

# **Continuing Vocational (Firm-Specific) Training and Human Resource Management Practices – Complementary Relationship? Evidence from IAB Establishment Panel.**

**Silvia Teuber<sup>1</sup>**

Priliminary Version - Please do not quote, comments welcome

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## **Non-Technical Abstract**

This paper investigates the question if productivity effects of vocational and especially firm-specific training can be raised by exploiting complementary relationships between training and Human Resource Management practices. For this purpose an econometrical model (cross-section and panel) is conducted on the basis IAB Establishment Panel using the waves between 2002 and 2005. Although there is an extensive literature on the effects of training on an enterprise's productivity as well as some literature on complementarities between HRM Practices (including training) the effect of a coherent system of HRM practices on different training forms (general/specific) is under-researched, especially in Germany. The initial points of this paper are the theory-contradicting empirical findings that firm-specific training has a lower (partly insignificant) effect on firm's productivity than general training. The theoretical basis which would suggest contrary empirical outcomes is the knowledge-based view (and its roots: resource- and capability-based view). Within this paper possible knowledge barriers of an individual knowledge keeper are presented as the latter one plays a decisive role within rather informal training forms in whose context predominantly firm-specific knowledge is transferred. Based on these barriers several Human Resource Management measures can be identified as a remedy. Within this paper bundles of them are tested regarding their complementary relationship to (firm-specific) training and their possibility to improve (firm-specific) training's contribution to productivity. The econometrical analysis cannot corroborate this paper's hypothesis that the individual-based barriers of knowledge transfer can be reduced by a combination of a coherent system of Human Resource Management Practices and thus (firm-specific) training's productivity effect can be raised. However, it can be stated that HRM measures have a positive and significant complementary effect on general as well as on general and specific training.

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<sup>1</sup> Silvia Teuber, University of Basel, Center for Economic Sciences (WWZ), Department for Human Resources and Organization, Rosshofgasse 2, CH-4051 Basel, Switzerland, Phone: +41-61-267-2754, Fax: +41-61-267-2758, E-mail: [silvia.teuber@unibas.ch](mailto:silvia.teuber@unibas.ch)

## 1. Introduction

Regarding megatrends like economy's globalisation with its associated dynamic and complexity, the rising importance of intellectual capital (see HAMEL/PRAHALAD 1997: 349, SVEIBY 1997: 7) or developments like skill-biased technological/organizational changes (see BECKMANN 2004: 88ff, 128ff) it becomes obvious that knowledge as the 'fourth production factor' (STEWART 1998) will be or is already the primary resource (see DRUCKER 1994: 4, also ACEMOGLU/PISCHKE 1999). In order to ensure enterprises' sustainability in the fierce competition and to hold up their own employability (PIELER 2003: 4) employees have to learn their whole life long. This pressure rises even more under the aspect of knowledge's sinking half-life (see WARNECKE 1993: 106, PRANGE 2002: 18). Taking all these arguments into account it is obvious why firms should and actually do have a high interest in continuous vocational training as also numbers proof. In 2000 European firms invested an average of 2.5% of the wage sum in training (see MARQUARDT/KING/ERSHKINE 2002: 6f). In 2004 about 84% of firms in Germany conducted training. On the average the enterprises' training expenses per employee were 1.072 Euros, projected for all employees in Germany 26.8 billion of Euros were invested in vocational training (see WERNER 2006). Many studies show that these investments pay off as training has a positive (although frequently insignificant) effect on productivity (see e.g. BISHOP 1991, HOLZER 1993). However, a more differentiated look can be dared as different systematizations of training forms exist in literature. BÜCHEL and PANNENBERG (2004:76f; BMBF 2003: 183ff) distinguish between formal (internal and external courses) and informal training (job rotation, instruction, on-the-job training, quality circles, informative meetings and self-directed learning). FAULSTICH (1998: 134) differentiates between institutional learning (internal/external courses), workplace oriented learning (instruction, projects and job-rotation, job-enrichment, job-enlargement, and quality circles) and informal learning (learning at the workplace, self-organized learning, tradeshowes and fairs)<sup>2</sup>. The most popular and global differentiation stems from BECKER (1993: 29ff) who distinguishes between general and specific training. The knowledge and skills communicated in the frame of general training raise productivity by equal amounts in every firm. In contrast, during specific training only firm-specific knowledge is imparted. This immaterial resource is bound to a single company and only raises productivity in the firm where it was provided. Hence, when transferred to another firm this firm-specific knowledge loses its value

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<sup>2</sup> For information about the usage of informal training and learning forms see BMBF (2003: 196; 2005: 54; 2006: 191f)

completely. Of course in reality the training forms respectively the knowledge imparted in their frame don't exist in this purity but a tendency is clearly visible.

In general, it can be assumed that the greater the informal part of training the more firm-specific knowledge is contained and transferred. Having now a more differentiated look on productivity effects literature shows that training transferring firm-specific knowledge has much lower returns than training imparting general knowledge (see e.g. ZWICK 2005; BLACK/LYNCH 1996, 2001; BARRETT/O'CONNELL 2001). These results surprise especially against the background of the resource-based view. Taking its criteria of a long-lasting competitive advantage into account it is obvious that especially firm-specific knowledge fulfils them. This contradiction is this paper's motivation and basis for the hypothesis that the employee – in this case the knowledge keeper – is the limiting factor. Especially concerning informal training forms the experienced employee plays the decisive role as he has to transfer his knowledge to ensure the success of this training. However, if incentives for knowledge transfer are missing the employee has no reason to fulfil his important role. Thus, only HRM measures at best in form of a coherent bundle can ensure the optimal environment for knowledge transfer and simultaneously for the success of informal and firm-specific training forms. This thesis of a complementary relationship between firm-specific training and HRM practices will be tested by conducting first a standard Cobb-Douglas production function with cross-sectional data using the IAB panel data of 2003, followed by a panel estimation based on the waves 2002-2005.

This paper is constructed as follows: firstly it starts in section two with the main features of the resource- respectively knowledge-based view and their application to firm-specific knowledge. In the third section a short review of the existing literature about training's productivity effects is presented in order to stress the contradiction between theory and practical experience. Part four gives a derivation of the hypothesis which will be tested within this paper. The underlying estimation model and the used data are described in part five. The estimation results are presented in section 6, finally a short summary is given.

## **2. Theoretical Background**

Knowledge is 'the most strategically important (one) of the firm's resources' (GRANT 1996: 110) in order to generate a sustainable competitive advantage. The knowledge-based view (KBV) which is the "outgrowth" (GRANT 1996: 110) of the resource-based view<sup>3</sup> (RBV) as

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<sup>3</sup> The resourced-based view predicates on the considerations of PENROSE (1959), where the enterprise is seen as a bundle of resources for the first time. In the mid 1980s this approach has been developed further e.g. by

well as of the capability-based view (CBV) is based on this assumption. Therefore, it unionizes aspects of both theoretical streams (MÜLLER-STEWENS/LECHNER 2005: 362f). Within this paper it is purposeful to focus both on the RBV related static view and the CBV related dynamic view as it is of major interest if the related criteria of superior resources - heterogeneity, ex post and ex ante competition limitations, and imperfect mobility (see PETERAF 1993: 179ff; BARNEY 1991: 99ff) – and of core competencies – heterogeneity, value, uniqueness and its protection as well as transferability (see HAMEL/PRAHALAD 1997: 308ff) – can be fulfilled by firm-specific knowledge. The underlying assumption of the RBV is that an enterprise consists of a unique resource bundle and can generate sustainable competitive advantage by possessing superior resources<sup>4</sup>. While the RBV assumes that physical (plant, etc.), human (experience of workers, etc.), and organizational (coordinating systems, etc.) resources are all equally able to generate an idiosyncratic and impossible to duplicate competitive advantage (see BARNEY 1991: 101) the knowledge-based view places emphasis on the importance of human capital resources, especially knowledge (see GRANT 1996: 111f). Looking at the dynamic view knowledge can even be seen as a core competence as the latter represents decisive knowledge-based abilities of a company which emerged through collective learning. Core competencies do not imply only a singular but a bundle respectively a complex system of capabilities and technologies (see PRAHALAD/HAMEL 1990: 82) which allow a firm to coordinate and if possible combine resources newly and creatively. In the following, the focus does not lie on the question if knowledge in general but in particular if firm-specific knowledge can be seen as a creator of a competitive advantage.

Firstly, specific knowledge is by definition *heterogeneous* (see PETERAF 1993: 180, BECKER 1993: 29ff). As it differs significantly between the competitors within an industry (otherwise firm-specific training would be transferable between them) a high degree of heterogeneity can be stated, unlike general knowledge which is apparently characterized by its applicability to many companies. Hence, especially firm-specific knowledge should be appropriate to generate competitive advantage. Beside this aspect of heterogeneity superior resources respectively core competencies must be valuable. In the static view this means that

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WERNERFELT (1984, 1989) and RUMELT (1984). Through these idiosyncratic firm resources competitive advantages are possible. This approach contrasts the market-based view, which considers the market as well as the branch structure as decisive for superior performance and extraordinary rents (see PORTER 1980, 1985; BAIN 1956).

<sup>4</sup> As a resource one can denominate everything which a firm can access directly or indirectly (see MÜLLER-STEWENS/LECHNER 2005: 357). So both material (machines, etc.) and immaterial (human capital, etc.) are included. 'By a resource is meant everything which could be thought of a strength or weakness of a given firm' (WERNERFELT 1984: 172)

resources should neutralize threats or exploit opportunities<sup>5</sup> by higher ‘intrinsically differential levels of ‘efficiency’’ (PETERAF 1993: 180) thus, allowing lower average costs compared to the competitors and the realization of so-called Ricardian Rents<sup>6</sup>. Apparently, firm-specific knowledge can achieve this. Looking at the dynamic view it is also obvious, that firm-specific knowledge can influence a firm’s capability to effectively transfer resources into valuable products and thus generate customer value. Hence, through a knowledge-based and innovative combination of resources Schumpeterian Rents can be generated. Furthermore, sustainable benefits can be realized in the long run by *ex post competition limits* as they protect profitable companies from imitators or new entrants e.g. by preventing that resources or core competences get accessible and thus allowing them to keep their scarce and unique nature. Critical factors here are substitutes and imitates. As Porter’s Five-Forces-Model (PORTER 1980: 4) has identified substitutes as danger on the output-side, the (input) resource and capability side apparently has the same weak point which can only be limited by continuous development and careful market observation. Looking at imitates, different reasons for imperfect imitability can be identified. RUMELT (1984: 567) mentions ‘isolating mechanisms’ like resource’s property rights (e.g. patents on technologies), quasi-rights (e.g. information asymmetries) as well as changing or searching costs. Furthermore, ‘causal ambiguity’<sup>7</sup> (BARNEY 1991: 109f) or social complexity<sup>8</sup> turn out to be an important mechanism. Summing up, in order to achieve sustained competitive advantage the degree of possible *imitation* is of crucial importance and it depends beside the above mentioned factors to a large extent on the firm-specificity and the idiosyncratic way of the underlying creation-process, as well. Firm-specific knowledge is built up over time through the choice of a fitting and firm-specific way of investment (see DIERICKX/COOL 1989: 1506: ‘appropriate time paths of flows’). Thus, for the accumulation of an organizational knowledge base or for the competences built up through collective learning (see PRAHALAD/HAMEL 1990: 82ff) previous learning levels, earlier made investments in immaterial resources as well as firm-specific historical construction processes (‘path dependencies’, ‘history matters’ see TEECE/PISANO/SHUEN 1997: 522f) are decisive influence factors. As a result of ‘time

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<sup>5</sup> This environmental aspect reveals the complementary connection of the RBV to the MBV, as latter’s models facilitate the recognition of extern opportunities and threats outside the enterprise (see BARNEY 1991: 106).

<sup>6</sup> As long as the price (given by the market in a neoclassical model) lies above the average costs of a firm, this enterprise realizes Ricardian Rents to the amount of the difference value multiplied with the quantity (see PETERAF 1993: 180ff).

<sup>7</sup> One alludes to this phenomenon when even the possessing enterprise does not know exactly the distinctive features of their superior resources respectively how they have been built up. Thus resource imitation is impossible for all, either the better performing enterprise or the competitors (see DIERICKX/COOL 1989: 1508f).

<sup>8</sup> The competitive advantage may be apparent to the competitors but they aren’t able to imitate it because the necessary knowledge is dispersed on to many employees who complete each other complementarily.

compression diseconomies' (DIERICKX/COOL 1989: 1507) the accumulated stock of e.g. firm-specific knowledge can't be reached in a shorter time period, even if large investments are made<sup>9</sup>. Hence, firm-specific knowledge seems to be much more protected against imitation and thus, is a much stronger basis for a sustaining competitive advantage than general knowledge. Apart from the already mentioned prerequisites *imperfect mobility* plays an important role as it allows sustained competitive advantage based on heterogeneity. One can distinguish between perfect immobility and imperfect mobility. The first characterizes resources for which e.g. property rights are not well defined or which generate value only for the particular enterprise (see DIERICKX/COOL 1989: 1506ff). Strictly speaking this applies to firm-specific knowledge. However, also when defining firm-specific knowledge more broadly, it can be subsumed under imperfect mobile resources. Although these are tradable they simultaneously fit in a special manner to firm-specific needs and complete them complementarily (which raises its value for the relevant firm comparing to its competitors). All in all, no matter if firm-specific knowledge is defined in the strict or broad way it is bounded closely to the enterprise (in contrast to general knowledge) and therefore can be used as a long-lasting basis for competitive advantage. Finally, firm-specific knowledge is protected by *ex ante competition limits* (see PETERAF 1993: 185). Before the acquisition of superior resources has taken place uncertainty exists about their actual value. If all competitors knew before which resource would guarantee superior market positions a tough price competition would start ending with such a high resource price that additional rents would be impossible. However, as firm-specific knowledge mostly develops its value over time by a co-production between employer and employee the argument of ex ante competition limits can be seen as attenuated<sup>10</sup>. Last but not least, firm-specific knowledge as a core competence should be transferable to as many fields as possible. Yet, as '(...) transfer and imitation are blades of the same scissor' (KOGUT/ZANDER 1992: 383) and the imitation of knowledge is quite difficult the transfer is afflicted with problems, as well. Hence, according to SZULANSKY (1996: 30f, 36f) different reasons such as a lack of absorptive capacity of the knowledge recipient or causal ambiguity (see above) can cause an 'internal stickiness' (SZULANSKY 1996: 30) of knowledge. Among others (informal) training has the difficult task to solve these problems and to ensure the (firm-specific) knowledge's spread within the enterprise.

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<sup>9</sup> Through the strictly convex adjustment costs sink the returns from the rise of one variable (investments) when the other variable (time) is fixed simultaneously.

<sup>10</sup> Even without uncertainty the competitors' bids would never reach the maximum value of the optimal fitting company as their expected returns were much lower.

The theoretical background suggests that especially firm-specific knowledge and its management should create a sustainable competitive advantage. Hence, the conclusion that firm-specific knowledge's transfer in the frame of informal training should generate at least the same productivity gain as formal trainings with their emphasis on general knowledge occurs trivial. However, the following literature review paints another picture.

### **3. Empirical Background – Literature Review**

In this section a survey of the results in empirical literature on training's productivity effects is presented<sup>11</sup>. First, some studies without distinction of different training methods are shortly mentioned. In the following, special attention is given to studies that differentiate between various training forms whereupon the focus lies especially on the results concerning 'softer' training measures in whose context firm-specific knowledge is transferred. As discussed in Chapter 1 it can be assumed that firm-specific knowledge is transferred primarily within the framework of informal training which takes place on the job (see ZWICK 2005: 175, Lynch 1992: 311).

This paper's approach is to use a firm-level dataset in a regression framework to estimate the impact of training on productivity. Hence, the focus of the literature review lies on studies of this type<sup>12</sup>. Naturally, firm-level databases suffer from diverse problems. For instance, lacks of accuracy in modelling an adequate production function for a sample of heterogeneous firms or the problem of possible endogeneity bias can limit the resulting estimation. Finally missing cost information complicates the estimation of the productivity impact (BARTEL 2000: 504f, 510). However, these firm-level studies guarantee representativeness to a high extent and can be generalized much more than case studies.

Within his paper BISHOP (1991) estimates the impact of formal training in the first three month for new hired employees on the two-year growth productivity of a typical worker. For this purpose he uses data from the Employment Opportunity Pilot Projects (EOPP) and

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<sup>11</sup> There exist vast empirical literatures (e.g. BOOTH 1993, BLANCHFLOWER/LYNCH 1992, BARTEL 1995, WINKELMANN 1994, KUCKULENZ/ZWICK 2003) of the effects of training on wages which can be used as an indirect measure of productivity. However, in this paper this research stream is not focused as this indirect method implicates the severe disadvantage of an inadequate estimation of the productivity effects. This is especially the case in an imperfect labour market where wages and productivity aren't perfectly identical (see DEARDEN/REED/VAN REENEN 2000: 3ff). So the 4% increase of productivity is accompanied by a 1.6 % wage increase so about half the size of the productivity effect. Another reason for the divergence of wages and productivity could be the fact that employees receive non-monetary compensation or earn less money during the training period (kind of cost sharing) but their wages rise exorbitantly after training which would cause an overestimation of the productivity effect of training.

<sup>12</sup> For a deeper insight into case study-papers see e.g. KRUEGER and ROUSE (1998), ICHNIOWSKI ET AL. (1997), PINE and TINGLEY (1993), PHILLIPS (1994). For a firm-level study comparing different developing countries, see TAN and BATRA (1995).

collects further information by phone interviews. The estimated Return on Investment on 100 hours of new hire training ranged from 11% to 38%. However, the results depend largely upon the subjective statements of the employer and BISHOP'S underlying assumptions regarding e.g. the costs of training.

BARTEL (1994) publishes about the considered issue several times (see also BARTEL 1989, 1992). In her paper of 1994 she investigates the impact of formal training programs on productivity by using data of a 1986 Columbia Business School survey. First, she estimates a simple cross-section production function. An effect of formal training on productivity in the same year cannot be observed which might be a consequence of unobserved heterogeneity between firms. Consequently, she estimates a first difference model which shows that a new implemented formal training program increases productivity annually by six percent in the following three years compared to businesses that didn't introduce formal training.

HOLZER ET AL. (1993) concentrate on the impact of training hours – state-financed by a grant program – on employee performance, measured by scrap rates. Therefore, the authors use three-year panel data of manufacturing firms in Michigan that applied for these state subsidies for private-sector training. The financial aid was given for any formal or structured training program. Estimating the variables in differences the authors try to avoid unobserved heterogeneity. A positive (but over the years decreasing) effect of training on the output quality can be observed (decreasing scrap rate of 7% by a doubling of worker training).

In HUSELID (1995) the linkage between High Performance Work Practices, which training is a part of and firm performance is examined. The average number of training hours received by a typical employee over the last twelve month is surveyed in the frame of the cross-sectional analysis and together with selection, information sharing and quality of work life assigned to the human resource category<sup>13</sup> of 'employee skills and organizational structure'. A positive correlation with both profit measures (Tobin's  $q$  and gross rate of return on capital<sup>14</sup>) can be estimated. In the following panel-data study HUSELID AND BECKER (1996) conduct a correction of endogeneity which lowers the results dramatically and makes them insignificant.

In their cross-sectional estimation based on the IAB establishment panel BELLMANN and BÜCHEL (2001) test the productivity effects of training via a Cobb-Douglas production function. First, they come to the result that training intensity has a positive and significant

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<sup>13</sup> The other category 'employee motivation' consisted of pay-for-performance, promotions based on merit or seniority (see HUSELID 1995: 646f).

<sup>14</sup> Tobin's  $q$  is defined as 'the market value of the firm divided by the replacement cost of its assets' (HUSELID 1995: 652). In contrast, the 'cash flow divided by gross capital stock' (HUSELID 1995: 652) is called gross rate of return on capital.



effect on productivity. However, when controlling for selectivity in the decision of whether or not to offer training the productivity effect of training intensity becomes insignificant. Of course their study might suffer from unobserved heterogeneity bias as they don't use panel data. Yet, in this paper BELLMANN and BÜCHEL (2001) hint to the interesting aspect of complementary relationships between training and workplace practices respectively establishment characteristics.

Apparently, the data bases as well as the estimation techniques (including controls for selection bias and other factors that influence performance like the time frame of the study, etc.) play a decisive role for the measurement of productivity effects of training. Yet, as seen above, all studies surveyed state a positive (although frequently insignificant) impact of training on productivity. Thus, investment in training seems to pay off. However, looking carefully at the different training forms there exist crucial differences between their productivity impacts which is discussed in the following literature.

The cross-sectional study of BLACK and LYNCH (1996) uses the data of the National Center on the Educational Quality of the Workforce (EQW) National Employer's Survey which includes especially establishments in the manufacturing sector and those with over 100 employees. They differentiate between on-the-job and off-the-job training. The first training relevant result BLACK and LYNCH present is that training lowers productivity in the first moment, but has a positive lagged effect on productivity. The authors attribute this effect to an "adjustment costs associated with the introduction of new skills (...) into the workplace which are then followed by positive improvements in productivity" (BLACK/LYNCH 1996: 265). Secondly, the percentage of formal off-the-job training (outside working hours) has in contrast to on-the-job training a positive significant impact on productivity. Thirdly, the content of training is of crucial importance<sup>15</sup>. However, their cross-section estimation could be biased as a consequence of unobserved heterogeneity and the fact that they take training as an exogenous variable. In their following paper, Black and Lynch (2001) use panel data from the Longitudinal Research Database (LRD) in addition to their database of the 1996 article in order to correct for unobserved time-invariant heterogeneity between firms. Furthermore, they conduct several estimation methods (e.g. within and GMM estimator). Doing so, the authors

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<sup>15</sup> To the special relationship between training's productivity impact and the training topics respectively target groups see also BALLOT ET AL. (2001) who try to investigate the effect of R&D expenditures and human capital level measured by past and present firm-sponsored training on firm's productivity. For this purpose they use panel data between 1987 and 1993 of mostly large firms in France and Sweden. The authors come among others to the result that in France training – especially that of the target group 'manager' – effect significantly firm's value added in a positive way. This complementary effect between human capital and training is also in accordance with the results of DEARDEN, REED and VAN REENEN (2000: 40).

take account of the endogeneity at least in the time-variant parameters included in their first estimation step in which frame they calculate the average firm-specific, time-invariant residual in a fixed effects Cobb-Douglas production function (excluding workplace practices, training methods, and other firm and employee characteristics). However, their following step – in which frame the authors regress the average establishment residual on training and the other quasi-fixed factors – is prone to selectivity bias. During this estimation the authors don't differentiate between various training forms and finally come to the result that the number of employees trained has no effect on productivity.

DEARDEN, REED and VAN REENEN (2000) present an industry-level estimation of training's impact on productivity which is based on a combination of the Labour Force Survey and a complementary industry-level data source between 1983 and 1996. Though the investigation is not conducted on firm-level, this study is integrated as the authors provide a sophisticated analysis and come to interesting results and interpretations. The authors estimate with several panel data techniques which partly take simultaneously unobserved heterogeneity as well as selectivity of training into account (e.g. system GMM). DEARDEN ET AL. (2000) conclude that training significantly increases productivity. However, when differentiating between off- and on-the-job training the results show a relatively higher impact on firm's productivity of off-the-job<sup>16</sup> training. Besides this result, a complementary relationship between training and professionals respectively managerial workers can be stated, as the integration of the interaction term was significant on a 10%-level. The authors suggest a constant underestimation of previous studies according to the fact, that firms tend to train their employees when they face negative demand shocks and therewith show low productivity.

BARRETT and O'CONNELL (2001) estimate the effect of employer-provided training on productivity and distinguish between Becker's two training forms: general and specific. The authors use a firm-level dataset based on a two wave survey of enterprises in Ireland and show that training itself has a positive and significant effect on productivity growth. However, having a more differentiated look on the training forms it becomes obvious that general training (paraphrased by 'providing broad skills and knowledge') has a positive and significant impact on productivity growth while specific training (paraphrased by 'directly related to the operation of the company') has no significant effect (see BARRETT/O'CONNELL 2001: 15).

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<sup>16</sup> The focus of the distinction between off- and on-the job training lies in the frame of this study especially on the formality aspect: "on-the-job" training is defined as learning by example and practice whilst actually doing the job, whilst "off-the-job" training refers to training which is conducted as a formal training course (such as a classroom or training section' (DEARDEN/REED/VAN REENEN 2000: 13)

Regarding the German training sector ZWICK (2005) concentrates his analysis on different continuing vocational training forms. For his sophisticated econometric model (regarding the estimation method see also BLACK/LYNCH 2001) he uses the waves 1997 – 2001 of the IAB establishment panel which allows him to measure productivity effects on firm level. The results show that formal external courses cause the largest positive impact (28%) on productivity though mostly standardized general knowledge is communicated<sup>17</sup>. On-the-job training and to a lesser extent job rotation which focus notably on the transfer of firm-specific knowledge even have a negative productivity impact.

Recapitulatory the empirical studies differentiating between general/specific (BARRETT/O'CONNELL 2001), on-/off-the-job (BLACK/LYNCH 1996, DEARDEN ET AL. 2000) and different training forms (ZWICK 2005) state a much higher positive impact of formal (general knowledge-transferring) training on productivity than informal (specific knowledge-transferring) training activities<sup>18</sup>. Here the question arises why the reality contradicts knowledge-based view's assumptions which state that firm-specific knowledge can build an essentially higher competitive advantage than general knowledge (see Chapter 2). Why do these contradictions between theory and empiricism appear?

#### **4. Recent Explanations and New Thesis**

Some explanations have been given: BLACK and LYNCH (1996: 265f) mention the loss of work time hour when doing on-the-job training and furthermore suggest that those employers who train off the job invest to a greater extent in more advanced and time-intensive skill development. BARRETT and O'CONNELL (2001) regard the fact that general training is more transferable and thus more valuable for the employees; hence, it is rational for them to put more effort on learning and applying the new general skills in contrast to firm-specific knowledge. Furthermore, workers regard general training both as a gift (knowledge can be used also outside the firm) and as a signal that they are important organizational members who can expect a long working relationship. This is why they increase their productivity and loyalty. According to ZWICK (2005: 176) negative biases could arise through e.g. an informal training's correlation with high turnover rates (see also BARRETT/O'CONNELL 2001: 18) or restructuring measures which both lower productivity and hence cause a minor productivity

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<sup>17</sup> Quality circles (17%) have a smaller positive effect, participation at seminars and talks, self-induced learning and formal internal training don't have any long-lasting impact on productivity, see ZWICK (2005: 175f).

<sup>18</sup> “[...], it can be argued that the productivity-increasing training forms contain more general human capital content than the other training forms.” ZWICK (2005:175).

coefficient of on-the-job training. Also a wrong indication of the establishments (caused by socially desirability) or the short extract of the database are possible weak points.

In the following, a further possible explanation for the contradiction of theory and empiricism will be given, complemented by an empirical check of this thesis. In the course of the knowledge-based view 'employee-centred' (SPENDER/GRANT 1996: 6) thinking became prevalent as a consequence of the awareness, that knowledge per se and in particular its sharing is not controllable or manageable directly but only via the human being as an intermediate factor. The employee as the knowledge owner has to be spotlighted as knowledge is bounded to him<sup>19</sup> (see NORTH 2002: 256; OELSNITZ/HAHMANN 2003: 19f, SEIDEL 2003: 46, 61ff). Especially in the frame of informal training measures and the transfer of firm-specific knowledge employees and their willingness to disperse their knowledge play the decisive role. However, as there exists an interest divergence concerning the knowledge transfer between the enterprise (knowledge diffusion within the firm) and its employees (keeping one's knowledge exclusively) an analysis of knowledge keeper's individual barriers can provide an opportunity for possible counteractive measures<sup>20</sup>. While addressing these individual-based barriers by a system of coherent Human Resource Management Practices the hypothesis is tested that – especially firm-specific – training and HRM activities are in a complementary relationship with each other and thus, can both generate an important competitive advantage through their virulent relationship and higher the impact of firm-specific training on productivity.

Different knowledge hurdles can be observed. In a theoretical-analytical procedure SEIDEL (2003: 79ff) classifies the barriers into ability<sup>21</sup>, motivation<sup>22</sup>, and opportunity<sup>23</sup> on sender- as well as on recipient-side (see PROBST/BÜCHEL 1994: 177ff). As the knowledge

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<sup>19</sup> Following an autopoietic and system-theoretic view of knowledge (see VICARI/KROGH/ROOS/MAHNKE 1996:185) a 1:1-transfer isn't possible as knowledge is bounded to person and context. Successful communication therefore strongly depends on similarity of mental models and a common context as knowledge is constructed by the recipient based on his criteria of relevance (for constructivist view of communication see WILLKE 2001: 7ff, 48, SENGE 1990: 8f, 186ff, OELSNITZ/HAHMANN 2003: 59ff, MATURANA 2002: 84ff, PICOT ET AL. 2001: 103ff).

<sup>20</sup> The first difficulty is that information asymmetries regarding the employee's knowledge level and his transfer attitude exist (hidden information, see KRÄKEL 2004: 22). Furthermore, knowledge transfer is neither completely observable (in quantity and quality) nor perfectly measurable and hence difficult to contract ex-ante and not fully controllable ex-post (problem of hidden action, see KRÄKEL 2004: 22). The latter has moral hazard, ex-post opportunistic behavior (non-sharing) as a consequence (see principal-agent-theory, KRÄKEL 2004: 85ff).

<sup>21</sup> Under the ability aspect on knowledge recipient side cognitive problems like information overload or missing problem awareness (see SCHÜPPEL 1996: 122ff) can be subsumed.

<sup>22</sup> Motivational barriers can become manifest on recipient side in resort thinking (e.g. the 'Not Invented Here'-syndrome, see KATZ/ALLEN 1988) or fear of disgrace if one confesses his ignorance by asking for help or information.

<sup>23</sup> This barrier category concerns the opportunity given to the sender as well as to the receiver to communicate and learn from each other. Often structural hurdles caused by the organization like hierarchy (bureaucracy) constellations or missing time are mentioned in this context. However, as training measures are geared to knowledge transfer these barriers are only of minor relevance in the framework of this paper.

owner and in particular his motivational barriers are of high interest these barriers are focused in the following.

According to SEIDEL (2003: 94ff) the knowledge keeper's motivational<sup>24</sup> barriers can be split into the theory of power, the theory of competition, the theory of psychology and finally the theory of game perspective. The first can be described by Sir Francis Bacon's quote: 'Knowledge is power'<sup>25</sup>. Assuming that an organization is full of political and power-influencing behaviour knowledge can be seen as an important source of power. This may especially be the case when knowledge is exclusive (within the firm and outside of it, which applies mainly to firm-specific knowledge) and from extraordinary concern for the firm (see CROZIER/FRIEDBERG 1993: 50ff, MINTZBERG 1983: 24ff, 183f). Through this power the individual can allow himself room and autonomy (two main needs whose importance rises the higher specialization accompanied by greater dependence of colleagues). Therefore, it is rational for the knowledge owner to adhere his position of exclusive power by keeping his knowledge private. However, coming from these barriers several potential counter activities are possible. Hereby, especially immaterial incentives like intrinsically motivating tasks with room for autonomy and independence through delegation or participation (these factors correspond to Herzberg's 'motivators' see COMELLI/V. ROSENSTIEL 1995: 135 and should enhance especially intrinsic motivation<sup>26</sup>, see V. ROSENSTIEL 1999: 65f, BENZ 2000: 92ff, OSTERLOH/FREY 1999: 18)<sup>27</sup> in combination with low hierarchical structures with decentralized competences and responsibilities have to be mentioned (see e.g. the hypertext-organisation NONAKA/TAKEUCHI 1997: 182ff as a fruitful example for a combination of bureaucracy and a flexible project organization)

The individual conclusion not to share (firm-specific) knowledge also follows from a theory of competition perspective. If an employee exclusively (low supply, in extreme knowledge monopoly, see LULLIES/BOLLINGER/WELTZ 1993: 253) possesses an often asked (high demanded) and important knowledge for the firm his intra-organizational market value is extremely high. However, if he shares his knowledge the immaterial source keeps or

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<sup>24</sup> '(...) knowledge transfer is intimately connected to motivation (...)' (FREY/OSTERLOH 2000b: 538).

<sup>25</sup> The original expression was: 'Nam et ipsa scientia potestas est' (Bacon 1597).

<sup>26</sup> Intrinsic motivation is of crucial importance in the context of knowledge transfer (see OSTERLOH/FROST 2000: 65, FREY/OSTERLOH 2000b: 538). The individual contribution (knowledge transfer) is not measurable, hence not extrinsically payable (moral hazard problem, see KRÄKEL 2004: 85ff, BECKMANN 2004: 20ff) and additionally the problem of multiple tasks (see KRÄKEL 2004: 92ff, FREY/OSTERLOH 2000b: 540; HOLMSTRÖM/MILGROM 1991: 24ff, HOLMSTRÖM/MILGROM 1994: 973) intensifies the situation. Hence extrinsic incentives alone seem not to be able to solve the problem (see also crowding-out effect).

<sup>27</sup> For participative leadership-style respectively delegation and empowerment see PICOT/DIETL/FRANK (1997: 224, 171), ANTONI (1999: 570), WELLINS/BYHAM/WILSON (1991).

elevates its value but the owner's value<sup>28</sup> sinks rapidly as his singular supply position disappears (new knowledge proprietors are even possible multiples). Hence, the employee becomes dispensable and in times of (fierce) competition has to have fear for his promotion (see rank-order tournaments BACKES-GELLNER/LAZEAR/WOLFF 2001: 155ff, 197ff; KRÄKEL 2004: 90ff, 231ff) or even his job. And finally, the opportunity costs (time and effort) of knowledge production and sharing which are even rising with the degree of competition have to be taken into account. Since it takes place during the regular working hours it is mainly informal training like adjustment for new job that causes opportunity costs. Again a bundle of measures can help to lower the sharing hurdle: in order to reduce the competition at the expense of cooperation tournaments basing also on the degree of knowledge sharing (see KRÄKEL 2004: 230) e.g. through subjective performance evaluation of the team mates or the supervisor (as complement to accurate objective incentive pay plans, see BAKER/GIBBONS/MURPHY 1994), material incentives like team- (e.g. Holmstrom-solution, see HOLMSTROM 1982) or firm incentives (profit sharing or employee share ownership see BACKES-GELLNER/LAZEAR/WOLFF 2001: 336ff; SCHNEDLER 2001: 47) should be implemented. A profit sharing component for the informal trainer should be introduced, as well, if the supported person outperforms in his further development. Furthermore, employment security (often correlated with work councils, see FREEMAN/LAZEAR 1995: 28f, FRICK/SADOWSKI 1995: 58, BACKES-GELLNER/FRICK/SADOWSKI 1997: 333) bureaucratic rules (only after some time of observation is a promotion possible, see also matching approach BECKMANN 2004: 47ff; JOVANOVIC 1979) or time-based (according to employee's qualification, see OSTERLOH/FREY 1999: 19) and seniority-based pay (see LAZEAR 1998; BACKES-GELLNER/LAZEAR/WOLFF 2001: 264ff) can bring noticeable improvements as they lower fierce competition for employment or promotion.

In the psychological field several dare-barriers can be identified. Some employees fear the possible disgrace if they tell mistakes from which they have learned. Furthermore, fear of possible consequences of improvement proposals e.g. job economization or rising work burden (accompanied by social sentence) hinders knowledge sharing. Also the underestimation of the own knowledge can play an important role. Measures like the above mentioned employment security (see AOKI 1988: 174ff) can lower the fear of job economization, again profit sharing and employee shares on the firm let everybody participate in the rising profits and thus increase the colleagues' support for lessons learned and

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<sup>28</sup> 'Because individuals try to maximize their gain, they restrict their information sharing when they believe that their unique value to the firm is reflected in the information they control and selectively share.' (RUSSELL 1996: 29)

improvements. Moreover, a corporate culture (see SCHEIN 1995: 30ff; FÖHR/LENZ 1992) of openness, trust and the emphasis on the importance of knowledge (in the firm's mission statement (see PRANGE 2002: 73) and leadership attitude, through the implementation of knowledge-oriented controlling systems (see e.g. KAPLAN/NORTON 1996: 126ff), a good reputation of knowledge sharers, communities of practice, see WENGER/SNYDER 2000) or material incentives can solve the problem of an underestimation of knowledge.

The last barrier concerns game-theory. On the basis of the prisoner's dilemma it can be shown that not cooperation (knowledge sharing<sup>29</sup>) but defection in terms of non-sharing of knowledge is the dominant strategy for all parties as the own benefit can be maximized (see KRÄKEL 2004: 52ff, FÖHR/LENZ 1992: 131, SEIDEL 2003: 107ff). While the Pareto-optimum (collectively optimal) lies in the first quadrant (cooperation/cooperation) the individually optimal and dominant strategy is to defect. Hence, the Nash-equilibrium is a mutual defection, the result a suboptimal dilemma. However, some cooperation-friendly measures can be identified: long-lasting relationships<sup>30</sup> with repeated and frequent interactions, reciprocity<sup>31</sup>, personal relationships (see OSTERLOH/FREY 1999: 18), communication and trust (e.g. through culture, see FÖHR/LENZ 1992: 111ff) as well as a low calculation interest thus future pay-offs are regarded as precious. Also supergame-strategies like the trigger-strategy (see KRÄKEL 2004: 265) can influence the pay-off matrix of an actor to a high degree. On the one hand, cooperation's profits can rise through material incentives (see above) or immaterial rewards (integration in the enterprise's family, see v. ROSENSTIEL 1999: 65f; SCHEIN 1985: 105f). On the other hand, the punishment for detection can be increased by lower wages (Holmstrom-punishment, see HOLMSTROM 1982), peer pressure in case of norm violation (see KANDEL/LAZEAR 1992: 807f, 814f) coupled with several other HRM practices, e.g. selection procedures or up-front expenditures in order to lower the free-rider problem (see FREY/OSTERLOH 2000c: 68, OSTERLOH/FREY 2005: 344ff) or worse evaluations through the supervisor and thus worse promotion chances. The latter has the additional effect that it increases the punishment effect of the trigger-strategy as the employee stays in his peer group and has to bear the pressure and the social isolation as a consequence of his norm disregard, see FEHR/GÄCHTER (2002).

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<sup>29</sup> Knowledge sharing is closely associated with the willingness to cooperation (see REINMANN-ROTHMEIER/MANDL 2000: 19, 28).

<sup>30</sup> In terms of uncertainty on actor's side regarding the last interaction (infinite game). In finite games one can prove by backward induction that defection is the dominant strategy in all periods (see KRÄKEL 2004: 56, 88).

<sup>31</sup> "In fact, implicit incentives based on reciprocity or on repeated interactions are frequently among the most relevant and most powerful incentives in economic contexts" (FEHR/FALK 2002: 717).

Summing up, a bundle of activities could be identified concerning areas like leadership, tasks, organizational culture and norms, material as well as immaterial incentives, and controlling systems<sup>32</sup>. Of course also the recruitment of fitting employees is of crucial importance. Unfortunately, not all these activities are measurable or asked in the IAB Panel. This is why in the following econometric estimation the focus is only parts of these aspects, like the delegation of responsibilities to non-managers, teamwork, units with their own cost/result responsibility, etc. (see section 5.3 for details).

Literature shows that many of the above discussed measures which are often described as characteristic for High Performance Workplaces (WHITFIELD 2000: 1f, HUSELID 1995: 635f, 639f, U.S. Department of Labor 1993, OECD 1999) have productivity effects themselves (e.g. profit sharing KRUSE 1993, training, see section 3, information sharing KLEINER/BOUILLON 1988) and can be complementary to each other meaning that they bring larger (productivity) effects (synergies) when clustered together in a coherent manner, than do the sum of component effects due to individual practices<sup>33</sup> (see MILGROM/ROBERTS 1990), MILGROM/ROBERTS 1995, ICHNIOWSKI/SHAW/PRENNUSHI 1995, 1997, KANDEL/LAZEAR 1992, BAKER/GIBBONS/MURPHY 1994). Also a positive relationship between HPWP and training can be stated in such a way that the company's training needs rise with the implementation of HPWP (see e.g. OSTERMAN 1995, FRAZIS ET AL. 1997, LYNCH/BLACK 1997, CARMICHAEL/MACLEOD 1993). WHITFIELD (2000) and WOLF/ZWICK (2003) find a positive relationship between training and the introduction of participative HRM measures in the sense that higher employee participation raises personnel's training motivation on the one hand. On the other hand, the necessity to train grows as employees are confronted with new tasks and challenges. With reference to the papers of ICHNIOWSKI, SHAW and PRENNUSHI (1995, 1997) it becomes prevalent, that training (without distinction between general and

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<sup>32</sup> Of course these measures could also be added by medial applications like intranet, intra-organizational journals, etc. There becomes visible who transferred knowledge and hence who is important for the organization, furthermore the employee ensures himself an intellectual property right (see DAVENPORT/PRUSAK 1998, CAMPBELL/GÜTTEL 2005, GÜTTEL 2007: 475f). However this paper focuses on the HRM possibilities.

<sup>33</sup> 'The traditional economic concept of complementarity typically requires nonnegative mixed partial derivatives. However, firms' objective functions are not likely to be twice differentiable with respect to discontinuous "inputs" like HRM policies. Milgrom and Roberts (1993) and Holmstrom and Milgrom (1994) propose the use of supermodularity in objective functions to extend the concept of complementarity to discontinuous inputs like organizational policies. If a firm's production function is supermodular with respect to two HRM policies, then interaction effects among HRM policies will be significant. With supermodularity, the sum of (a) the productivity increase from adopting the first policy in isolation and (b) the productivity increase from adopting the second policy in isolation will be less than the productivity increase from the simultaneous adoption of both HRM policies' (ICHNIOWSKI ET AL. 1995: 8).



specific one) and HPWP stand in a complementary relationship to each other, hence training has to be accompanied by a coherent<sup>34</sup> cluster of HRM measures<sup>35</sup>.

This paper tries to analyze this relationship in a deeper way by having a closer look on the different training types (general and firm-specific) and examining complementary effects between general/specific training and HRM measure bundles. The expectation is that the increase in output when investing in one complement (firm-specific training) should be greater in the presence of complements (HRM measures) than in their absence.

In the following the estimation equation is derived coming from estimation problems concerning training and its productivity effects. Furthermore, the used data is described.

## **5. Econometric Analysis**

### **5.1 Estimation problems and particularities**

Several estimation problems in the context of training have to be taken into account. The central estimation problem is that the training decision and other production factors like labour and capital are endogenous as all of them depend on the firm's gross value added (see ZWICK 2005: 162ff, DEARDEN ET AL. 2000: 25ff). This fact can lead to estimation biases. Two different sources of training's endogeneity can be differentiated. Firstly, firms that train may be structurally different from firms that train little or even not at all. Time-invariant firm-specific factors like management quality, the activity of the personnel department, industrial relationships, etc. (GRILICHE/MAIRESSE 1998: 174ff) can be the reason for these unobserved time-invariant firm-specific heterogeneity which is controllable by panel regression (see BLACK/LYNCH 2001: 438, DEARDEN/REED/VAN REENEN 2000: 24, ZWICK 2005: 156f). Secondly, transitory shocks like new production technologies can influence the training decision as they influence productivity and training efforts simultaneously (see DEARDEN/REED/VAN REENEN 2000: 25, ZWICK 2005: 157). Firms do not decide for or against training randomly, selection effects become visible. Enterprises often offer training when they are in trouble (see BLACK/LYNCH 1997: 27, DEARDEN/REED/VAN REENEN 2000: 10) or have a structurally lower productivity (see BARTEL 1994: 420, 423). In these cases training's productivity effect is likely to be underestimated unless training is treated as an endogenous variable (DEARDEN ET AL 2000: 9f). But also the contrary effect can be visible in such a way that booming organizations train as they can afford the partly expensive training measures

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<sup>34</sup> Coherence plays a decisive role especially in the context of incentives. If they do not complement each other, negative effects like crowding-out of intrinsic motivation through pay for performance could be the consequence (see FREY/OSTERLOH 2000a: 26ff, 35ff; FREY 1997: 7ff).

<sup>35</sup> 'HRM system variables are shown to raise productivity substantially, and the effects of these system variables exceed the effects of the full set of individual practices' (ICHNIOWSKI et al. 1997: 311).

(see ZWICK 2004b: 364). Hence, in this case the effect of training would be overestimated. In order to avoid selectivity biases and caused to the fact that this paper's differentiated question does not allow an endogenous switching model or the instrumentation of the different training forms only training enterprises are included in the estimation.

## 5.2 Derivation of the estimation equation

Coming from the above mentioned problems and particularities the following estimation equations and techniques are used. Analogous to the estimations in the previous literature a Cobb-Douglas production function is used. The thesis of complementarity between (firm-specific) training and HRM practices will be tested by conducting firstly a cross-sectional analysis followed by a panel estimation whereby both times the method of interaction effects of BRESHNAHAN/BRYNOLFSSON/HITT (2000: 174ff) is used.

### Cross-section Estimation

The cross-section estimation model is based on the following log-linear equation:

$$(I) \quad \ln Y_{it} = \alpha + \beta_1 \ln K_i + \beta_2 \ln L_i + \gamma_1 D_{SH} + \gamma_2 D_{SL} + \gamma_3 D_{GH} + \gamma_4 D_{TH} + \gamma_5 D_{TL} + \sum_{j=1}^n \delta X_i + \varepsilon_i$$

Output  $Y_i$  of establishment  $i$  is a function of capital  $K_i$ , labour  $L_i$  as well as of several explanatory variables  $X_i$  of which a large number is included in order to control for omitted variable bias (see ZWICK 2005: 161f, BLACK/LYNCH 2001: 438). Analogous to literature, especially further employee (like the share of qualified employees, etc.) as well as firm characteristics (e.g. dummies for industry sector, region, exporters, the legal form or employer size) are used (see DEARDEN/REED/VAN REENEN 2000: 11f; ZWICK 2004a: 654, ZWICK 2005: 161f, 171). As training does not raise productivity immediately (see ZWICK 2005: 162, DEARDEN ET AL. 2000: 31f, BLACK/LYNCH 1996: 265), different values of the dependent variable are taken:  $Y_{it}$  (t=2003, 2004) in order to include these lagged productivity effects.

In their work MILGROM and ROBERTS (1990, 1995) show that maximal returns can only be realized through the introduction of a coherent cluster of measures (in this case: HRM practices). Regarding these cognitions, it is obvious that single HRM measures are closely correlated to each other (see e.g. ICHNIOWSKI ET AL. 1995: 15f, see also factor analysis, reliability analysis and cluster analysis in MACDUFFIE 1995: 204ff) which will be tested with a correlation matrix. Taking these interactions into account it becomes apparent that an observation of single HRM practices (interacted with the different training forms) will yield biased coefficients due to the omission of the other HRM measures. Avoiding this omitted

variable bias by including all HRM measures can arouse the problem of collinearity which makes none of the coefficient interpretable. Therefore, the core pieces of the regression are in accordance with BRESHNAHAN/BRYNOLFSSON/HITT (2000: 174ff) the integration of interaction effects between the inputs training (firm-specific/general/both) and bundles of the above mentioned HRM measures into the log-linear equation. Hence, mutually excluding dummy variables are built to examine how various input combinations affect productivity:

$D_{SH}$ : specific training only (S) - high level of HRM measures (H, above the median)

$D_{SL}$ : specific training – low HRM (L, less than the median)

$D_{GH}$ : general training only (G) – high HRM

$D_{TH}$ : both training forms (specific and general, T) – high HRM

$D_{TL}$ : both training forms – low HRM

As reference category  $D_{GL}$ : general training – low HRM

By these interaction components the average productivity levels of firms in each quadrant can be estimated relative to the baseline case of general training – low HRM. Regarding the thesis above one would expect that the combination of firm-specific training and bundles of many HRM practices has a higher and positive effect on productivity than general training accompanied by only few HRM measures. Even at the risk of getting not interpretable coefficients due to collinearity single HRM practices (with the remaining HRM measures as control variables) are also solely interacted with the training forms in order to identify the possible complementarity drivers. Then these positive variables are bundled again and combined with training in the above described way.

### **Panel regression**

Despite the large number of control variables the cross-section estimation may still suffer from omitted variable bias due to unobserved establishment characteristics like management's quality, influence of technological progress, etc. (see GRILICHES/MAIRESSE 1998: 174ff) which simultaneously influence explanatory variables (especially labour and capital) and the gross value added respectively output  $Y$ . By using panel data these omitted time-invariant establishment-specific effects can be removed (see BLACK/LYNCH 2001: 438, ZWICK 2004a: 655, ZWICK 2005: 164f). However, in a fixed-effects-regression or other panel estimators, observable time-invariant variables like firm characteristics (industry sector, etc.) are skipped as well as the key variables training and HRM measures which are additionally only asked for in selected years. Hence, their influence cannot be measured. Therefore, in the coming-up panel estimation a two-step estimation technique is conducted (see BLACK/LYNCH 2001:

437ff, ZWICK 2005: 164ff) in order to avoid the problems of missing and quasi-fixed predictor variables. In the first step a correction of selectivity is strived for by making capital and labour exogenous. Also the time-invariant heterogeneity can be corrected by the panel estimation (using the within estimator) including only labour and capital as well as year and sector dummies as variables (in order to control for differences in the business cycle and between sectors). Hence, the first step can be formally described as:

$$(II) \quad \ln Y_{it} = \alpha + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \delta'_1 D_{\text{industry}} + \delta'_2 D_{\text{year}} + v_i + \varepsilon_{it}$$

with  $D_{\text{industry}}$  and  $D_{\text{year}}$  as industry respectively year dummies. The important step in this context is the decomposition of the error term into  $v_i$  which is the firm's unobservable time-invariant fixed-effect<sup>36</sup> and  $\varepsilon_{it}$  as the idiosyncratic component of the error term. With this result the firm's average time-invariant fixed effect is calculated. In the second step this average fixed effect is regressed on the above described interaction terms as well as on the remaining control variables.

$$(III) \quad v_i = \gamma_1 D_{\text{SH}} + \gamma_2 D_{\text{SL}} + \gamma_3 D_{\text{GH}} + \gamma_4 D_{\text{TH}} + \gamma_5 D_{\text{TL}} + \sum_{j=1}^n \delta X_{ij} + \xi_i$$

As described above, by this method the advantages of panel estimations can be utilized at least regarding the coefficients of capital and labour. Hence, endogeneity biases due to correlations with the firm-specific unobserved fixed effect can be controlled. Yet, it is obvious that the two-step estimation technique 'does not address biases that may arise in the second step' (BLACK/LYNCH 2001: 443). As possible biases again selectivity (e.g. of the training decision) as a consequence of a possible correlation between training and the unobserved establishment characteristics can be mentioned (see BLACK/LYNCH 2001: 443ff, ZWICK 2005: 159).

### 5.3 Database

The following analysis of the effects of different training forms under inclusion of Human Resource Management measures is based on the IAB Establishment Panel. The latter is an annual (since 1993 held in the middle of the year) representative survey of establishments employing at least one employee who pays social security contributions (see BELLMANN/KOHAUT/KÜHL 1994, BELLMANN 1997, KÖLLING 2000 for a more detailed

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<sup>36</sup> ZWICK (2005: 165) gets the firm's unobservable fixed effect to the point by describing it as: 'the establishment-specific difference from productivity expected on the basis of the inputs and controls. This time-invariant variable therefore measures whether establishment productivity structurally is below or above that of the other establishments during the observation period.'

description of the IAB-Establishment Panel). The selected enterprises are annually asked about turnover, employment, personal problems, apprenticeship training, investments, innovations and governmental aids. In some years special questions about training or HRM practices are queried. In 2004 establishments participating in the IAB Establishment Panel were asked the following questions: “Have there been introduced one or more of the following organizational changes in your establishment over the last 2 years?” The following answer possibilities were available:

- (i) Rearrangement of supply and distribution channels respectively clients’ relationships (clients’ relationships)
- (ii) Reorganization of divisions and functional areas (reorganization)
- (iii) Delegation of responsibility and power of decision to non-managers (delegation)
- (iv) Implementation of units with own cost and result responsibility (profit centre)

All of the above mentioned practices allow the employees more responsibility, autonomy and independence. Their tasks become more challenging which could raise their intrinsic motivation as a consequence. Furthermore, this shift of responsibility is a sign that the management entrust its employees which also could raise their motivation and identification with the firm.

- (v) Introduction of team-work and self-responsible working groups (teamwork)

Besides the already mentioned raise of responsibility, autonomy, and independence through teamwork, a climate of communication and trust as well as the development of personal relationships and reciprocal support can emerge connected with the wish to become part of this team. Therefore, possible peer pressure would be a real punishment.

- (vi) Improvement of quality management (quality management)

With this variable the aspect is included that not only costs but quality are relevant, as well. Hence, in order to ensure this aim the employee has to yield his own mental input. New ideas and improvements are desired, a culture of knowledge, openness and advancement arises.

Furthermore, several other variables are added to HRM measures:

- (vii) Low (under the median) fluctuation ratio (low fluctuation)

Here, fluctuation is used as a proxy for employment security, good organizational climate, as well as long-lasting relationships which are important for cooperation (see e.g. theory of game perspective).

- (viii) Financial incentives like employee share ownership or profit sharing (asked in 2005, material incentives).

As described above, by these financial incentives everybody can participate in the rising profits of the firm. Therefore, the identification with the enterprise as well as the motivation to contribute to the firm's success rises, even when the own share might be marginal. Thus, also the willingness to implement improvements and cognitions of lessons learned increases. Simultaneously associates a higher appreciation of knowledge keeper and sharer.

(ix) Existence of work councils (work councils)

Even if work councils cannot purely be categorized as HRM measures, they play an important role regarding employment security and trust of the employees into the management. It is obvious that in an environment where employees and their knowledge are highly appreciated work councils have a higher relevance than in case when only few of the above mentioned Human Resource Management practices are implemented.

Regarding the training variables, in 2003 firms were firstly asked: 'Did your establishment support continuous vocational training in the first part of 2003?' If the respondents answered with yes, they had to specify themselves through the question 'For which of the following internal or external measures, were employees exempted from work or were costs completely or partly taken over by the establishment?' The possible answers were:

- Formal external training (courses, seminars)
- Formal internal training (courses, seminars)
- Training on the job (introductory training, instructions)
- Seminars and talks
- Job rotation
- Self-induced learning (computer-assisted learning programmes, text books)
- Quality circles
- Additional continuous vocational training measures

According to KUCKULENZ/ZWICK (2003: 10f) and ZWICK (2005) on-the-job training, job rotation, self-induced learning and internal courses are ranked among firm-specific training, lectures and trade fairs, quality circles (see ZWICK 2005: 175) and external courses are attributed to general training.

As the capital stock is not asked directly, it is approximated by the annual investments. Obviously, this is a very rough approximation hence the normally appearing measurement errors of capital will be probably even worse. For future research the perpetual inventory method (see BLACK/LYNCH 2001: 438 ZWICK 2005: 167, HEMPELL 2005: 435f) is recommendable and planned. In the following analysis non-profit organizations and enterprises of the agricultural sector as well as of the bank and insurance field are excluded in

order to reduce heterogeneity. The same happens with enterprises that ex- or included firm parts. The latter is necessary as the second estimation step assumes constant firm characteristics (see ZWICK 2004a: 658f, 666). Finally, also enterprises with less than five employees and, as already mentioned, all non-training firms (that answered the above described first training question with no) are skipped.

## 6. Results

Firstly, it is tested if the Human Resource Management measures are really highly correlated with each other and therefore bundling seems to bring higher impacts. This is done in analogy to ICHNIEWSKI ET AL. (1995: 9f) by a correlation analysis. As Table 1 shows the HRM practices interact partly to a large extent.

Table 1: Correlation coefficients between different HRM measures

HRM practices	Clients' relationships	Reorganization	Delegation	Profit Centre	Teamwork	Quality Management	Material incentives	Low Fluctuation	Work Council
Clients' relationships	1								
Reorganization	0.219	1							
Delegation	0.157	0.271	1						
Profit Centre	0.136	0.217	0.19	1					
Teamwork	0.146	0.169	0.246	0.176	1				
Quality Management	0.267	0.274	0.22	0.154	0.201	1			
Material incentives	0.170	0.173	0.094	0.075	0.082	0.09	1		
Low Fluctuation	0.054	0.172	0.048	0.077	0.072	0.128	0.111	1	
Work Council	0.052	0.276	0.075	0.128	0.078	0.149	0.156	0.337	1

Source: IAB Establishment Panel; waves 2004 and 2005; own calculations

## Cross-section results

In the next step equation (I) is estimated. Firstly, all mentioned HRM practices are bundled and interacted with the different training forms. The results show that a shift from the reference category (general training – low HRM) to firm-specific training – high HRM (more than the median firm which conducts two practices) enhances the productivity however, only in an insignificant way (see Table 2).

Table 2: endogenous variable: lnY04 (lnY03), reference category: general training – low HRM, bundled HRM measures.

	High HRM (more than two)	Low HRM (less than three)
Firm-specific training only	0.181 (0.122) N = 45	0.076* (0.046*) N = 109
General training only	0.163* (0.168*) N = 152	n.n. N = 367
Both training forms	0.243** (0.235**) N = 1291	0.065** (0.052**) N = 951

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2003-2004), own calculations

Regarding the other coefficients, it becomes obvious that a shift to firm-specific training – few HRM practices seems to be a significant improvement compared to general training – low HRM (0.076 for 2004, 0.046 for 2003). This affirms knowledge-based view's assumption that firm-specific knowledge is a better basis for a sustained competitive advantage. Furthermore, the implementation of more than two HRM measures enhances general training's productivity impact significantly (0.163 for 2004, 0.168 for 2003). Last but not least, the HRM activity bundle of more than two measures has the highest positive, significant impact when it is combined with both training forms. Hence, one could conclude that complementary relationships between both training forms and HRM practices and furthermore, between firm-specific and general training exist ( $0.243 > 0.163$ ).

When taking the interaction effect firm-specific training – low HRM as reference category and shifting to the combination firm-specific training – high HRM a positive, however again insignificant improvement regarding firm-specific's productivity impact can be stated.

In the next step, single HRM practices are interacted with the different training forms in order to find positive respectively negative influencing HRM factors and thus, allowing the



generation of meaningful bundles. Firstly, general training – low HRM is taken as reference category.

Table 4: endogenous variable: lnY04 (lnY03), reference category: general training – low HRM

	Clients' relationships	No clients' relationships	Reorganization	No Reorganization	Delegation	No Delegation	Profit Centre	No Profit Centre	Teamwork	No Teamwork
Firm-specific training only	0.221 (0.034) N = 31	0.075* (0.056*) N = 210	0.158 (0.103) N = 36	0.056* (0.427*) N = 205	-0.034 (-0.105) N = 29	0.075* (0.070*) N = 212	0.593 (0.18) N = 1	0.043* (0.041*) N = 23	-0.026 (-0.204) N = 1	0.071* (0.067*) N = 22
General training only	0.038* (0.057*) N = 125	n.n. N = 732	0.048* (0.0336*) N = 122	n.n. N = 735	-0.007* (0.043*) N = 89	n.n. N=768	-0.015 (-0.017) N = 33	n.n. N= 824	0.023 (0.066) N = 51	n.n. N= 806
Both training forms	0.098** (0.094**) N = 618	0.042** (0.038**) N = 2017	0.159** (0.174**) N = 903	0.031** (0.017**) N = 1732	-0.026** (-0.015**) N = 487	0.053** (0.051**) N = 2148	0.072* (0.063*) N = 278	0.043** (0.037**) N = 2357	-0.025* (-0.031*) N = 280	0.052** (0.048**) N = 2355

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2003-2004), own calculations

Continuation Table 4:

	Quality Management	No Quality Management	Low Fluctuation	High Fluctuation	Material Incentives	No Material Incentives	Work council	No work council
Firm-specific training only	0.003 (-0.027) N = 69	0.107* (0.094*) N = 172	0.291 (0.199) N = 27	0.042* (0.033*) N = 214	0.23 (0.228) N = 45	0.063* (0.031*) N = 196	0.158 (0.076) N = 72	0.099* (0.099*) N = 169
General training only	0.053* (0.051*) N = 232	n.n. N = 625	0.052* (0.047*) N = 93	n.n. N =764	0.156* (0.092*) N = 118	n.n. N = 739	0.164* (0.142*) N = 222	n.n. N = 635
Both training forms	0.088** (0.031**) N = 1310	0.071** (0.064**) N = 1325	0.161** (0.133**) N = 734	0.036** (0.031**) N = 1901	0.238** (0.217**) N = 742	0.038** (0.023**) N = 1893	0.221* (0.194**) N = 1515	0.053** (0.044**) N = 1120

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2003-2004), own calculations

With general training – no clients’ relationships (or one of the other single HRM measures) as reference category some positive (clients’ relationships, reorganization, profit centre, low fluctuation, material incentives, work councils) and negative effects (delegation, teamwork, quality management in the short run) can be identified, however all of them are insignificant again (see also Table 2). The same happens when bundling these positive (but insignificant) measures (see Table 5).

However, as above the same interesting conclusions regarding the effects of the HRM practices on general training can be found. Clients’ Relationships, reorganization, teamwork, quality management, low fluctuation, material incentives and work councils seem to have a positive significant, delegation and profit centre a significant negative impact on general training. Apart from delegation and teamwork all HRM measures have again the highest significant productivity improvement when interacted with both training forms. Therefore, the above mentioned assumption of a complementary relationship between both training forms and HRM practices as well as between both training forms themselves seems to be corroborated.

Table 5: endogenous variable: lnY04 (lnY03), reference category: general training – low HRM, bundles of selected HRM measures (clients’ relationships, reorganization, profit centre, low fluctuation, material incentives, work council).

	High HRM (more than two)	Low HRM (less than three)
Firm-specific training only	0.402 (0.304) N = 22	0.120* (0.086*) N = 108
General training only	0.143* (0.144*) N = 66	n.n. N = 371
Both training forms	0.349** (0.326**) N = 826	0.118** (0.107**) N = 1243

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2003-2004), own calculations

### Panel estimation results

Regarding the panel estimation different results can be identified. Again firstly, all HRM practices are interacted with the different training forms, the combination general training – few HRM measures serves as reference category. Analogous to the cross section estimation, an only insignificant improvement can be stated when switching to firm-specific training – many HRM practices. Interestingly, the positive effects of HRM practices found in the cross

section estimation turn out to be negative in the panel estimation. Finally, the complementary relationship between both training forms and a bundle of HRM activities cannot be stated any longer.

Table 6: endogenous variable: average firm-specific fixed effect, reference category: general training – low HRM, bundled HRM measures.

	High HRM (more than two)	Low HRM (less than three)
Firm-specific training only	0.026 N = 45	0.182 N = 109
General training only	-0.027* N = 152	n.n. N = 367
Both training forms	-0.082* N = 1291	-0.058* N = 951

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2002-2005), own calculations

Regarding the single HRM measures interacted with the training forms, no significant effect concerning the change to firm-specific or general training can be found. However, some HRM measures seem to enhance at least the productivity effect of both training forms together (see clients' relationships and reorganization) which is in analogy to the cross section results. By contrast, delegation, profit centre, teamwork, quality management, low fluctuation, material incentives and work councils seem to have a negative impact on the impact of both training forms.

Table 7: endogenous variable: average firm-specific fixed effect, reference category: general training – low HRM.

	Clients' relationships	No clients' relationships	Reorganization	No Reorganization	Delegation	No Delegation	Profit Centre	No Profit Centre	Teamwork	No Teamwork
Firm-specific training only	0.019	0.252	0.039	0.253	0.0144	0.218	0.186	0.192	0.435	0.189
General training only	0.201	n.n.	0.073	n.n.	0.021	n.n.	0.166	n.n.	0.307	n.n.
Both training forms	0.056*	0.044*	0.125*	0.0001*	-0.041*	0.024*	-0.024	0.018*	-0.513	0.044*

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2002-2005), own calculations

Continuation Table 7:

	Quality Management	No Quality Management	Low Fluctuation	High Fluctuation	Material Incentives	No Material Incentives	Work council	No work council
Firm-specific training only	0.131	0.274	0.273	0.195	0.289	0.177	-0.025	0.175
General training only	0.120	n.n.	0.213	n.n.	0.026	n.n.	-0.172	n.n.
Both training forms	0.011*	0.064*	-0.021*	0.040*	-0.013*	0.022*	-0.100*	-0.033*

Levels of significance are represented by stars: \* significance under 10%, \*\* under 5%, \*\*\* under 1%

Source: IAB Establishment Panel (wave 2002-2005), own calculations

The panel estimation results are quite surprising and partly contradict the cross section conclusions. Possible reasons could be biases due to measurement mistakes of capital (which have a larger effect on the two-step panel estimation than on the cross section analysis) or inconsistencies of the within estimation (used in the first step) in case of a simultaneous choice of the input variables (capital and labour) and output. Further research shall reduce these problems.

## 7. Conclusion and further research

This paper is motivated by the contradictory relationship between knowledge-based theory and empiricism regarding the productivity effects of firm-specific training. Regarding knowledge sharing barriers it becomes apparent that Human Resource Management can take several actions in order to lower these barriers and thus enhancing the impact of firm-specific training on firm's productivity. This thesis is tested empirically by introducing mutually exclusive HRM-training bundles in the estimation equations.

The cross-section results show that neither single measures nor bundles of the Human Resource Management practices can enhance the productivity effect of firm-specific training significantly. However, the results gave a hint that at least complementary relationships between general and specific training and between both training forms and a bundle of HRM activities exist. Another interesting implication is that the productivity impact of general training can be improved by introducing HRM activities. Therefore, the cross section results

suggest that it is recommendable to implement measures like quality management, material incentives (employee share ownership or profit sharing) or employment security in order to exploit the complementary effects between these practices and general as well as general and specific training.

In further research several improvements regarding variable definition and estimation technique are planned. In order to improve the estimated coefficients of capital and labor (labor should account for  $2/3^{\text{rds}}$  of value added (here output), capital  $1/3^{\text{rd}}$ ) and to lower possible measurement mistakes of capital the perpetual inventory method (see HEMPELL 2005) will be used. Furthermore, a system GMM estimator should complement the within estimator in the first step of the panel regression. On the one hand, the within estimator can handle the correlation between the firm-specific fixed effect of the error term and the choice of capital respectively labour. On the other hand, however, it becomes inconsistent (upward bias) when the input variables (capital and labour) and output are chosen simultaneously (see BLACK/LYNCH 2001: 441f). Therefore, the system generalized method of moments (system GMM, see ARENALLO/BOVER 1995) should be used. As it 'uses the lagged first differences as instruments for the current input values in levels in addition to the usual lagged levels as instruments for the equations in first differences' (ZWICK 2005: 166) it corrects for simultaneity of inputs and outputs, can take account of unobservable time-invariant fixed effects, corrects for biases resulting from measurement errors in the dependent and independent variables, and avoids endogeneity of the input factors (see ZWICK 2005: 166, DEARDEN ET AL. 2000: 25f, ARENALLO/BOVER 1995). Hence, the system GMM will ensure better results in further research.

## Literature

- Acemoglu D./Pischke J.-S. (1999). Beyond Becker: Training in Imperfect Labour Markets. In: *Economic Journal* 109, pp. 112 – 143.
- Antoni C.H. (1999). Konzepte der Mitarbeiterbeteiligung: Delegation und Partizipation. In: Graf Hoyos C./Frey D. (Hrsg.): *Arbeits- und Organisationspsychologie: ein Lehrbuch*. Weinheim. S. 537 – 557.
- Aoki M. (1988). *Information, Incentives and Bargaining in the Japanese Economy*. New York: Cambridge University Press.
- Aranello M./Bover O. (1995). Another Look at the Instrumental Variable Estimation of Error-Components Models. In: *Journal of Econometrics*, Vol. 68, pp. 29 – 51.
- Backes-Gellner U./Lazear E.P./Wolff B. (2001). *Personalökonomik: Fortgeschrittene Anwendungen für das Management*. Stuttgart.
- Backes-Gellner U./Frick B./Sadowski D. (1997). Codetermination and Personnel Policies of German Firms: The Influence of Works Councils on Turnover and Further Training. In: *International Journal of Human Resource Management*, Vol. 8, pp. 328 – 347.
- Bain J. (1956). *Barriers to New Competition*. Cambridge.
- Baker G./Gibbons R./Murphy K.J. (1994). Subjective Performances Measures in Optimal Incentive Contracts. In: *Quarterly Journal of Economics*, November 1994, 108(8), pp. 1125 – 1156.
- Ballot G./Fakhfakh F./Taymaz E. (2001). Firms' human capital, R&D and performance: a study on French and Swedish firms. In: *Labour Economics*, Vol. 8, Issue 4, September 2001, pp. 443 – 462.
- Barney J. (1991). Firm Resources and Sustained Competitive Advantage. In: *Journal of Management*, Vol. 17, No. 1, pp. 99 – 120.
- Barrett A./O'Connell P. (2001). Does Training Generally Work? The Returns to In-Company Training. In: *Industrial and Labour Relations Review* 54, pp. 647 – 662.
- Bartel A. (2000). Measuring the Employer's Return on Investments in Training: Evidence from the Literature. In: *Industrial Relations*, Vol. 38, No. 3, p. 502 – 524.
- Bartel A.P. (1995). Training, Wage Growth, and Job Performance: Evidence from a Company Database. In: *Journal of Labour Economics*, 13(3), pp. 401 – 425.
- Bartel A. (1994). Productivity Gains from the Implementation of Employee Training Programs. In: *Industrial Relations*, Vol. 33, No. 4, pp. 411 – 425.
- Bartel A. (1992). *Productivity Gains from the Implementation of Employee Training Programs*. Working Paper No. 3893. National Bureau of Economic Research, Cambridge, MA.
- Bartel A. (1989). *Formal Employee Training Programs and Their Impact on Labour Productivity: Evidence from a Human Resource Survey*. Working Paper No. 3026. National Bureau of Economic Research, Cambridge, MA.
- Bauer T.K. (2003). *Flexible Workplace Practices and Labor Productivity*. IZA Bonn and CEPR. Discussion Paper No. 700.
- Becker G.S. (1993). *Human Capital. A Theoretical and Empirical Analysis with Special Reference to Education*. 3<sup>rd</sup> edition. Chicago and London.

- Beckmann M. (2004). *Betriebliche Personalpolitik im technologischen und organisatorischen Innovationsprozess*. München und Mering.
- Bellmann L. (1997). *The EAB-Establishment Panel with an Exemplary Analysis of Employment Expectations*. IAB Topics No. 20 IAB, Nürnberg.
- Bellmann L./Büchel F. (2001). Betrieblich finanzierte Weiterbildung und Unternehmenserfolg. In: Backes-Gellner U./Moog P. (eds.): *Bildungssystem und betriebliche Beschäftigungsstrategien*. Berlin, S. 75 – 92.
- Bellmann L./Kohaut S./Kühl J. (1994). Enterprise Panels and the Labour Market: Using Enterprise Panels to Meet the Needs of the White Paper. In: Ojo E. (ed.): *Enterprise Panels and the European Commission's White Paper*, Luxembourg, pp. 57 – 74.
- Benz M. (2000). Partizipation und Kommunikation als Motivatoren. Wie Unternehmen implizite Arbeitsverträge verbessern können. In: *Zeitschrift Führung + Organisation (zfo)*, Jg. 69, Heft 1. S. 92 – 96.
- Bishop J. H. (1991). On-the-Job Training of New Hires. In: Stern D./Ritzen J. (eds.): *Market Failure in Training?* New York, pp. 61 – 98.
- Black S./Lynch L. (2001). How to Compete: The Impact of Workplace Practices and Information Technology on Productivity. In: *The Review of Economics and Statistics* 83, pp. 434 – 445.
- Black S./Lynch L. (1997). *How to Compete: The Impact of Workplace Practices and Information Technology on Productivity*. National Bureau of Economic Research, Working Paper No. 6120.
- Black S./Lynch L. (1996). Human Capital Investments and Productivity. In: *American Economic Review* (Papers & Proceedings) 86, pp. 263 – 267.
- Blanchflower D./Lynch L.M. (1992). *Training at work: a comparison of US and British youths*. London School of Economics, Centre for Economic Performance, Discussion Paper No. 78.
- Booth A. (1993). Private sector training and graduate earnings. In: *Review of Economics and Statistics*, 75, pp. 164 – 170.
- Breshnahan T.F./Brynjolfsson E./Hitt L.M. (2000). Technology, Organization, and the Demand for Skilled Labor. In: Blair M.M./Kochan T.A. (ed.): *The New Relationship. Human Capital in the American Corporation*. Washington D.C., pp. 145 – 193.
- Büchel F./Pannenberg M. (2004). Berufliche Weiterbildung in West- und Ostdeutschland: Teilnehmer, Struktur und individueller Ertrag. In: *Zeitschrift für Arbeitsmarktforschung (ZAF)*, 2. S. 72 – 126.
- Bundesministerium für Bildung und Forschung BMBF (2006) (Hrsg.): *Berichtssystem Weiterbildung IX. Integrierter Gesamtbericht zur Weiterbildungssituation in Deutschland*. Bonn, Berlin.
- Bundesministerium für Bildung und Forschung BMBF (2005) (Hrsg.). *Berichtssystem Weiterbildung IX. Ergebnisse der Repräsentativbefragung zur Weiterbildungssituation in Deutschland*. Bonn, Berlin.
- Bundesministerium für Bildung und Forschung BMBF (2003) (Hrsg.): *Berichtssystem Weiterbildung VIII. Integrierter Gesamtbericht zur Weiterbildungssituation in Deutschland*. Bonn.

- Campbell D.F./Güttel W.H. (2005). Knowledge production in firms: research networks and the “scinetification” of business R&D. In: *International Journal of Technology Management*, Vol. 31, pp. 152 – 175.
- Carmichael H.L./MacLeod W. B. (1993). Multitasking, Technical Change, and the Japanese Firm. In: *The Economic Journal*, January 1993, 103(416), pp. 142 – 160.
- Comelli G./v. Rosenstiel L. (1995). *Führung durch Motivation. Mitarbeiter für Organisationsziele gewinnen*. München.
- Crozier M./Friedberg E. (1993). *Die Zwänge kollektiven Handelns: Über Macht und Organisation*. Frankfurt a. M.
- Davenport T.H./Prusak L. (1998) *Wenn Ihr Unternehmen wüsste, was es alles weiß...: das Praxisbuch zum Wissensmanagement*, Landsberg am Lech.
- Dearden L./Reed H./van Reenen J. (2000). *Who Gains When Workers Train? Training and Corporate Productivity in a Panel of British Industries*. IFS Working Paper No. 00/01, London.
- Dierickx I./Cool K. (1989). Asset stock accumulation and sustainability of competitive advantage. In: *Management Science*, Vol. 35, No. 12, pp. 1504 – 1511.
- Drucker P. (1994). *Post-Capitalist Society*. New York.
- Faulstich P. (1998). *Strategien der betrieblichen Weiterbildung: Kompetenz und Organisation*. München.
- Fehr E./Falk A. (2002). Psychological foundations of incentives. In: *European Economic Review*, Vol. 46, pp. 687 – 724.
- Fehr E./Gächter S. (2002). Altruistic punishment in humans. In: *Nature*, Vol. 415, 10, pp. 137 – 140.
- Föhr S./Lenz H. (1992). Unternehmenskultur und ökonomische Theorie. In: Staehle W.H./Conrad P. (Hrsg.): *Managementforschung 2*. Berlin, New York. S. 111 – 162.
- Frazis H./Gittleman M./Horrigan M./Joyce M. (1997). Formal and Informal Training: Evidence from a Matched Employee-Employer Survey. In: Libecap G.D. (ed.): *Advances in the Study of Entrepreneurship, Innovation and Economic Growth*. Greenwich, England.
- Freeman R. B./Lazear E. P. (1995). An Economic Analysis of Works Councils. In: Rogers J./Streeck W. (eds.): *Works Councils: Consultation, Representation, and Cooperation in Industrial Relations*. Chicago: University of Chicago Press, pp. 27 – 52.
- Frey B.S./Osterloh M. (2000a). Motivation – der zwiespältige Produktionsfaktor. In: Frey B.S./Osterloh M. (Hrsg.): *Managing Motivation: Wie Sie die neue Motivationsforschung für Ihr Unternehmen nutzen können*. Wiesbaden. S. 19 – 42.
- Frey B.S./Osterloh M. (2000b): Motivation, Knowledge Transfer, and Organizational Forms. In: *Organization Science*, Vol. 11, No. 5. S. 538 – 550.
- Frey B.S./Osterloh M. (2000c). Pay for Performance – Immer empfehlenswert? In: *Zeitschrift für Führung und Organisation*, Vol. 69, No. 2, pp. 64 – 69.
- Frey B.S. (1997). *Not Just for the Money: an economic theory of personal motivation*. Cheltenham.
- Frick B./Sadowski D. (1995). Works Councils, Unions and Firm Performance: The Impact of Worker’s Participation in Germany. In: Buttler F./Franz W./Schettkat R./Soskice D.



- (eds.): *Institutional Frameworks and Labor Market Performance: Comparative Views on the U.S. and German Economies*, London, Routledge, pp. 46 – 81.
- Grant R.M. (1996). Toward a Knowledge-Based Theory of the Firm. In: *Strategic Management Journal*, Vol. 17, Special Issue: Knowledge and the Firm. S. 109 – 122.
- Griliches Z./Mairesse J. (1995). Production Functions: The Search for Identification. In: Strøm, S. (ed.): *Econometrics and Economic Theory in the 20<sup>th</sup> Century*, Cambridge: Cambridge University Press, S. 169 – 203.
- Güttel W.H. (2007). Wissenstransfer in Organisationen: Koordinationsmechanismen und Anreizsysteme als Gestaltungsparameter. In: *zfbf – Zeitschrift für betriebswirtschaftliche Forschung*, Juni, pp. 465 – 486.
- Hamel G./Prahalad C. (1997). *Wettlauf um die Zukunft*. 2. Auflage. Wien.
- Hempell T. (2005). What's spurious, what's real? Measuring the productivity impacts of ICT at the firm-level. In: *Empirical Economics*, Vol. 30, pp. 427 – 464.
- Holmstrom, B. (1982). Moral Hazard in teams In: *The Bell Journal of Economics*, Vol. 13, No. 2, pp. 324 – 340.
- Holmstrom, B./Milgrom P. (1994). The Firm as an Incentive System. In: *American Economic Review*, September 1994, 84(4), pp. 972 – 991.
- Holmstrom B./Milgrom P. (1991). Multi-Task Principal Agent Analyses: Incentive Contracts, Asset Ownership and Job Design. In: *Journal of Law, Economics and Organizations*, Vol. 7. S. 24 – 52.
- Holzer H./Block R./Cheatham M./Knott J. (1993). Are Training Subsidies for Firms Effective? The Michigan Experience. In: *Industrial and Labor Relations Review* 46(July), pp. 625 – 636.
- Huselid M. (1995). The Impact of Human Resource Management Practices on Turnover, Productivity, and Corporate Financial Performance. In: *Academy of Management Journal* 38 (June), pp. 636 – 672.
- Huselid M./Becker B.E. (1996). Methodological Issues in Cross-Sectional and Panel Estimates of the Human Resource-Firm Performance Link. In: *Industrial Relations*, Vol. 35, No. 3 (July), pp. 400 – 422.
- Ichniowski C./Shaw K./Prennushi G. (1997). The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines. In: *The American Economic Review* (87), June 1997, pp. 291 – 313.
- Ichniowski C./Shaw K./Prennushi G. (1995). *The Effects of Human Resource Management Practices on Productivity*. National Bureau of Economic Research, Working Paper 5333.
- Jovanovic B. (1979). Job matching and the theory of turnover. In: *Journal of Political Economy*, Vol. 87. S. 972 – 990.
- Kandel E./Lazear E.P. (1992). Peer pressure and partnership. In: *Journal of Political Economy*, Vol. 100, pp. 801 – 817.
- Kaplan R./Norten D.P. (1996). *The balanced scorecard*. Bosten: Harvard Business School Press.
- Katz R./Allen T.J. (1988). Investigating the Not Invented Here (NIH) Syndrome: A Look at the Performance, Tenure, and Communication Patterns of 50 R&D Project Groups. In: Tushman M.L./Moore W.L. (Hrsg.): *Readings in the Management of Innovation*. 2. edition. New York. pp. 293 – 309.

- Kleiner M./Bouillon M. (1988). Providing Business Information to Production Workers: Correlates of Compensation and Profitability. In: *Industrial and Labor Relations Review*, July 1988, 41(4), pp. 605 – 617.
- Kölling A. (2000). The IAB-Establishment Panel. In: *Applied Social Science Studies*, 120(2), pp. 291 – 300.
- Kogut B./Zander U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, 3, pp. 383 – 397.
- Kräkel M. (2004). *Organisation und Management*. 2. Auflage. Tübingen.
- Krueger A./ Rouse C. (1998),. The Impact of Workplace Education on Earnings, Turnover and Job Performance. In: *Journal of Labour Economics*, Vol. 16(January), pp. 61 – 94.
- Kruse D.L. (1993). *Profit sharing: Does it make a difference?* Kalamazoo, MI: Upjohn Institute.
- Kuckulenz A./Zwick T. (2003). *The Impact of Training on Earnings – Differences between Participant Groups and Training Forms*. ZEW Discussion Paper No. 03-57.
- Lazear E.P. (1998). Salaries and piece rates. In: *Journal of Business*, Vol. 59. S. 405 – 431.
- Lullies V./Bollinger H./Weltz F. (1993). *Wissenslogistik. Über den betrieblichen Umgang mit Wissen bei Entwicklungsvorhaben*. Frankfurt a. M.
- Lynch L./Black S. (1997). *Beyond the Incidence of Training*. London School of Economics, Centre of Economic Performance. Discussion Paper No. 362.
- Lynch L.M. (1992). Private sector training and the earnings of young workers. In: *American Economic Review*, Vol. 82, pp. 299 – 312.
- MacDuffie J.P. (1995). Human Resource Bundles and Manufacturing Performance: Organizational Logic and Flexible Production Systems in the World Auto Industry. In: *Industrial and Labor Relations Review*, 48(2), pp. 197 – 221.
- Marquardt M./King S./Ershkine W. (2002). *International Comparisons: ASTD's Annual Accounting of Worldwide Patterns in Employer-Provided Training*. Mimeo, Alexandria, VA.
- Maturana H./Pörksen B. (2002). *Vom Sein zum Tun: Die Ursprünge der Biologie des Erkennens*. Heidelberg.
- Müller-Stewens G./Lechner C. (2005). *Strategisches Management. Wie strategische Initiativen zum Wandel führen*. 3. Auflage. Stuttgart.
- Mintzberg H. (1983). *Power In and Around Organizations*. Englewood Cliffs.
- Milgrom P./Roberts J. (1995). Complementarities and Fit: Strategy, Structure, and Organizational Change in Manufacturing. In: *Journal of Accounting and Economics*, Vol. 19(2-3), pp. 179 – 208.
- Milgrom P./Roberts J. (1993): *Complementarities and Fit: Strategy, Structure and Organizational Change*. Manuscript
- Milgrom P./Roberts J. (1990). The Economics of Modern Manufacturing. In: *American Economic Review*, Vol. 80(3), pp. 511 – 528.
- Nonaka I./Takeuchi H. (1997). *Die Organisation des Wissens. Wie japanische Unternehmen eine brachliegende Ressource nutzbar machen*. Frankfurt a. M., New York.
- North K. (2002). *Wissensorientierte Unternehmensführung. Wertschöpfung durch Wissen*. 3. Auflage. Wiesbaden.

- OECD (1999). *Employment Outlook*. Paris: OECD.
- v. der Oelsnitz D./Hahmann M. (2003). *Wissensmanagement. Strategie und Lernen in wissensbasierten Unternehmen*. Stuttgart.
- Osterloh M./Frey B.S. (2005). Corporate Governance: Eine Prinzipal-Agenten-Beziehung, Team-Produktion oder ein soziales Dilemma. In: Schauenberg, B./Schreyögg G./Sydow J. (eds): *Institutionenökonomik als Managementlehre? Managementforschung 15*, Wiesbaden, pp. 333 – 364.
- Osterloh M./Frey B.S. (1999). *Motivation, Knowledge Transfer and Organizational Form. Institute for Empirical Research in Economics*. University of Zurich, Working Paper Series 1424-0459.
- Osterloh M./Frost J. (2000). Motivation und Wissen als strategische Ressource. In: Frey B.S./Osterloh M. (Hrsg.): *Managing Motivation: Wie Sie die neue Motivationsforschung für Ihr Unternehmen nutzen können*. Wiesbaden. S. 44 – 68.
- Osterman P. (1995). Skill, Training and Work Organization in American Establishments. In: *Industrial Relations*, Vol. 34, No. 2, pp. 125 – 146.
- Penrose E. (1959). *Theory of the Growth of the Firm*. London.
- Peteraf A. (1993). The cornerstones of competitive advantage: A resource-based view. In: *Strategic Management Journal*, Vol. 14, pp. 179 – 191.
- Phillips J.J. (1994). *Measuring Return on Investment*, Vol. 1, Alexandria, VA.
- Picot A./Reichwald R./Wigand R. (2001). *Die grenzenlose Unternehmung. Information, Organisation und Management*. 4. Auflage. Wiesbaden.
- Picot A./Dietl H./Franck E. (1997). *Organisation: eine ökonomische Perspektive*. Stuttgart.
- Pieler D. (2003). *Neue Wege zur lernenden Organisation*. 2. Auflage. Wiesbaden.
- Pine J./Tingley J.C. (1993). ROI of Soft-Skills Training. In: *Training* (February), pp. 55 – 60.
- Porter M. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York.
- Porter M. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York.
- Prahalad C.K./ Hamel G. (1990). The Core Competence of the Corporation. In: *Harvard Business Review*, No. 3, pp. 79 – 93.
- Prange C. (2002). *Organisationales Lernen und Wissensmanagement. Fallbeispiele aus der Unternehmenspraxis*. Wiesbaden.
- Probst G.J./Büchel B.S. (1994). *Organisationales Lernen. Wettbewerbsvorteil der Zukunft*. Wiesbaden.
- Reinmann-Rothmeier G./Mandl H. (2000). *Individuelles Wissensmanagement: Strategien für den persönlichen Umgang mit Information und Wissen am Arbeitsplatz*. Bern u.a.
- v. Rosenstiel L. (1999). Motivationale Grundlagen von Anreizsystemen. In: Bühler W./Siegert T. (Hrsg.): *Unternehmenssteuerung und Anreizsysteme*. Stuttgart. S. 44 – 77.
- Rumelt R.P. (1984). Toward a strategic theory of the firm. In: Lamb R. (ed.), *Competitive Strategic Management*. New York, pp. 556 – 570.
- Russell R.H. (1996). Providing Access: The Difference Between Sharing and Just Reporting Corporate Information. In: *Information Strategy*. S. 28 – 33.

- Schein E.H. (1995). *Unternehmenskultur: ein Handbuch für Führungskräfte*. Frankfurt a.M., New York.
- Schein E.H. (1985). *Organizational Culture and Leadership*. San Francisco u.a.
- Schnedler W. (2001). Kooperation, Verantwortung und Leistungsentlohnung: Eine empirische Untersuchung. In: Backes-Gellner U./Kräkel M./Sadowski D./Mure J. (Hrsg.). *Entlohnung, Arbeitsorganisation und personalpolitische Regulierung*. Beiträge zum 4. Köln-Bonner Kolloquium zur Personalökonomie. München und Mering.
- Schüppel J. (1996). *Wissensmanagement: organisatorisches Lernen im Spannungsfeld von Wissens- und Lernbarrieren*. Wiesbaden.
- Seidel M. (2003). *Die Bereitschaft zur Wissensteilung. Rahmenbedingungen für ein wissensorientiertes Management*. München/Wiesbaden.
- Senge P.M. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York u.a.
- Spender J.-C./ Grant R.M. (1996). Knowledge and the firm: overview. In: *Strategic Management Journal*, Vol. 17 (Winter Special Issue). S. 5 – 9.
- Stewart T. (1998). *Der vierte Produktionsfaktor. Wachstum und Wettbewerbsvorteile durch Wissensmanagement*. München.
- Sveiby K.E. (1997). *The New Organizational Wealth*. San Francisco.
- Szulanski G. (1996). Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm. In: *Strategic Management Journal*, Vol. 17, Special Issue: Knowledge and the Firm, pp. 27 – 43.
- Tan H.W./Batra G. (1995). *Enterprise Training in Developing Countries: Incidence, Productivity Effects and Policy Implications*. Unpublished Paper. The World Bank.
- Teece D.J./Pisano G./Shuen A. (1997). Dynamic capabilities and strategic management. In: *Strategic Management Journal*, Vol. 18, No. 7, pp. 509 – 533.
- U.S. Department of Labor. 1993. *High performance work practices and firm performance*. Washington D.C.: U.S. Government Printing Office.
- Vicari S./v. Krogh G./Roos J./Mahnke V. (1996). Knowledge Creation through Cooperative Experimentation. In: v. Krogh G./Roos J. (Hrsg.): *Managing Knowledge: Perspectives on cooperation and competition*. London, pp. 184 – 202.
- Warnecke H.-J. (1993). *Revolution der Unternehmenskultur – Das Fraktale Unternehmen*. 2. Auflage. Berlin.
- Wellins R.S./Byham W.C./Wilson J.M. (1991). *Empowered teams: creating self-directed work groups that improve quality, productivity and participation*. San Francisco.
- Wenger E./Snyder W. (2000). Communities of Practice: The organizational frontier. In: *Harvard Business Review*, January-February, pp. 139 – 145.
- Werner, Dirk (2006). Trends und Kosten der betrieblichen Weiterbildung – Ergebnisse der IW-Weiterbildungserhebung 2005. In: *IW-Trends – Vierteljahresschrift zur empirischen Wirtschaftsforschung aus dem Institut der deutschen Wirtschaft Köln*, 33. Jahrgang, Heft 1/2006. Köln.
- Wernerfelt B. (1989). From critical resources to corporate strategy. In: *Journal of General Management*, Vol. 14, pp. 4 – 12.

- Wernerfelt B. (1984). A resource based view of the firm. In: *Strategic Management Journal*, Vol. 5, No. 2, pp. 171 – 180.
- Whitfield K. (2000). High-Performance Workplaces, Training, and the Distribution of Skills. In: *Industrial Relations*, Vol. 39, No. 1, pp. 1 – 25.
- Willke H. (2001). *Systemisches Wissensmanagement*. 2. Auflage. Stuttgart.
- Winkelmann R. (1994). *Training, Earnings and Mobility in Germany*. Centre of Economic Policy Research, Discussion Paper, No. 982.
- Wolf E./Zwick T. (2003). Welche Personalmaßnahmen entfalten eine Produktivitätswirkung? In: *Zeitschrift für Betriebswirtschaft* 73, H. 4, S. 43 – 62.
- Zwick T. (2005). Continuing Vocational Training Forms and Establishment Productivity in Germany. In: *German Economic Review* 6(2), pp. 155 – 184.
- Zwick T. (2004a). Weiterbildungsintensität und betriebliche Produktivität. In: *ZfB – Zeitschrift für Betriebswirtschaft*, 74. Jhg., H. 7, S. 651 – 668.
- Zwick T. (2004b). Training – A Strategic Enterprise Decision? In: Fandel G./Backes-Gellner U./Schlüter M./Staufenbiel J. (Hrsg.): *Modern Concepts of the Theory of the Firm – Managing Enterprises of the New Economy*, Heidelberg, Springer-Verlag, S. 355 – 366.