

Production processes, tasks and skill requirements and their influence on the costs of apprenticeship training

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Short Abstract

The paper analyzes the relationship between production processes, skill requirements and tasks and the apprenticeship training costs of firms. In the first part of the paper, we argue that a restructuring of production and work within firms took place since the middle of the 1990s. The restructuring process induced a change of tasks to be carried out by skilled workers and consequently led to a modification of the skill requirements. Today, especially in larger companies, fewer tasks are to be carried out and those tasks remaining are narrowly defined. This change had an influence on how firms train their apprentices: Apprentices spend more time at the workplace and less in internal courses and company training center. Consequently, the apprentices' productive contributions to output increased leading to lower net-costs of training. In the second part of the paper, we make use of two data sets of the cost-benefit-surveys (CBS) of the Federal Institute of Vocational Education and Training (BIBB) of the years 2000 and 2007 to test this hypothesis empirically. Using regression and matching techniques we show that apprentices indeed spend more time with productive activities and less time with internal courses and practicing in company training center. We further show that this change in training organization is the major reason for the decrease of net-costs of apprenticeship training between the years 2000 and 2007 in Germany.

Production processes, tasks and skill requirements

In the 1980s and in the first half of the 1990s there was a shift away from a "tayloristic" organization of work characterized by a high specialization according to tasks, towards a more "holistic" organization of work containing job enrichment, job rotation and use of multiple skills (see Linbeck and Snower, 1999; Hammer and Champy, 1993; Pfeifer, 1994; European Foundation, 1997, 1998; OECD 1996). Since the second half of the 1990s, however, another important shift in work organization and production processes took place (see Neubäumer and Tretter, 2008; Blanpain, 1999; Kalleberg, 2003; Klobes 2005; Nienhüser and Baumhus, 2002; Lacher, 2007). The driving forces behind this renewed change were:

- A highly increased cost pressure
- An internationalization of production processes
- Increased necessity of flexibility due to faster technological progress, shorter product cycles and more individual treatment of customers
- Advances in information technologies.

The change, which became relevant in several economic sectors reaching from manufacturing to the service sector, can be characterized by three interrelated developments:

- "Retaylorization"

- Decentralization
- Standardization.

Companies *intensified their division of labour* to increase their productivity and, by this mean, to meet the high cost pressure imposed by globalization. They had to weigh the returns of specialization against the costs of coordinating the activities of different employees (see e.g. Becker and Murphy, 1992; Bolton and Dewatripont, 1994). The decrease of the latter, due to improved computerized information and communication systems led to greater specialization.¹

The process of specialization did not only take place within plants but for the first time also between different production sites of the same company (see Klobes, 2005; Martin and Nienhüser, 2002b; Matiaske and Kabst, 2002). This "*new decentralization*" (see Drumm, 1996) was observed both in the manufacturing and in the service sector (see Baethge 2006). Especially in the latter, a form of "*decentralized centralization*" was common practice (e.g. an insurance company centralized DP, charging contributions, settling claims and call centres at different locations).

Finally, the process of restructuring demanded *standardization* of work proceedings (see Buch, 2006; Baethge, 2006) and led to world-wide "holistic" production concepts (e.g. in the automobile industry, in banks and auditing companies). The implementation of these standardized organizational and production concepts was a result of more flexible and hence more complex production processes. The idea was to gain "process security", i.e. to avoid faults by detailed specifications of tasks and processes (Lacher, 2006, 2007).

The evidence for this organizational change of production and work in Germany consists of a large number of case studies showing that tasks and skill requirements changed too (see e.g. Baethge, 2004, 2006; Clement and Lacher, 2006a, 2006b; Pechar, 2006; Lacher, 2007).

From the change of tasks to the change of training costs

The restructuring processes especially led to:

- A greater heterogeneity of tasks and skill requirements
- Less need for general and firm-specific expert knowledge and more need for social and communicative competence
- A change in the training behavior of firms.

Specialization and standardization had the effect that today many skilled employees, especially in large companies, have fewer different tasks and that their tasks are more narrowly defined than in the past. These employees have skilled routine jobs, working in groups (case studies for automotive manufacture, machine and plant construction, electrical industry, insurances, banks; see e.g. Baethge, 2006; Lacher, 2007; Zeller, 2007). Accordingly, the skill requirements for these jobs changed, shifting away from general and firm-specific knowledge towards social and communicative competence to work in teams and deal with customers. Further, an overview of the production processes is needed (see Clement and Lachner, 2006b).

On the other hand, some employees need to carry out an increasing number of different tasks and require multiple skills. An indicator for these increasing disparities in skill requirements is the change of work groups. Homogeneous teams, where "everybody can do everything", were often displaced by heterogeneous teams (e.g. a team leader, a team member for repair, another member for quality control and ordinary team members).

¹ An empirical indicator for this is the shortening of cycle time from 5 minutes at the beginning of the 1990s to 1 minute at present (see Jürgens, 2006; p. 19).

Our hypothesis is that the organizational change of production and work and the resulting alteration of tasks and skill requirements led to a modification of firms' training behavior and a reduction in the costs of training. Apprentices sooner are instructed at the workplaces, being assigned a small number of different tasks with lower skill requirements and less accident-sensitive production processes due to "process security" (see Lay, 2006; Loebe and Seering, 2005; Rauner, 2008). Furthermore, apprentices can learn "in the process" and can improve their social and communicative competence on the job. On the other side, time spend in internal courses and in company training centres is reduced, since skill requirements of apprentices are more narrowly defined and best trained through working practice.

Empirical Analysis

For our empirical analysis we use two data-sets of the BIBB-Cost-Benefit-Surveys (BIBB-CBS) for the reference years 2000² and 2007³. In each survey close to 3000 training firms were interviewed with respect to costs and benefits of their apprenticeship training. Using a "cost model", we differentiate between gross costs, benefits and net costs. Gross costs consist of wage costs for apprentices and trainers, expenses for material, infrastructure, external courses and cost for hiring and administration of apprentices. Benefits are calculated using an equivalence approach, i.e. those times apprentices spend with either unskilled or skilled productive work are multiplied with the wage of unskilled or skilled workers, respectively. Since the skilled work carried out by apprentices is usually not yet at the same level as the work carried out by already fully trained workers we use a performance measure given by the firm to adjust the benefits stemming from apprentices' skilled work. Net-costs of apprenticeship training are then the gross-costs minus the benefits. The two surveys are highly comparable as they are based on the same concept. Only minor methodical changes were made⁴. The combined dataset consists of 5410 training firms, 2424 stemming from the 2000 CBS-survey and 2986 from the 2007 CBS-survey.

The empirical strategy consists of four steps. In a first step, differences in costs and benefits are compared descriptively. To assess whether the expected differences are robust with respect to the structural change, OLS-regressions are estimated. They include a dummy variable for the survey year and control variables as firm size, region (Eastern or Western Germany), economic sector or/and training vocation.

In a second, step a matching approach is used to analyze which factors of the cost model are responsible for the decrease in net-costs. Using a nearest-neighbor-matching (see Abadie et al., 2004) with the year as the treatment variable, we identify the treatment-effect of different parameters which we assume to be responsible for the cost reduction. These parameters can be categorized in three groups. First, we use variables determining the time apprentices spend with productive tasks. Especially the share of time at the workplace is of interest here. Second, parameters that could be used for the reduction in gross-costs, like hours of trainers, costs for training centers or external courses, are included in the analysis. The third group of parameters includes wages or wage costs. Note that rising wages play an important role in determining both gross costs (wages of full- and part-time-trainers) and benefits (wages for unskilled and skilled workers to calculate the productive contributions of apprentices). Thus, the impact of increasing wages on net-costs is not clear a priori.

Third, for each firm of the survey of 2000, the matched parameters are replaced by the estimated values (i.e. the values the firm would have if it was a firm surveyed in the year 2007). We recalculate the cost model for the firms of 2000 under conditions of 2007 (and vice versa) and identify the effect of the above parameters on gross-costs, benefits and net-costs.

² See Beicht et al. (2004).

³ See Schönfeld et al. (2010).

⁴ For information on the methodical changes see Schönfeld et al. (2010).

This method has been used by Dionisius et al. (2009) to analyze differences in net-costs between Germany and Switzerland. Finally, in the last step, OLS-regressions are estimated to check how much of the net-cost difference remains unexplained.

The main result of the econometric analysis is that firms in 2007 indeed train their apprentices differently than firms in 2000. The most important factor for explaining the net-cost difference between 2000 and 2007 is the time apprentices spend with productive tasks. This result goes hand in hand with the hypothesis that restructuring processes starting in the late 1990s induced a change of tasks and skill requirements, which in turn influenced the training organization and consequently the training costs of firms.