity, the flow share of atypical workers and a new competence content characterising labour demand. Linking to what said above for past productivity effect, in this case the coefficient associated to the productivity index does not overcome the 90% significance level, although has a positive sign attached.

A second index captures instead the *coverage* for formal training[37]. The same size and sectoral effects outlined above are confirmed. A different outcome is associated to skill intensity, which is here highly statically significant. Productivity trends also explain coverage levels for formal training. Finally, a negative sign here emerges for the variable capturing net employment certain (low significance nonetheless)[38].

Finally, we focus on the index capturing the generality/specificity content of training activities. Size and sectoral effects are crucial and dominate other explanatory factors: large and medium size firms, service and metalwork firms do provide more general training. Other significant factors emerging from the econometric exercise are the flow of atypical workers and a "new competencies" oriented labour demand (positive signs); a negative sign is instead linked to labour demand driven by market demand expansion. It is worth noting that a very significant positive coefficient is associated to a variable capturing the trend of informal training in terms of workers involved and hours per worker provided, when included as additional explanatory variables. Once again, the idea of complementarity among training practices emerges neatly[39].

As an additional analysis, we restricted the dataset to the sole 170 firms providing training, in order to analyse eventual different results and to include new determinants related to the motivations of training provision (a set of dummy variables). Results (not presented here) show that among the main determinants of formal training, using different proxies, are the motivations associated to "professional roles", specific mansion" and educational level, while the duration of contract and hierarchical position within the firm do not result being relevant driving motivations for firms. The outcome may reinforce the counterintuitive

[37] Results derive from OLS regression corrected for heteroskedasticity. The two stage heckman-like analysis is not associated to significant outcomes. Sample selection between training and non-training firms seems do not generally occur. A possible explanation may be related to the fact that eliciting information on training by surveys concerns a certain degree of vagueness on what is considered to be training, mainly for small/medium firms (what is the threshold for defining "training" a specific formal or informal HRM activity?). If this is true, the revealed zero values could be in reality one values; in other words, training as a whole could be underestimated when discrete training variables are observed, although it remains true that as far as training intensity is concerned the elicitation problem is less problematic, as the variable lies on a continuous ground.

[38] Coverage indexes were available also for informal training. The same size and sectoral factors emerge. As for the probit analysis, private firms seem to be more involved in informal training. Past productivity keeps its positive and significant coefficient. Two new labour demand characteristics (motivations) now arise among significant explanatory factors of informal training coverage: market demand expansion and substitution of workers. The bundles of explanatory factors for informal and formal training seem to suggest and confirm that a more innovative behaviour is positively associated to the provision of higher levels of formal training.

[39] For the Specificity index, a Tobit analysis lead to similar results; estimates are OLS corrected for heteroskedasticity. A two stage heckman-like regression does not prove to be robust for this index.

irrelevant role played by tenure in this case (recalling that long-term tenure was defined over 5 years), and the predominance of skill effect in explaining training at the level of workforce characteristics.

Summing up results for the first case study here presented, we note that strong size effects are present. The smallest firms are less likely to invest in training. A sector-oriented cut highlights that services firms, and to a lesser extent manufacturing firms, do invest more. The need of acquiring new competencies and introducing innovations are two factors associated to training adoption. Linked to the positive effect of productivity levels on training, a widening gap may distinct small, non-innovative firms from larger and more innovative-oriented firms. Considering also the positive role associated to the skill content of the workforce, the risk is one of observing a dynamic sharp and widening gap between (admittedly few) high-performance high-innovative firms and (many) low performance low innovative oriented ones. The insufficient level of training, which nevertheless characterise the most part of firms in the Province, may represent a lacking crucial element for stimulating an economic virtuous circle in the local area. Finally, a note on the role of labour flexibility, a crucial element of the current policy debate. While the share of contractual flexibility in terms of flow enhances the probability of adopting training practices, the share in terms of stock decreases this probability. This is another factor which may distinguish pro-active innovative firms, using flexibility integrated with innovative practices, from stagnant entities, exploiting flexibility, presumably for labour cost reduction motivations, with a low innovative content.

4.2.2 The Province of Reggio Emilia: training, innovations, workforce features and past performances

The analysis of training efforts by firms for the dataset concerning Reggio Emilia begins with two probit regressions concerning the provision of (formal and informal) training to employees and to new hired workers[40]. This preliminary analysis highlights the positive role played by size (medium-large firms in the Reggio Emilia survey[41]), by labour flexibility and by the adoption of organisational innovation (see table 6 for a full definition of variables). A lesser important role, though still significant, is played by past productivity performances (a real account data indicator in this case) and process innovation adoptions.

As above, we investigate the correlation between different training practices (employees and new hired here) by means of bivariate probit model, which specifies a joint distribution. The null hypothesis of no correlation is rejected. Results show (table 6) that size factors are more determinant for new hired training than for employee's training. Then, while education/skill workforce content explains both forms of training, labour flexibility is only crucial in explaining employee training. Organisational innovation is explaining both forms, although it is statistically not highly significant. Among innovation practices, task rotation plays the main and only role for new hired, while TQM is the only significant factor in employee regressions. Finally, the variable capturing industrial relations dynamics arises with a medium level significance if

[40] We recall that there is no aim to compare results for the two provinces, given the different sets of dependant variables and covariates used for the econometric analysis, deriving from two different surveys. We decided not to test the correlation between formal and informal training in this case given that informal training data only concerned co-workers training.
[41] We also recall that all firms belong to the manufacturing sector. Pavitt indicators are used as sectoral control dummies.

included, slightly lowering the effect of organisational innovations (this is explained maybe by the positive correlation between the two variables).

Those are the outcomes for the preliminary probit analysis. Three further training indexes are specified and studied: the index concerning the variety of training practices[42] adopted by firms, the index related to formal training coverage and an index capturing the generality/specificity content of training. Results, presented in table 6, are summed up below.

For the first of the three listed dependant variables, the most significant and positive explanatory factors are: size (large and medium-large firms), cooperative-like firm[43], process innovation, labour flexibility, the share of manual workers and organisational innovation. Industrial relations enter as a positive factor but statistically weak. We note that among organisational innovations, the leading factor is TQM, followed by JIT and QC. The other two elements considered are not significant. Past performances indicators seem do not influence the "intensity" in training practices adoption (see Storey, 2004)[44]. Among variables entering the regression with a negative sign on the coefficient, we note hierarchical levels on functions and plant flexibility.

Secondly, formal training coverage is mainly explained by size effect (medium size firms), cooperative-like firms, workforce education level, share of manual workers, process innovation intensity, workers involvement in management initiatives and organisational innovation (TQM as only significant driving force). Together with workers involvement, also past productivity levels emerge as being positively associated to training performances for this second index considered. Other past performances indicators included, as investments per employee, net profit/revenue, labour cost per employee, and gross wages, never reach a minimum significant threshold, for all the specified training indexes[45]. Like above, explanatory factors linked to a negative and significant coefficient are plant flexibility, hierarchical levels and the share of revenue originating from the final market[46].

As a further exercise, we study coverage indexes for different worker groups: non-manual workers, manual workers, both skilled and unskilled. Coverage figures are weighted for the share of each group of workers in setting up the new indexes[47]. Table 6 (cont) shows results for coverage. This more detailed analysis on coverage indexes confirms on the one hand outcomes we already commented but also show further insights. Size effects are now more ambiguous: medium and medium-large firms explain size effects (with a negative surprising sign for non manual workers) and the large firm dummy does not arise

[42] As far as Reggio Emilia is concerned, training indexes refer to the complete set of formal and informal practices.
[43] For this first training index, the two-stage heckman analysis does not lead to meaningful results.
[44] It is worth noting that when considering the same index only for new hired workers, slightly different results emerge: while size effect are present as before, labour intensive and private firms seem less likely to provide different typologies of training. in addition, organisational innovation is not among the significant factors.
[45] Though not significant, Net profits are associated to a positive coefficient, as expected. We remark that even if productivity emerges as the key driving factor, productivity is positively correlated to all the other performance indicators, which we included one at a time.
[46] Tobit estimates do not differ. While the heckman model is associated to higher significance level of the inverse mill ratio covariate, the sample selection is weak, we then do not comment results.
[47] In this case, given the absence of limit values at one, we transformed the fractional index variable in a censored at zero one adopting the transformation y/1-y; estimates by OLS and Tobit show that results do not change. The transformation by using log (y/(1-y)) suggested by Papke and Woolridge (1996) is prevented given the bulk of zero values. When fractional variables are used and limit observations do not constitute a large share of observations, the above transformation is nevertheless a useful method for coping with index variables.

significant. Further, Education plays a positive role for non-manual, while labour flexibility is negatively affecting training for manual workers. Concerning HRM practices, TQM confirms its pivotal role for both manual and non-manual; while for non-manual skilled workers alone practices seem to be significant only their sum/intensity effect is considered. Interestingly, process innovation and productivity are positively linked to training for non-manual total and non-manual skilled alone samples. To finish, the analysis on workforce sub-samples is the only case where wages seem to exert an effect on training: this effect is negative but low for non-manual and highly significant and positive for skilled manual workers. In addition to showing more in-depth results, the analysis demonstrates the usefulness of investigating training focussing on sub-groups of the workforce.

The third and final index concerns the general content of training. The size effect is here dominant, since al three dummies are very significant. Private and labour intensive firms are instead less likely to provide general training, while cooperative firms are still associated to a positive effect on training. As far as other determinants are concerned, we note the very significant impact of education level (skills), and the positive while less significant role exerted by labour flexibility, organisational innovation[48], technological innovation and employee formal evaluation. It is worth noting that while a Tobit analysis does not change the outcome, here the two stage Heckman-like regression leads to results that are more robust[49]. Building on the selection model, a slightly different picture arises: while size effects still dominates, workforce skill content and technological innovation are the only other two key driving forces for general training. The impact of organisational innovation is weak and a detailed analysis shows a mixed outcome: task rotation exerts a positive effect while team working, though not overcoming the 90% threshold, seems to produce a negative effect on general training provision.

As it is evident, the database used for this second case study is different and it opens other directions of analysis and discussion. First, the analysis confirms the pivotal role played by HRM practices, more specifically high-performance organisational innovations. Those practices arise as a complement for training activities. Among the five practices here considered, mainly TQM and to a lesser extent task rotation seems to play a key role. This leaves open the question on whether is meaningful to consider specific separated effects, or a joint index of higher-performance practices intensity is more apt to capture the main relationships. Size effects confirm to be relevant: larger firms –with more than 100 employees and more- are more involved in training and provide more general training. The size effect is reinforced by the negative and positive signs associated respectively to private and cooperative firms[50]. Among other variables considered, it is also confirmed the minor role played by market features, while a negative association is found between training and both hierarchical levels and plant flexibility. Labour flexibility, here captures by a synthetic

[48] Nevertheless TQM is the only significant factor; for this index the explanatory power of organisational innovation is definitely lower.
[49] The t ratio of the inverted mill ratio ranges from 1.5 to 1.7 in different specifications.
[50] The “coop” dummy included both cooperative firms and firms belonging to cooperative groups, while the private firm dummy did not include firms belonging to “groups”, which is the baseline – thus not estimated- variable.

index, generally exerts a positive impact on training, although this is not to be taken for granted. Past productivity arises as a positive determinant of training for some training indexes, while net profits, though linked to positive coefficients, never reaches statistical significance.

5. Conclusions

We conclude by bringing together the outcomes for the two provinces, trying to summarising results (see also table 7). As far as the driving forces of training activities are concerned, a mixed but clear size effect in both environments si present. Given the representativeness of the two provinces for the Northern Italy situation, this outcome supports the widespread view that size is a key factor for technological and organisational innovation, including high-performance practices. Major national and local policy efforts should be focussed toward the size-enlargement of Italian firms. Market variables such as the share of revenue linked to foreign markets and to the final market, although usually associated to higher patterns of technological innovations, seem to play here a very minor role: size effects dominate in terms of explanatory factors in a multi-variable analysis.

Training is then generally positively associated to organisational high-performance practices, confirming the existence of strong complementarities between organisational innovation and human capital investments. Nevertheless, when different practices are considered separately, only TQM and task rotation exert a positive impact. This could suggest both that the intensity of high-performance practices adoption is relevant (the number of practices adopted) and that some exert a greater impact. Nevertheless, it should be noted that TQM is the most widespread and used practice, exerting its influence along the productive process; this could be an explanation of its impact here. Since high-performance practices are highly correlated to worker's involvement in firm management and industrial relations, the significance of those practices highlights the instrumental role-played by good industrial relations in affecting innovation within the firm.

Labour flexibility seems to be positively associated to training activities, although this result, given the impossibility of speculating a precise hypothesis ex ante, is to be confirmed case by case. Moreover, the different effect of flow and stock flexibility is another key issue worth investigating more which the present study has addressed. Hierarchical levels and plant flexibility have a minor but expected negative association with training activities.

As far as the effects of performances are concerned, both case studies show a positive role played by productivity levels. Financial variables, including profits, do not have an impact, maybe highlighting a mis-management by firms at a dynamic level. Only wages, interestingly, are associated to training when disaggregated data for specific workers groups are considered. Although it is worth noting that performance variables are correlated to each other, the pivotal role played by (past) productivity levels could suggest that a dynamic virtuous circle is present, characterised by co-evolutionary increases in productivity and training efforts, probably mainly financed by sources external to the firm. The gap between high performance and

low performance firms, if this is true, is widening. Further data on future productivity, when available, could reinforce this statement, if a productivity → training/HRM → productivity dynamic relationships is confirmed by data.

As far as workforce characteristics are concerned, we note the predictable key role played by education levels and skills embodied in workers, which positively affect training efforts, and the lesser role, somehow counter intuitive, but explainable, played by tenure.

Moving to the side of labour demand characteristics, it is worth noting that firms recruiting workers for motivations associated to the necessity of acquiring "new competencies" and introducing "process-product innovation" seem to invest more in training. Innovative-like labour demand is thus a driving force for training.

Considering different training activities, we also found a robust correlation both between formal and informal training and between training for employees and training for new hired. Although correlated, the set of significant driving forces associated to each form of training may be different.

We thus recommend analysing the correlation between different training activities, as single (probit) regression could me not meaningful and studying training efforts at the level of specific group of workers (skilled/unskilled; blue collar/white collar). More insightful and interesting considerations may arise compared to the analysis of more aggregated indexes.

On a methodological ground, the study also shows that in presence of fractional variables, the use of different econometric models is worthwhile to make the analysis more robust, but often leads to similar outcome in terms of coefficients significances. In the present case study, sample selection effects are generally not a relevant issue; the reason may be found in the often subtle difference between "training firms" and "non training firms", given that data derives necessarily from surveys which are characterised by a certain degree of subjective interpretation (by firm management) on the meaning of what is considered to be training. A general statement concerns the complexity of the analysis of firm training efforts, deriving from the very diverse proxies which are available from general surveys or we may elicit from ad hoc specific case study surveys. This complexity is tackled by presenting results for different indexes of training, from binary variables to coverage to intensity to general training content. The analysis of diverse indexes, using different econometric specifications, help generalising results and highlighting eventual differences concerning the determinants of training or, in a weaker sense, the variables positively or negatively associated with training activities.

We conclude that training activities emerge positively associated with productivity, high-performance practices, innovative labour demand features, workforce skill level, firm size, and affected by labour and plant flexibility in various directions. The analysis suggests that a widening gap, between innovatively evolving and more stagnant firms, could characterise the future dynamics of those local areas. This is a key concern for the current debate on local systems in the European and Italian environment.

Table 1. Training dependant variables (Reggio Emilia)

Variable	*Acronym*	Type	Description	Mean value
Training for employees	TRAIN-EMP	Dummy		
Training for new hired employees	TRAIN-NEW	Dummy		
Training Coverage	TRAIN-COV	Continuos 0 1		
Index of Training typologies adoption	TRAIN-ADOP	Continuos 0 1	The index captures the number/variety of formal and informal training activities adopted by firms	
Index of Training generality	TRAIN-GEN	Continuos 0 1	The index captures the specific/general content of training activities: it takes the value of one if training is completely general; specific forms of training reduces the index	

Table 2. Training dependant variables (Ferrara)

Variable	*Acronym*	Type	Description	Mean value
Formal training	TRAIN-FOR	Dummy		0.49
Informal training	TRAIN-INF	Dummy		0.55
Training Coverage	TRAIN-COV	Continuos 0 1		0.26
Index of Training typologies adoption	TRAIN-ADOP	Continuos 0 1	The index captures the number/variety of formal and informal training activities adopted by firms	0.61
Index of Training Generality	TRAIN-GEN	Continuos 0 1	The index captures the specific/general content of training activities: it takes the value of one if training is completely general; specific forms of training reduces the index	0.28
Index of formal training firm effort/intensity	TRAIN-EFF	Continuos 0 1	The index accounts for trends concerning financial resources, coverage and percentage of workers involved	0.43

Table 3- Explanatory variables (Reggio Emilia)

	Variables	**Type**	acronym

A	***Firm typology***		
A.1	Firm size (small, medium, medium-Large and large firms)[51]	3 Dummies	MEDIUM, MEDIUM-LARGE, LARGE
A.2	Productive orientation à la Pavitt (labour intensive LI, resource intensive RI, specialized suppliers SS, scale intensive SI)	3 Dummies	LI, SI, SS
A.3	Private firm, cooperative firms/cooperative group	2 Dummies	PRIV, COOP
A.4	Share of revenue on domestic markets	Continuos 0 1	NAT-REV
A.5	Share of revenue from market or subcontracting	Continuos 0 1	MKT-REV
A.6	Firm hierarchical structure (hierarchical levels/firm functions)	Continuos 0 1	HYERARC
A.7	Employees education level	Continuos 0 1	EDUC
A.8	Share of manual workers	Continuos 0 1	MANUAL
B	*Flexibility in production process and labour services*		
B.1	Plant flexibility	Continuos 0 1	PLANT-FLEX
B.2	Labour services flexibility in work organizations	Continuos 0 1	LABSERV-FLEX
B.3	Synthetic index of labour relation flexibility	Continuos 0 1	FlEX-REL
B.4	Synthetic index of labour flexibility	Continuos 0 1	LAB-FLEX
C	***Industrial relations***		
C.1	Worker's participation in firm management	dummy	PART
C.2	Synthetic index of worker's involvement in firm management initiatives	Continuos 0 1	INVOLV
C.3	Synthetic index of industrial relations (management vs. unions' delegates)	Continuos 0 1	IND-REL
D	*Performance variables (mean values period 1995-2001)*		
D.1	Net profit / revenue	Continuos	PROF
D.2	Value added per employee (productivity)	Continuos	PRODUC
D.3	Labour cost per employee	Continuos	LAB-COST
D.4	Net Investments per employee	Continuos	NET-INV
D.5	Gross employee wage	Continuos	WAGE
E	Innovations		
E.1a	Synthetic index of organizational innovation (5 high-performance practices)	Continuos 0 1	INNO-ORG
E.1b	high-performance practices (quality circles, team-working, just-in-time, task rotation, total quality management)	dummies	QC, TEAM, JIT, TASK, TQM
E.2	Product Innovation	dummy	INNO-PROD
E.3	Process Innovation	dummy	INNO-PROC
E.4	Quality product innovation	dummy	INNO-QUAL
E.5	Technological Innovation index	Continuos 0 1	INNO-TECH
E.6	Employee Formal Evaluation	Continuos 0 1	FORM-EVAL

Table 4- explanatory variables (Ferrara)

	Variables	Type	acronym
A	*Firm typology*		

[51] 100-249; 250-499; >500.

A.1	Firm size (small, medium and large firms)[52]	2 Dummies	MEDIUM, LARGE
A.2	Private firm; cooperative firms/cooperative group	2 Dummies	PRIV, COOP
A.3	Sectors: Services, manufacturing/metalwork, other industry	2 dummies	SERV, MANUF
A.4	Share of revenue on domestic markets	Continuos 0 1	NAT-REV
A.5	Share of revenue from market, from subcontracting	Continuos 0 1	SUBCONTR
A.6	Employees education level (skill index)	Continuos 0 1	SKILL
B	*Flexibility in labour services*		
B.1	Tenure index	Continuos 0 1	TENURE
B.2	Turnover	Continuos 0 1	TURNOV
B.3	Flexibility of employment contracts for the stock of employees	Continuos 0 1	FLEX-STOCK
B.4	Flexibility of employment contracts for the flow of employees (2000-2002)	Continuos -1 1	FLEX-FLOW
C	*Labour demand determinants*		
C.1	Market demand growth	dummy	GROWTH-DEM
C.2	Firm growth	dummy	GROWTH-FIRM
C.3	New competencies required	dummy	NEW-COMP
C.4	Introduction of new products and processes	dummy	INNO-PROC-PROD
D	Formal Training *determinants*		
D.1	Professional status	dummy	
D.2	Education	dummy	
D.3	Specific task	dummy	
D.4	Individual characteristics	dummy	
D.5	Seniority	dummy	
D.6	Hierarchical level	dummy	
E	*Performance variables*		
E.1	Synthetic index of performance trend 2000-2002 (employment, profit, productivity, turnover, indebtedness)	Continuos –1 1	PERF-TREND
E.2	Index of productivity trend 2000-2002	Continuos –1 1	PRODUC
F	Training indexes		
F.1	Intensity of informal training practices	Continuos –1 1	INT-TR-INF

[52] 20-49; 50-99; >99.

Table 6. Training regressions (Reggio Emilia)

	TRAIN-EMP TRAIN-NEW		**TRAIN-ADOP**	**TRAIN-GEN**	**TRAIN-SPEC**
	Bivariate probit		OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity	2-stage Heckman
	New hired	Employee			
Cons-	-2.37***	-3.14§	0.325	0.153*	-0.097
MEDIUM	0.773***	0.132	0.123**	0.125§	0.107§
MED-LARGE	1.045*	1.478*	0.259§	0.119***	0.145§
LARGE			0.186***	0.157§	0.091**
PRIV				-0.077***	
COOP			0.2873§	0.193***	
SI					0.060*
SS					
LI	-0.764***	-0.010		-0.066**	
NAT-REV					
MKT-REV					
EDUC	6.906***	5.92***			1.298§
MANUAL			1.34§		
HYERARC			-1.569§		
PLANT-FLEX			-1.306§		
LAB-FLEX	2.048	5.816§		0.3805**	
INVOLV					
INNO-ORG[53]	**	**	§	*	*
TEAM	-0.739	-0.150	-0.0214	-0.0307	-0.041
QC	0.353	0.872	0.080*	-0.0234	-0.034
JIT	-0.658	0.633	0.100*	0.0327	-0.030
TASK	0.599*	-0.162	0.035	0.0423	0.070**
TQM	0.291	0.801***	0.148***	0.0471*	0.003
INNO-PROC					
INNO-PROD				-0.107*	
INNO-QUAL				-0.093***	
INNO-TECH				0.148***	0.103**
FORM_EVAL				0.170**	
PRODUC					
INVERSE MILL RATIO					-1.781**
correlation value (bivariate probit)	0.655§				
F test (significance level)	0.0000		0.00017	0.0000	0.0000
Adj-R^2			0.1638	0.3198	0.3062
N	166		166	166	136

We recall coefficients are not to be interpreted as elasticities; we emphasise coefficients which arise significant at 20%, 10%, 5% and 1% (*, **, *** and § in table).

[53] When INNOORG is significant (as shown), an additional regression is estimated using the 5 high performances practices instead of INNOORG, in order to see what driving forces lie behind INNOORG.

Table 6 (CONTINUED)

	TRAIN-COV	COV- NONMAN	COV-MAN	COV-MAN-SK
	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity
Cons-	-0.980§	0.070	-0.165	-1.618***
MEDIUM	0.104§		0.049§	
MED-LARGE		-0.020***		0.107***
LARGE	-0.076*			
PRIV	-0.976**	-0.014**	-0.046***	
COOP	0.243***	0.059§		
SI			-0.044**	-0.128§
SS	-0.060*		-0.046***	-0.084§
NAT-REV	0.001*		0.000**	
MKT-REV	-0.208***		-0.000***	-0.001***
EDUC	1.368§	0,4531§		
MANUAL	0.628***			
HYERARC	-0.624**			
PLANT-FLEX	-0.707§			
LAB-FLEX			-0.204**	
INVOLV	0.114*			
INNO-ORG[54]	***	**	***	0.138***
TEAM	0.056	0.007	0.027	[Single HRM practices do not are significant when included as dummies. Only TQM does at 20% level]
QC	0.045	0.004	-0.004	
JIT	0.022	0.007	0.008	
TASK	-0.005	-0.006	0.004	
TQM	0.118***	0.020§	0.059§	
INNO-PROC	0.170§		0.053§	0.088§
PRODUC	0.465§	0.041**	0.182§	0.213**
PROFIT		-0.013*		
WAGE (WHITE COLLARS)		-0.081*		
WAGE (BLUE COLLARS)				0.446***
F test (significance level)	0.0000	0.0000	0.00001	0.0000
Adj-R^2	0.266	0.423	0.198	0.183
N	166	166	166	166

[54] When INNOORG is significant (as shown), an additional regression is estimated using the 5 high performances practices instead of INNOORG, in order to see what driving forces lie behind INNOORG.

Table 5. Training regressions (Ferrara)

	TRAIN-FOR/ TRAIN-INF		TRAIN-ADOP	TRAIN-COV	TRAIN-GEN	TRAIN-EFF
	Bivariate probit		OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity
	informal	formal				
Cons_	0.652	-0.582	0.101*	0.031	0.103***	0.749
PRIV	-0.567***	-0.253				
MEDIUM	-0.330*	-0.053			0.088**	0.097*
LARGE	0.897§	0.719§	0.116§	0.140§	0.010***	0.263§
SERV	0.496***	0.636***	0.094§	0.168§	0.116§	0.244§
MANUF	-0.019	0.512**			0.833**	0.078*
NAT-REV	-0.769**	-0.387				
TENURE	-1.338**	-0.165	-0.114*			
FLEX-FLOW	0.557***	0.539***	0.069**		0.070*	0.096**
FLEX-STOCK			-0.132*			
SKILL	0.230	0.518*	0.126§	0.174§		0.125*
NEW-COMP	0.657***	0.764§	0.082**		0.098***	0.162***
INNO-PROC-PROD			0.072**	0.065	0.054	0.083
GROWTH-DEM					-0.0739***	
PRODUC	0.192	0.168	0.059§	0.085***		0.048
INT-TR-INF					0.207§	
correlation value (bivariate probit)	0.600§					
F test (significance level)	0.0000		0.0000	0.0001	0.0000	0.0000
Adj-R^2			0.196	0.107	0.126	0.183
N	243		243	243	243	243

We recall coefficients are not to be interpreted as elasticities; we emphasise coefficients which arise significant at 20%, 10%, 5% and 1% (*, **, *** and § in table).

Tab. 7- Firm Training-related variables

	In terms of training adoption	*In terms of training coverage*	*In terms of general training content*
Factors which are **positively and highly** associated to training activities	Size Cooperative firm/cooperative group Service sector Workers' New competencies Productivity Workforce skill	Productivity Process Innovation Wages (skilled manual workers) Organisational Innovation (TQM) Size Service sector Cooperative firm/cooperative group Education level/ Workforce skill content Workers' New competencies	Education level Size Service sector Workers' New competencies Informal training
Factors which are **positively and moderately** associated to training activities	Labour flexibility (<u>flow</u> of atypical workers) Labour demand driven by innovation introduction	Organisational Innovation (TaskRot)	Organisational Innovation (TaskRot) Technological Innovation Manufacturing sector
Factors which are **negatively and moderately** associated to training activities	Tenure	Hierarchical levels Labour flexibility (general index)	
Factors which are **negatively and highly** associated to training activities	Hierarchical levels Plant flexibility Labour flexibility (<u>stock</u> of atypical workers)	Plant flexibility Market revenue's share	Labour demand driven by Demand growth
Factors not associated to training activities	"Performance" and financial variables other than productivity (gross and net profits, labour costs, investments per employee)[55]		

[55] Nevertheless, all performance variables are highly correlated over the period considered.

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