Working Paper No. 16

WHY DO FIRMS TRAIN APPRENTICES? THE NET COST PUZZLE RECONSIDERED

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UNIVERSITÄT BERN

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October 2008

Published as: "Why do firms train apprentices? The net cost puzzle reconsidered." Labour Economics, 16(2009)6: 631–637. By Jens Mohrenweiser and Thomas Zwick.
Available at: http://dx.doi.org/10.1016/j.labeco.2009.08.004

The Swiss Leading House on Economics of Education, Firm Behavior and Training Policies is a Research Programme of the Swiss Federal Office for Professional Education and Technology (OPET).

www.economics-of-education.ch

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Oktober 2008

ABSTRACT

This paper analyses the impact of replacing unskilled or semi-skilled employees by apprentices on establishment performance. We use representative matched employer–employee panel data and correct for different sources of estimation biases. We show that an increase of the proportion of apprentices in trade, commercial, craft or construction occupations has a positive impact on firm performance. In contrast, companies that increase the share of apprentices in manufacturing occupations face a negative impact on performance, however. These results shed a new light on the popular stylised fact that apprenticeship training always leads to net costs during the apprenticeship period: we argue that firms only hire apprentices at a cost if their skills are relatively specific, their retention rate is high and skilled employees are hard to hire.

JEL Classification: C33, D24, J24
Keywords: apprenticeship training, performance, panel estimation.

* This paper was supported by the Swiss Federal Office for Professional Education and Technology through its Leading House on Economics of Education, Firm Behaviour and Training Policies and by a grant of the German Research Foundation (DFG) "Heterogene Arbeit: Positive und normative Aspekte der Qualifikationsstruktur". We thank Uschi Backes-Gellner, Kathrin Göggel, Katja Görlitz, Simon Janssen, Matthias Kräkel, Samuel Mühlemann, Christian Pfeifer, Juerg Schweri, and Stefan Wolter for useful comments and the Research Data Centre (FDZ) of the Federal Employment Agency at the Institute for Employment Research (and here especially Peter Jacobebbinghaus) for the data access and the support with analysis of the LIAB data. The data basis of this publication is the Longitudinal Model (version 2) of the Linked Employer-Employee Data of the IAB (years 1997-2002). Data access was via guest research spells at FDZ and afterwards via controlled data remote access at the FDZ.

I. Introduction

The German dual apprenticeship system is often regarded as a potential model for other countries because it allows enterprises to provide and pay for training in specific and general human capital (Harhoff and Kane 1997; Acemoglu and Pischke 1999b; Steedman 2001). From an international perspective the apprenticeship system achieves high skill levels among young people who have not had a college–based education (Freeman and Schettkat 2001). It is also believed to lead to relatively low youth unemployment rates because it facilitates an orderly school-to-work transition (Ryan 2001).

In spite of these positive facts, the dual apprenticeship system seems to impose high costs on the training companies during the apprenticeship period and therefore forces these companies to invest in apprenticeship training. This is often seen as a competitive disadvantage for German companies facing increasing cost pressure in globalised markets. A frequently used argument is that enterprises are increasingly hesitant to accept net costs during the apprenticeship training period when they cannot be certain of retaining a sufficient number of apprenticeship graduates to earn these costs back after the training period. This is a cause for concern because it is a widely assumed stylised fact that enterprises necessarily incur net costs during the apprenticeship period. This stylised fact stems from an influential series of descriptive cross-section costs and benefits evaluations by the Federal Institute for Vocational Education and Training (Bundesinstitut für Berufsbildung - BIBB), which shows that almost all training companies incur sizeable net costs.

Since apprenticeships are unanimously considered to partly offer general skills, the assumption of inevitable net costs during apprenticeship training seems to be a puzzle which has motivated many theoretical studies to analyse market imperfections as a source of company-sponsored general training (Franz and Soskice 1995; Acemoglu and Pischke 1998; Acemoglu and Pischke 1999a; Kessler and Lülfelsmann 2006). Many empirical studies of the German

apprenticeship system also make the assumption of net costs without testing it (Harhoff and Kane 1997; Acemoglu and Pischke 1998; Dustmann and Schönberg 2004). While there seems to be an abundance of theoretical explanations for the stylised fact of net costs, the 'fact' itself has not been subjected to scrutiny, although it is one of the keys to understanding the dual apprenticeship system and to evaluating it by comparison to other training systems.

In this paper we therefore aim to reconsider the question whether German enterprises have to accept short-term disadvantages when they offer apprenticeships. In contrast to the descriptive costs and benefits evaluations we cannot directly measure the net costs of apprenticeship training during the apprenticeship period. We can however analyse the arguably more relevant question if establishments replacing unskilled or semi-skilled employees by apprentices face a reduction in their profits and how establishment productivity is affected. [1] This approach contributes to the existing literature in two ways. First, it replicates the decision of personnel managers to hire an apprentice instead of an unskilled or semi-skilled employee. Second, it takes into account the relevant factors for establishment performance and the endogeneity of the qualification shares as well as unobserved time invariant establishment heterogeneity we are able to identify the causal impact.

We show that replacing unskilled or semi-skilled employees by apprentices in trade, commercial, craft, and construction occupations has a positive impact on contemporary firm performance. The apprentices´ relative productivity balances out their relative cost and they are potential substitutes to unskilled or semi-skilled workers. In contrast, apprentices in manufacturing occupations have higher relative training costs in comparison to their benefits – contemporary establishment performance declines when their share on the employees increases after replacing unskilled or semi-skilled employees.

[1] The substitutability of apprentices to unskilled and semi-skilled workers is modelled and shown by Lindley (1975) and recently shown by Harhoff and Kane (1997) and discussed by Mohrenweiser and Backes-Gellner (2008) and Dionisius et al. (2008).

These results shed new light on discussions of the German apprenticeship system. The most important conclusion is that the system does not necessarily represent an anomaly, because enterprises do not accept net costs during apprenticeship training in which they provide general skills to apprentices who may potentially leave after the apprenticeship period. Apprentices in commercial and trade occupations, such as clerks, are sufficiently productive during their apprenticeship to make them competitive with respect to unskilled or semiskilled substitutes. These occupations require more general skills, ones that are applicable in different enterprises and industries. Further, apprentices in craft occupations, such as hairdressing or brick-laying, are also sufficiently productive to put them at an advantage with respect to unskilled or semiskilled employees during the apprenticeship. On the one hand these apprentices quickly realise productivity gains and on the other hand they receive relatively low wages (Wolter *et al*. 2006). Finally, manufacturing apprentices require a larger share of specific skills that take time to acquire. In addition, they earn substantially higher wages on average than apprentices in craft occupations. They can apply their skills only in a specific industry and they are often part of strong internal labour markets. Therefore, firms can afford to exempt their manufacturing apprentices from being competitive with respect to unskilled or semiskilled substitutes during the training period. Therefore our results demonstrate the efficiency of the dual apprenticeship system: it incurs a temporary performance disadvantage only for those companies in manufacturing occupations. Here firms have to invest in order to obtain adequately trained employees because these are not easily available on the labour market. Interestingly, in these occupations, companies train apprentices also in mostly school-based systems for vocational education – here Britain is an example (Ryan *et al.* 2007).

The remainder of this paper is structured as follows: first we present an overview of the discussion of whether establishments incur net costs during apprenticeship training (section 2). Then we describe our theoretical framework

(section 3) and our estimation approach (section 4). In the fifth section we discuss our data set and in the sixth section we present the results. The paper ends with a discussion of our results.

II. Costs and Benefits of Apprenticeship Training

There is a broad literature that singles out the dual apprenticeship system in Germany as an anomaly because the companies pay for the provision of general human capital and they do not recoup their costs until the end of the training period (Franz and Soskice 1995; Harhoff and Kane 1997; Acemoglu and Pischke 1998; Acemoglu and Pischke 1999b; Dustmann and Schönberg 2004; Kessler and Lülfelsmann 2006). This seems to be a puzzle because in theory, firms should be interested in paying only for specific non-transferable skills, while the apprentices should pay for general skills themselves.

Many contributions try to solve this perceived puzzle by explaining the willingness of firms to pay for general human capital through reference to different sources of market imperfections. Outside firms might find it difficult to judge the quality of the training programme in other firms (Katz and Ziderman 1990; Chang and Wang 1996) or there might be asymmetric information about the productivity of apprentices (Elbaum and Singh 1995; Franz and Soskice 1995; Acemoglu and Pischke 1998). These market imperfections would allow the firms to pay their own apprenticeship graduates less than the market wage for skilled workers and hereby recoup the net costs incurred during the apprenticeship period (Acemoglu and Pischke 1999a). Moreover, there might be complementarities between general and firm-specific skills. General skills can be used more efficiently when the worker has some firm-specific knowledge and skills and it is possible for the training firm to obtain some of the returns of general training (Franz and Soskice 1995; Acemoglu and Pischke 1999a; Kessler and Lülfesmann 2006). Furthermore, labour market institutions, such as minimum wages, unions or works councils, can induce enterprises to accept net costs during the

apprenticeship period (Acemoglu and Pischke 1999a; Dustmann and Schönberg 2004). Finally, there might be other costs for apprenticeship graduates and employees when apprentices move to another employer after their apprenticeship period, such as mobility costs, search costs, training on the job, etc. (Harhoff and Kane 1997; Acemoglu and Pischke 1998).

These theoretical contributions are all based on the stylised fact of net costs during the apprenticeship period in Germany. The net costs assumption stems from a series of descriptive cost benefit studies conducted by the BIBB (Bardeleben *et al*. 1997; Beicht *et al.* 2004). These evaluations calculated the relevant costs during apprenticeship training for about 50 occupations and compared them with the economic value of the productivity contribution of a typical apprentice. The evaluations are based on surveys of about 2,500 (personnel) managers who assessed one occupation each. They consistently find that all occupations and 96 per cent of the companies face sizeable net costs during the apprenticeship period.[2]

The results of the descriptive costs and benefits calculations are, however, thrown into doubt by some recent empirical studies. First, Mohrenweiser and Backes-Gellner (2008) show that about 14 per cent of German training enterprises consistently do not hire their apprenticeship graduates during a period of several years. This contradicts the notion of there being net costs during the apprenticeship period for virtually all training enterprises, because these companies have no opportunity to recoup the net costs. Second, in a costs and benefits study for Switzerland also based on surveys of personnel managers, Wolter *et al.* (2006) find that two-thirds of Swiss companies with fewer than 100 employees and one-half of the larger ones are able to recoup their training costs during apprenticeship training. The differences between the two countries are quite surprising, because

[2] This refers to the full cost account, which is usually cited in scientific publications.

the training systems in both countries are very similar[3]. Third, Zwick (2007) finds on the basis of multivariate panel profit estimation that an increase in the share of apprentices does not decrease profits. He concludes that, on average, German establishments do not face net costs during the apprenticeship period.

Besides the study by Zwick (2007) there are only two studies we are aware of that assess the causal effect of apprenticeship training on firm performance. Fougère and Schwerdt (2002) analyse the contribution of apprentices on firm performance in Germany. They find a positive effect of apprentices on the value added only in medium-size firms. Problematic in their cross section study is that the reference qualification group is "other than unskilled and skilled workers" and therefore not specified. Askilden and Nilsen (2005) partly confirm the hypothesis that firms face net costs during apprenticeship training by analysing the recruitment of apprentices during the business cycle in Norway. They find that apprentices are substitutes for skilled workers and are recruited primarily in boom phases. However, all of these studies treat the apprentices as a homogeneous group and do not discriminate between the training occupations.

III. Theoretical Framework

Contrary to the previous studies, we treat the apprentices not as a homogenous group but we demonstrate that differentiating between occupational groups can teach us more about the motivation of enterprises to hire apprentices. The apprenticeships differ from each other because of the expected mobility of the apprenticeship graduates. This is easily modelled by a two stage game, where the company trains the apprentice in the first stage and can employ those in the second stage, probably taking advantage of market imperfections discussed above. However, the expected mobility of the apprenticeship graduates in the second

[3] Dionisius *et al.* (2008) compare the results of the German and Swiss cost/ benefit study and show that 78 percent of the differences in the calculated net costs between both countries can be explained by the wage structure, the design of the vocational education system and the task allocation of the apprentices at the workplace.

stage differs between the occupations because of the specificity of the acquired skills and internal labour markets. If the expected mobility is low, the company can invest in the skills of the apprentices and gain by the employment of the former apprentice in the second stage. Otherwise the company is forced to exploit the productive work of the apprentices already in the first stage. The company can use both strategies in the first stage because the German apprenticeship system is characterised by a duality of training sites, which means that the apprentices spend 1-2 days a week in a vocational school, and 3-4 days in the training company (Franz and Soskice 1995). The integration of the apprentices in the production process is an important part of the German apprenticeship system, because the companies can (partly) recoup the training costs during the training period. The value of productive work and the costs of the apprentices in the first stage should be compared with those of unskilled workers.

The potential substitutability between apprentices and unskilled or semi-skilled workers is described by Lindley (1975) and Harhoff and Kane (1997). It can be analysed within a simple micro-economic production model with two substitutable input factors (apprentices and unskilled or semi-skilled workers) where the employment shares are dependent on their relative unit labour costs (Mohrenweiser and Backes-Gellner 2008). In using the substitution training model we exploit the property of part-time productive work of the apprentices in their training companies and analyse a standard Cobb Douglas function, including the number of employees, weighted by their occupation or skill level (Dearden et al. 2006). Therefore, we aim at establishing a causal relationship between the decision of a company to recruit apprentices instead of unskilled or semi-skilled workers, and its performance.

Accordingly, our model divides the number of employees (L) in different skill and occupational groups (s), where θ refers to their performance differences:

$$L = \sum_{s} (1 + \theta_s) L_s \ . \qquad (1)$$

Then we define a reference category (in our case the proportion of unskilled or semi-skilled employees) and multiply all summands by L/L, logarithmise, use the approximation $s \approx \ln(s+1)$ for small *s*, define $l_s = L_s/L$, and solve to:

$$\ln L = \ln L + \sum_s \theta_s l_s \ . \qquad (2)$$

Then we insert (2) in a standard logarithmic Cobb Douglas function and solve this to get:

$$\ln \pi_{it} = \ln A + \alpha \ln k_{it} + \beta \sum_s \theta_s l_{sit} \ , \qquad (3)$$

where π is the establishment performance per capita, *k* is the capital per head and the l_s indicate the proportions of different skill or occupational groups *s* in the company *i* at time *t* and *A* are other company or market characteristics. The parameters α and β are the elasticities of the Cobb Douglas function for capital and labour respectively and θ presents the firm performance differences between the skill and occupational groups.

Therefore, we aim at establishing a causal relationship between the decision of a company to recruit apprentices instead of unskilled or semi-skilled workers, and its performance. We argue that the different impact on firm performance is caused by the expected mobility of apprenticeship graduates in certain occupations. We consider three occupational groups: manufacturing occupations, craft and construction occupations, and trade and commercial occupations.[4] Our occupational classification is not the same as that used by Beicht *et al.* (2004) who mainly differentiate occupations by the institutions involved (for example chambers of commerce and industry vs. chambers of crafts) it is instead chosen so that their impact on firm performance is as homogeneous as possible.

The first group of apprentices consists of commercial and trade occupations which are commonly named white collar workers. White collar workers mostly

[4] The list of occupations in the three groups can be found in Appendix Table A6. The different retention rates of these three groups are for example shown by Büchel and Neubäumer (2001).

acquire transferable, general skills such as languages, IT or social skills (Smits and Zwick 2004). More general skill bundles lead to a higher probability for an external job offer (Lazear 2004) and a higher mobility of apprenticeship graduates (Geel *et al.* 2008). Therefore, firms with apprentices in commercial occupations are more likely forced to ensure that costs and benefits of apprenticeship training are not worse than hiring unskilled or semiskilled employees. We therefore propose our first hypothesis:

HYPOTHESIS 1: Additional apprenticeships in commercial and trade occupations are offered if the apprentices are at least as attractive as unskilled or semi-skilled workers for the employer.

Second, apprentices in manufacturing occupations are generally considered to acquire a highly specific combination of skills. This reduces the transferability of skills between firms and gives training firms bargaining power after graduation (Geel *et al.* 2008). In addition, blue collar workers, such as manufacturing apprentices, are generally considered to face a strong internal labour market in the establishment that provided apprenticeship training. Soskice (1994) therefore describes apprenticeships in manufacturing occupations as possible ports of entry into the internal labour market. This leads to a longer tenure and higher incentives for companies to provide training (Doeringer and Piore 1970). The more specific skill bundles and the stronger internal labour markets result in a lower probability for apprentices to leave the training firms. This increases the incentive for companies to hire apprentices even if their cost/benefit mixture is less attractive than that of unskilled or semi-skilled employees because they have a high chance to earn back investments incurred during the apprenticeship training after taking the apprentices over as skilled employees. Furthermore, it is not easy to find skilled employees in manufacturing occupations on the labour market and therefore establishments have to offer apprenticeship training themselves in order

to be able to get new skilled employees in the future (Fougere and Schwerdt 2002). This leads to our next hypothesis:

HYPOTHESIS 2: *Apprenticeships in manufacturing occupations are also offered if the apprentices are less attractive than unskilled or semi-skilled employees during the apprenticeship training period.*

The final occupational group consists of crafts and construction occupations. These occupations are characterised by a relatively low retention rate and a high occupational mobility after the apprenticeship (Büchel and Neubäumer 2001). For most craft employees, switching from one employer to another is quite widespread and easy because most skills are not company-specific. Moreover, the crafts and construction companies face a strong product market competition which forces them to cut labour costs and hire apprentices if they are as least as attractive as their substitutes. These apprentices are however probably rather attractive employees in these occupation groups because they obtain a certain productivity level rather quickly. That can be shown by a greater share of productive working time during the apprenticeship in these occupations (Wolter *et al.* 2006). Prime examples are almost all construction occupations, where the apprentices are productive from practically the first training days on. This leads us to our third hypothesis:

HYPOTHESIS 3: Apprenticeships in craft and construction occupations are only offered if the apprentices are at least as attractive as unskilled or semi-skilled employees.

IV Empirical Framework

In order to identify the causal effects on establishment performance of replacing unskilled and semi-skilled employees by apprentices in the three occupational groups, we use a Cobb Douglas function according to equation (3):

$$\ln \pi_{it} = \delta_1 com_{it} + \delta_2 man_{it} + \delta_3 crafts_{it} + x'_{it}\beta_i + \eta_i + u_{i,t}, \qquad (4)$$

where *t* is a time indicator, *i* is an establishment indicator, *com*, *man* and *crafts* are the proportion of apprentices in commercial and trade, manufacturing, crafts and constructions occupations respectively. The dependent variable π measures the firm performance per capita and *x* is a column vector of other covariates including all variables in (3) such as capital per head and the proportion of skilled and unskilled workers as well as other explanatory variables. Finally, η denotes the unobservable time invariant factors and *u* stands for the normally distributed error term with an expected value of zero.

Our main focus lies on calculating the impact of replacing an unskilled or semi-skilled employee by an apprentice from a certain occupational group on contemporary and lagged firm performance. This effect is identified by the coefficients of the occupation shares because we use the share of unskilled and semi-skilled employees as reference unit in the qualification shares. Our estimation procedure takes into account different sources of estimation bias or endogeneity problems such as selectivity, unobserved time invariant heterogeneity and simultaneity. In order to assess the changes incurred by estimation biases, and as a benchmark, we start with a pooled OLS estimation, i.e. a cross-section which treats observations of a company from different years as independent.

We control for time invariant unobserved variables influencing both firm performance and share of apprentices (unobserved establishment heterogeneity: $E(x,\eta) \neq 0$) by estimating the model in first differences or by demeaning the

cross-section equations. Unobserved heterogeneity causes an upward-bias when good industrial relations or good personnel management lead to better firm performance on the one hand and to higher training endeavours on the other hand. This estimation explains the change in firm performance from one year to the next by means of a change in the composition of employee qualifications and other covariates or in other words we switch from a between establishments to a within analysis.

A further possible source of estimation bias is the endogeneity of the share of apprentices. First, establishments may alter their qualification structure and firm performance simultaneously and both may be influenced by exogeneous shocks such as a positive trend in demand because they lead to an increase in the workforce. Otherwise, simultaneity can for example occur if a relatively low firm performance is a signal for a structural labour costs problem which firms might try to solve by substituting apprentices for unskilled workers. Another source of estimation bias is selectivity in apprentice training. Neubäumer and Bellmann (1999) find for example that the probability to train is higher in industries with low net apprenticeship costs. These two sources of estimation bias are removed in our third estimation specification by an instrumental variable panel regression. It is convenient, in this respect, to use general method of moments (GMM) estimations with internal instruments, because lagged internal instruments do not pose causality problems contemporary external instruments might have given the assumptions stated below. In addition, we do not have enough external instruments for the potentially endogeneous variables. More precisely, the difference GMM Estimator instruments the first differences of the explanatory variables with the corresponding levels of the lagged variables whereby potentially endogenous variables need the lags *t*-2 and predetermined ones the lags *t-1* (Arellano and Bond 1991). Therefore we make the so-called sequential exogeneity assumption ($E(x_{i,t}, \Delta u_{i,t-1}) = 0 = E(x_{i,t}, u_{i,t-1} - u_{i,t-2})$) which means that contemporary exogenous shocks have no impact on lagged explanatory variables. We therefore need at least

four time periods, where the fourth lag is the instrument. Unfortunately, the predictive power of the internal instruments may be small if the time series are highly persistent. That means in our case for example that the qualification structure of the employees hardly changes from one year to another. That could evoke biases in the GMM Estimator in first differences (Arellano and Bover 1995).

Therefore we prefer the so-called System GMM Estimator by Blundell and Bond (1998). Here, the differences are instrumented again with lagged levels as internal instruments and the levels of the covariates are simultaneously instrumented by adequate lagged differences. The main advantage of this approach is that besides the temporary differences, differences in levels between firms are also taken into account. This improves the information used in identifying the effect and usually enhances the precision of the estimator. A necessary condition for the System GMM Estimator is that the correlations between the unobserved fixed effects and the first differences of the covariates remain constant over time (Arellano and Bover 1995).[5] In our investigation this means for example that the particular propensity for personnel management or industrial relations does not change much over the analysed time period of six years. The estimations are carried out with the help of a two-step method under the application of Windmeijer's adjustment process for variances (Windmeijer 2005), using the command `xtabond2` in STATA 9.2 (Roodman 2006). In addition, we impose common factor restrictions using a minimum distance estimator in order to obtain a single coefficient for all covariates in the dynamic model (Blundell and Bond 1998).[6]

We can identify the effect of changes in the proportion of occupational groups of apprentices on firm performance because of market inflexibilities. First, dismissal protection causes that firms can directly affect their share of apprentices

[5] This is also called the stationarity assumption, given the derived stationarity from this assumption.
[6] The DPD package of the System GMM estimator displays both results but it is not included in the STATA version.

but shrinking firms may face an inefficient composition of staff because employees cannot be replaced and laid off at will. Second, there may be a lack of suitably skilled job applicants. As a consequence, some firms might not have their optimal employee mix and an increase in the share of a particular employee group would influence the firm performance.

V. Data

Our data are taken from the waves 1997-2002 of the linked employer employee data set of the IAB (LIAB). The LIAB combines Federal Employment Agency individual-based employment statistics with plant-level data from the IAB Establishment Panel. The distinctive feature of the LIAB is the combination of administrative information on individuals and details concerning the establishments that employ them (Jacobebbinghaus 2008).

The employment statistics of the LIAB are drawn from the German employment register, which contains information on more than 98 per cent of the employees and trainees included in the establishment panel (Jacobebbinghaus 2008). The information on the schooling level of the employees may be inconsistent because the information is not obligatory. Therefore we use the correction method proposed by Fitzenberger et al. (2006).

To take account of the top coding of earnings at the earnings ceiling for social security contributions for roughly 11 per cent of the sample, we impute wages for those employees at the censored level. To this end, we first create 20 cells differentiated by gender, education (the six schooling groups identified in Appendix Table A1) and nationality (German vs. non-German), and run censored wage regressions for each cell. The covariates comprise age, age squared, and dummies for job characteristics. Further, our procedure takes into account that the level at which wages are top coded differs between eastern and western Germany and are adjusted every year. Predicted wages for each censored observation are then calculated and imputed for each individual.

The plant-level component of the LIAB, the IAB Establishment Panel, was initiated in 1993 (Kölling 2000). It is based on a stratified random sample – strata for 16 industries and 10 employment size classes – from the population of all establishments. Although larger plants are over-sampled, within each cell the sampling is random.

All labour-related variables are calculated from the reliable individual Social Security Records and all other company-related variables are compiled from the IAB Establishment Panel. We use the so-called longitudinal version of the LIAB which includes daily information on the employee characteristics for all establishments. We calculate on a monthly basis the proportion of all employment-related variables and then derive their yearly mean. This approach is mainly chosen because the proportion of apprentices changes cyclically during the year, with a minimum around July and a maximum around the New Year, and the training period differs between occupations: for example most apprenticeship training in commercial occupations takes three years while apprenticeships in manufacturing usually last three and a half years. Therefore, the cross-section data that entail the employee characteristics on only one day per year – the 30th of June - underestimate the true ratio of apprentices. Even more importantly, the difference between the true average proportion of apprentices and the measured proportion of apprentices at this date differs between the groups of apprentices because of the different training durations (Jacobebbinghaus *et al.* 2008).

In obtaining our estimation sample, we exclude not-for-profit organisations and, agriculture and mining establishments, as well as establishments that do not report sales (such as banks and insurance companies). We also exclude establishments with fewer than 20 employees[7] and any establishments that have more than 60 per cent apprentices in their workforce (training companies). In addition, only individuals aged between 16 and 64 years and covered by social

[7] This excludes the group of firms for which the calculated net costs are near to zero (Beicht et al. 2004). Therefore the establishments in our sample should have on average higher net costs than the entire establishments.

security are included in the sample. We also omit all employees with wages lower than the minimum income limit for compulsory social insurance, and apprentices who earned more than the social security contribution ceiling. Matching the selected employees to the selected establishments', results in a sample of 1879 establishments.

The firm performance variable is on the one hand gross profit per head calculated by subtracting the total wage bill and the inputs from firms' revenue. On the other hand, firm performance is measured by productivity per head calculated by firm´s revenue minus the inputs. We take logs in order to reduce the impact of outliers. As we do not have a variable directly indicating capital and capital costs in the panel, we can only include investments as a control variable proxy using the perpetual inventory method (Zwick 2004). We assume that using aggregated investments instead of capital is innocuous, especially in the estimation specifications based on differences, because it seems improbable that capital costs vary with the proportion of apprentices employed. However, in contrast to other variables it is not clear whether high investments boost gross profits or whether high gross profits enhance the investment affinity. Investments, gross profits and employee characteristics are divided by the number of employees in order to avoid having to measure scale effects such as a positive correlation between the levels of investments and profits.

VI. Findings

Our three homogeneous occupational groups cover 85 per cent of all apprentices. More specifically, commercial and trade occupations cover 25 per cent, crafts and construction occupations 30 per cent and manufacturing occupations 30 per cent of all apprentices. The entire summary statistics on establishment (mean) characteristics for the estimation sample used for the System GMM regressions are given in Table A1 of the Appendix.

In the first step, we analyse the impact of apprentices on gross profits in the three occupational groups in comparison to semi- and unskilled workers. Afterwards, this is compared with the relative effect of apprentices on productivity. This shows us if apprentices are attractive because they increase productivity or merely because they have lower wages.

Our pooled OLS estimation in Table 1 suggests that the contribution of apprentices to the gross profits in commercial and trade occupations is significantly positive in comparison to that of unskilled or semi-skilled workers. In contrast, the contribution of crafts and construction apprentices, as well as that of manufacturing apprentices, is significantly negative correlated with the gross profit. All further covariates have the expected signs (see Table A2 in the Appendix): higher investments per capita, the presence of works councils, collective bargaining, and the export share are positively correlated with gross profits. The share of employees with a lower than tertiary-level qualification has a negative correlation, while the share of employees with a higher qualification is positively correlated with gross profits.

The pooled regression is possibly biased, however, because observations of the same firm in different years are considered as independent, and endogeneity cannot be taken into account. The Fixed Effects Regression (FEM) in Tables 1 and A3 has, correspondingly, a smaller number of significant coefficients. The contribution of all apprentice groups to firm performance is now insignificant.

In order to tackle endogeneity, we prefer a System GMM approach with lagged levels respectively lagged differences as internal instruments. More specifically, we treat worker-related variables as potentially endogenous (apprentices' occupation and job characteristics – see Appendix) and instrument them with lags (t-2) and all further available lags. The investment variable is seen as predetermined and is instrumented with lag (t-1) and further lags. All establishment-related variables are seen as exogenous (works councils, industry and so on, see Appendix). The System GMM Estimation is reported in Table A4

in the Appendix. All test statistics confirm our specification (autocorrelation tests and test of over-identification restrictions) and the coefficients of the lagged dependent variable are in the expected range between the lagged OLS and the lagged FEM specification (Roodman 2006) – see Tables A6 and A7.

Table 1: Gross Profit Estimation, Dependent Variable: log(value added minus total wage bill per capita)

	OLS		FEM		Sys GMM	
	Coef.	t-value	Coef.	t-Value	Coef.	t-Value
Share of Apprentices in:						
Commercial or Trade Occ.	1.8628	7.61	-0.3443	-0.91	0.9683	2.78
Manufacturing Occ.	-0.6416	-3.25	-0.2180	-0.65	-1.2437	-2.65
Crafts or Constructions Occ.	-0.6695	-3.62	0.2423	0.68	1.4731	3.80
Number of Establishments	8169		2146		1879	
R / Number of instruments	0.1773		0.0195		269	

Comments: full output in the Appendix Tables A2-A5, reference category: share of unskilled workers. Source: LIAB waves 1997–2002.

Taking endogeneity into account shows that apprentices in commercial and trade occupations have a higher positive impact on gross profits than unskilled and semi-skilled workers according to Hypothesis 1. In detail, a one per cent increase in the proportion of commercial apprentices raises the contemporary gross profit by around one per cent. The apprentices in commercial and trade occupations are obviously on average sufficiently productive and receive sufficiently low wages to make them as attractive as semi-skilled or unskilled employees during the training period. In accordance with our second hypothesis the contribution of manufacturing apprentices to the firm's gross profits is negative in comparison to unskilled workers. These apprenticeships therefore impose a burden on the companies during the training period, and their benefits have to come by employing the own apprenticeship graduates. Further, apprentices in craft and construction occupations have a significantly more beneficial impact on gross

profits than unskilled workers, which confirms our third hypothesis. The employment of these apprentices is more beneficial than to employ unskilled workers. In contrast to the manufacturing occupations, the training establishments do not need to take over the apprenticeship graduates. Finally, the lagged endogeneous variable and the proportion of skilled employees have a positive significant impact on gross profits while the proportion of part-time employees and the size of investments per capita have no impact. Exporting firms and firms with works councils have a higher gross profit (see Table A4 and A5).

The effect on gross profit is the relevant reason to replace unskilled workers by apprentices. We cannot infer however whether this effect stems from the relative productivity or wages of the apprentices. In order to disentangle both effects, we additionally calculate the impacts on productivity (Appendix Tables A2-A5). Comparing both parts of the tables suggests that usually the impact on productivity is more positive (or less negative) than the impact on gross profit. This means that the commercial apprentices are more productive than unskilled workers (given their productive working time) but their relatively higher training wages reduce the benefits. Nevertheless, the apprentices still have more favourable unit labour costs than unskilled or semi-skilled workers. Another possible interpretation is that the costs of an increase in the proportion of apprentices are higher than those for an increase in the proportion of unskilled or semi-skilled employees, where one has to take into account the indirect salary costs for supervisors. An exception is the relation between gross profits and productivity for the craft and construction occupations (see Table A5). Here the gross profit impact is about the same as the productivity impact. This might be a consequence of relatively low apprentice wages and other training costs in enterprises that train apprentices in craft or construction occupations (or relatively high productivity of apprentices in relation to their relative costs).

In order to check the robustness of our results, we also calculate everything in deviations from sector means. This slightly changes the interpretation because

we cancel out the level effects between sectors. Now the question is whether a higher share of apprentices in certain occupations than the sector average goes hand in hand with a higher gross profit than the sector average. The results are very similar to those presented before and therefore we do not display them separately here. Furthermore, we run all regressions for those companies that offer apprenticeships only. This also does not change the results significantly. This is a consequence of our within enterprise identification strategy whereby non-training companies have no additionally explanatory power. Finally, we run all regressions for the average apprenticeship share instead of differentiating between occupations groups. We obtain a result analogous to that of Zwick (2007): replacing unskilled and semi-skilled employees by apprentices does not have an impact on gross profits (and productivity).

VI. Conclusions

This paper presents the first causal assessments of the impact of different occupational groups of apprentices on enterprise performance. It shows that it is necessary to discriminate between different groups of occupations when assessing the motivation of enterprises to train apprentices. In particular, we find that replacing unskilled and semi-skilled employees by apprentices in trade, commercial, craft, and construction occupations has a positive impact on contemporary gross profits. In contrast, a replacement by apprentices in the manufacturing occupations (which constitute about 30% of all apprentices) reduces contemporary gross profits. This means that enterprises offering apprenticeships in manufacturing occupations accept a lower performance during the apprenticeship period in comparison to hiring unskilled or semi-skilled employees.

Our findings shed a new light on the stylised fact based on descriptive cross-section analyses that almost all training enterprises necessarily incur net costs during apprenticeship training. Our results are compatible with these findings

if on average unskilled and semi-skilled employees have higher marginal wages than productivity in activities for which apprentices in commercial and trading as well as in construction and craft occupations can be hired. We argue however that the absolute level of measurable costs and benefits during the apprenticeship training is less important for the decision on the share of apprentices than their marginal contribution in relation to substitutes (the unskilled or semi-skilled employees). Our approach therefore imitates the decision process of personnel managers on the share of apprentices in different occupations and takes into account unobserved heterogeneity between establishments and the endogeneity of the qualification structure.

This paper demonstrates the efficiency of the German apprenticeship system: companies train skills in occupations such as manufacturing at a cost if chances are high that apprentices stay in the training establishment, the human capital acquired is relatively specific and it is difficult to obtain adequately skilled employees elsewhere. Otherwise, they offer new apprenticeships in occupations with more general skills and higher between company mobility only if apprentices are not less attractive than the employment of suitable substitutes such as unskilled or semi-skilled employees.

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Appendix

Table A1: Descriptive Statistics (means at establishment level)

	mean	sd	minimum	maximum
Log(Value Added per Capita)	10.7928	0.8851	5.9221	16.0026
Log(Gross Profits per Capita)*	14.7562	1.6614	6.5207	21.1845
Apprentices Occupations:				
Commercial and Trade	0.0110	0.0246	0.0000	0.2698
Manufacturing	0.0146	0.0315	0.0000	0.4126
Crafts and Construction	0.0110	0.0341	0.0000	0.4506
Other	0.0080	0.0235	0.0000	0.3341
Job Characteristics:				
Share of Apprentices	0.0445	0.0517	0.0000	0.4773
Share of Unskilled/Semi-skilled Workers	0.1776	0.2370	0.0000	1.0000
Share of Skilled Workers	0.7116	0.2551	0.0000	1.0000
Share of Part Time Workers**	0.0637	0.1422	0.0000	1.0000
Share of Others	0.0025	0.0119	0.0000	0.4346
Schooling Level:				
Share without a Completed Apprenticeship	0.1081	0.1232	0.0000	0.9429
Share with a Completed Apprenticeship and without a Secondary School Degree	0.7099	0.1883	0.0000	1.0000
Share without a Completed Apprenticeship and with an Secondary School Degree	0.0412	0.0489	0.0000	1.0000
Share with a Completed Apprenticeship and with a Secondary School Degree	0.0346	0.0446	0.0000	0.5946
Share with a Polytechnic Degree	0.0488	0.0662	0.0000	0.8279
Share with a University Degree	0.0574	0.0960	0.0000	0.8844
Share of Foreigners	0.0369	0.0793	0.0000	0.8375
Establishment Characteristics:				
Log(Investment per Capita)*	7.0486	3.1714	0.0000	13.9270
Company founded during last 5 Years	0.0644	0.2455	0.0000	1.0000
Dummy: Exporting Company	0.3913	0.4881	0.0000	1.0000
Dummy: Works Council	0.5747	0.4944	0.0000	1.0000
Dummy: Collective Bargaining Contract	0.6503	0.4769	0.0000	1.0000
Dummy: Located in East Germany	0.6131	0.4871	0.0000	1.0000

Table A1 continued:

Firm Size Categories:				
20 - 100	0.5881	0.7676	0.0000	1.0000
101 - 500	0.3245	0.4682	0.0000	1.0000
> 500	0.0874	0.2824	0.0000	1.0000
Number of Observations	5916			
Number of Establishments	1879			

** Profit per capita and investment per capita are added with a constant - the largest negative number found in the variables - to make sure that all values are positive and hence can be logarithmised.*

*** Full time workers can be divided in different job characteristics but not part time workers.*

Source: LIAB Wave 1997 – 2002, sample used for System GMM regressions, see Tables A4 and A5.

Table A2: OLS Estimations

	Productivity		Gross Profits	
	Coef.	t-Value	Coef.	t-Value
Share of Apprentice Occupation Group (Ref.: Unskilled Workers):				
Commercial and Trade	2.3047	5.97	1.8980	7.63
Manufacturing	-0.9650	-3.10	-0.6299	-3.13
Crafts and Construction	-1.3709	-4.70	-0.6729	-3.58
Further Job Characteristics (Ref: Unskilled Workers):				
Share of Skilled Workers	0.0613	1.24	0.0082	0.26
Share of Part Time Workers	-0.1635	-2.15	0.0729	1.48
Schooling Level (Ref.: without Completed Apprenticeship and with Secondary School Degree):				
Share without a Completed Apprenticeship	-0.3768	-2.97	-0.1647	-2.01
Share with a Completed Apprenticeship and without a Secondary School Degree	-0.2542	-2.89	-0.0946	-1.67
Share with a Completed Apprenticeship and with an Secondary School Degree	1.5043	6.97	0.9524	6.85
Share with a Polytechnic Degree	0.3906	2.27	0.1859	1.68
Share with a University Degree	0.7134	5.04	0.2645	2.90
Share of Foreigners	-0.2030	-1.37	-0.1875	-1.96
Establishment Characteristics:				
Log(Investment per Capita)	0.0804	18.35	0.0490	17.35
Company founded during last 5 Years	0.0415	1.28	0.0448	2.14
Dummy: Exporting Company	0.1464	6.10	0.0747	4.82
Dummy: Works Council	0.2079	9.29	0.0740	5.13
Dummy: Collective Bargaining Contract	0.0458	2.13	0.0196	1.41
Dummy: Located in East Germany	-0.4437	-18.89	-0.1750	-11.56
R^2	0.2397		0.1687	
F (38, 8130)	67.46		43.43	
Number of Establishments (Observations)	8169		8169	

Notes: Regressions also include 2 firm size dummies, 11 industry, 1 dummy for employees with unknown occupational qualification, 1 dummy for apprentices with other occupations, and 5 year dummies. Productivity: log(value added per capita), Gross Profits: log(value added minus total wage bill per capita).
Source: LIAB 1997-2002

Table A3: Fixed Effect Estimation

	Productivity		Gross Profits	
	Coef.	t-Value	Coef.	t-Value
Share of Apprentice Occupation Group (Ref.: Unskilled Workers):				
Commercial and Trade	-0.0913	-0.15	-0.3814	-0.98
Manufacturing	-0.4404	-0.81	-0.2344	-0.68
Crafts and Construction	0.1393	0.24	0.2272	0.62
Further Job Characteristics (Ref: Unskilled Workers):				
Share of Skilled Workers	0.1728	1.00	0.0863	0.79
Share of Part Time Workers	1.1293	4.56	0.7048	4.51
Schooling Level (Ref.: without Completed Apprenticeship and with Secondary School Degree):				
Share without a Completed Apprenticeship	0.1043	0.26	-0.1042	-0.42
Share with a Completed Apprenticeship and without a Secondary School Degree	-0.1600	-0.47	-0.2657	-1.24
Share with a Completed Apprenticeship and with an Secondary School Degree	0.3035	0.57	-0.0309	-0.09
Share with a Polytechnic Degree	-0.0874	-0.17	-0.6769	-2.12
Share with a University Degree	-0.1808	-0.38	-0.3225	-1.07
Share of Foreigners	-1.5490	-4.08	-1.1966	-4.99
Establishment Characteristics:				
Log(Investment per Capita)	0.0373	1.87	0.0067	0.53
Company founded during last 5 Years	-0.0153	-0.41	0.0286	1.22
Dummy: Exporting Company	0.0192	0.65	0.0065	0.35
R^2	0.0174		0.0186	
F (23, 6019)	4.63		5.49	
Number of Establishments (Groups)	2146		2146	

Notes: Regressions include 2 firm size dummies, 1 dummy for employees with unknown occupational qualification, 1 dummy for apprentices with other occupations, and 5 year dummies. Productivity: log(value added per capita), Gross Profits: log(value added minus total wage bill per capita).
Source: LIAB 1997-2002.

Table A4: System GMM Estimation

	Productivity		Gross Profits	
	Coef.	t-Value	Coef.	t-Value
L1 (y)	0.4733	10.37	0.4885	9.80
Share of Apprentice Occupation Group (Ref.: Unskilled Workers):				
Commercial and Trade	3.8442	1.94	2.6077	2.01
L1	-1.9406	-1.30	-0.8194	-1.11
Manufacturing	-0.1603	-0.07	-0.5364	-0.37
L1	-0.1118	-0.05	0.6001	0.45
Crafts and Construction	-0.4390	-0.23	0.3290	0.29
L1	-0.9130	-0.51	-0.9359	-0.88
Further Job Characteristics (Ref: Unskilled Workers):				
Share of Skilled Workers	0.6837	1.19	0.1776	0.48
L1	-0.5879	-1.11	-0.1802	-0.52
Share of Part Time Workers	1.4794	1.53	0.5851	0.96
L1	-0.9690	-0.99	-0.2344	-0.38
Schooling Level (Ref.: without Completed Apprenticeship and with Secondary School Degree):				
Share without a Completed Apprenticeship	0.3621	0.64	0.1970	0.56
Share with a Completed Apprenticeship and without a Secondary School Degree	-0.0357	-0.10	-0.0172	-0.08
Share with a Completed Apprenticeship and with an Secondary School Degree	1.7184	1.89	1.2460	2.00
Share with a Polytechnic Degree	1.5658	1.95	1.0975	1.88
Share with a University Degree	-0.0012	0.00	-0.4439	-1.01
Share of Foreigners	-1.0700	-1.35	-0.6004	-1.03
Establishment Characteristics:				
Log(Investment per Capita)	0.0056	0.21	0.0036	0.22
L1	0.0087	0.32	-0.0033	-0.20
Company founded during last 5 Years	0.0379	1.04	0.0228	0.98
Dummy: Exporting Company	0.0809	2.40	0.0507	2.36

Table A4 continued:

Dummy: Works Council	0.0942	2.99	0.0367	1.86
Dummy: Collective Bargaining Contract	0.0250	1.02	0.0072	0.48
Dummy: Located in East Germany	-0.2514	-2.99	-0.0781	-1.48
Number of Establishments (Groups)	1879		1879	
Number of Instruments	269		269	
Wald chi2(46)	1326.79		841.50	
Arellano-Bond Test for AR(1) in First Differences (p-Value)	0.00		0.00	
Arellano-Bond Test for AR(2) in First Differences (p-Value)	0.54		0.76	
Hansen Test of Over-Identification Restrictions (p-Value)	0.14		0.12	

Notes: Regressions include 2 firm size dummies, 1 dummy for employees with unknown occupational qualification, 1 dummy for apprentices with other occupations, 11 industry and 5 year dummies. Productivity: log(value added per capita), Gross Profits: log(value added minus total wage bill per capita). Source: LIAB 1997 - 2002

Table A5: Minimum Distance Estimator after System GMM

	Productivity		Gross Profits	
	Coef.	t-Value	Coef.	t-Value
L1 (y)	0.4417	11.27	0.4658	10.46
Share of Apprentice Occupation Group (Ref.: Unskilled Workers):				
Commercial and Trade	2.5468	3.58	0.9797	2.78
Manufacturing	-0.0277	-0.04	-1.2620	-2.66
Crafts and Construction	1.3915	2.22	1.4948	3.81
Further Job Characteristics (Ref: Unskilled Workers):				
Share of Skilled Workers	0.9723	5.09	0.2698	2.29
Share of Part Time Workers	1.3336	4.03	0.1759	0.87
Log(Investment per Capita)	-0.0105	-0.84	0.0066	0.82

Note: Only variable displayed which includes contemporary and lagged variables.

Table A6: Lagged OLS

	Productivity		Gross Profits	
	Coef.	t-Value	Coef.	t-Value
L1 (y)	0.7084	80.39	0.7269	83.22
Share of Apprentice Occupation Group (Ref.: Unskilled Workers):				
Commercial and Trade	2.3221	3.46	1.2170	2.84
L1	-1.0420	-1.59	-0.2096	-0.50
Manufacturing	-0.9361	-1.72	-0.7226	-2.08
L1	0.5229	0.93	0.5101	1.42
Crafts and Construction	0.4408	0.77	0.3271	0.90
L1	-0.9176	-1.64	-0.5291	-1.49
Further Job Characteristics (Ref: Unskilled Workers):				
Share of Skilled Workers	0.3414	1.92	0.1551	1.37
L1	-0.3044	-1.74	-0.1443	-1.29
Share of Part Time Workers	0.8089	2.98	0.5463	3.16
L1	-0.9158	-3.35	-0.5377	-3.08
Schooling Level (Ref.: without Completed Apprenticeship and with Secondary School Degree):				
Share without a Completed Apprenticeship	-0.0957	-0.95	0.0112	0.17
Share with a Completed Apprenticeship and without a Secondary School Degree	-0.0133	-0.19	0.0554	1.24
Share without a Completed Apprentice-ship and with an Secondary Degree	0.5951	3.34	0.4140	3.65
Share with a Polytechnic Degree	-0.0011	-0.01	0.0031	0.04
Share with a University Degree	0.2283	2.03	0.0853	1.19
Share of Foreigners	0.0360	0.31	0.0257	0.34

Table A6 continued:

Establishment Characteristics:				
Log(Investment per Capita)	0.0313	1.51	0.0095	0.72
L1	-0.0029	-0.14	0.0074	0.56
Company founded during last 5 Years	0.0355	1.25	0.0166	0.91
Dummy: Exporting Company	0.0667	3.52	0.0377	3.12
Dummy: Works Council	0.0573	3.28	0.0229	2.07
Dummy: Collective Bargaining Contract	0.0316	1.88	0.0122	1.13
Dummy: Located in East Germany	-0.1187	-6.28	-0.0333	-2.80
R^2	0.6471		0.6268	
F(46, 5869)	233.93		214.3	
Number of Establishments (Observations)	5916		5916	

Notes: Regressions also include 2 firm size dummies, 11 industry, 1 dummy for employees with unknown occupational qualification, 1 dummy for apprentices with other occupations, and 5 year dummies. Productivity: log(value added per capita), Gross Profits: log(value added minus total wage bill per capita).
Source: LIAB 1997-2002.

Table A7: Lagged Fixed Effect Estimation

	Productivity		Gross Profits	
	Coef.	t-Value	Coef.	t-Value
L1 (y)	0.0411	2.79	0.0475	3.13
Share of Apprentice Occupation Group (Ref.: Unskilled Workers):				
Commercial and Trade	0.7019	0.81	-0.0731	-0.13
L1	-1.9786	-2.71	-0.8875	-1.91
Manufacturing	-1.2974	-1.99	-0.8335	-2.01
L1	1.6877	2.63	1.2465	3.04
Crafts and Construction	1.4828	1.98	0.6187	1.30
L1	-0.6831	-1.02	-0.0474	-0.11
Further Job Characteristics (Ref: Unskilled Workers):				
Share of Skilled Workers	0.0433	0.19	0.0608	0.42
L1	-0.0792	-0.36	-0.0506	-0.36
Share of Part Time Workers	1.5477	4.33	0.8525	3.74
L1	-0.3273	-0.98	-0.1178	-0.55
Schooling Level (Ref.: without Completed Apprenticeship and with Secondary School Degree):				
Share without a Completed Apprenticeship	-0.4590	-0.93	-0.4249	-1.34
Share with a Completed Apprenticeship and without a Secondary School Degree	-0.5749	-1.33	-0.4338	-1.57
Share without a Completed Apprentice-ship and with an Secondary Degree	-0.0044	-0.01	-0.1157	-0.27
Share with a Polytechnic Degree	-0.1773	-0.28	-0.7337	-1.81
Share with a University Degree	-0.0052	-0.01	-0.3661	-0.95
Share of Foreigners	-1.5410	-3.26	-1.2365	-4.10

Table A7 continued:

Establishment Characteristics:				
Log(Investment per Capita)	0.0009	0.04	-0.0027	-0.16
L1	0.0212	0.87	0.0028	0.18
Company founded during last 5 Years	-0.0019	-0.04	0.0256	0.83
Dummy: Exporting Company	-0.04	-1.03	-0.03	-1.19
R^2	0.0262		0.0266	
F(31,4006)	3.48		3.53	
Number of Establishments (Groups)	1879		1879	

Notes: Regressions include 2 firm size dummies, 5 year dummies, 1 dummy for employees with unknown occupational qualification. Productivity: log(value added per capita), Gross Profits: log(value added minus total wage bill per capita).
Source: LIAB 1997-2002.

Table A8: List of occupational categories

	Number of occupation in IABS
Commercial and Trade	681-706,751-773,781-784,856,922
Manufacturing	141-162,191-291,311-323,541-543,547,631-634,744,857
Crafts and Construction	53,121-135,163-177,302-306,391-422,441-514,544-546,741-744,804,901-921,923-937

Note: the plain text of the selected occupations can be found in Jacobebbinghaus (2008).