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Task composition and vocational education and training – a firm level perspective

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ABSTRACT

In Germany, about half of the school-leavers – irrespective of their school-leaving certificate – start an apprenticeship instead of entering the labour market or university. Firms act as gatekeepers who influence which school-leavers start an apprenticeship. Previous studies have provided important information on the reasons firms train. By analysing tasks, I consider an additional characteristic that probably influences firms' training decisions. The aim of my study is twofold: I examine whether tasks performed in a firm first correlate with the decision to provide apprenticeship training and second with the school-leaving certificate of newly hired apprentices. I use the BIBB Establishment Panel on Training and Competence Development to estimate hybrid models with the task shares of firms as the main independent variables. The results suggest that firms' task composition affects their decisions concerning vocational education and training (VET). Firms with a high share of routine or manual tasks are more likely to be involved in VET. Moreover, high shares of manual and routine tasks are accompanied by a higher demand for apprentices with lower secondary certificates, and high shares of interactive tasks by a high demand for apprentices with the highest secondary school-leaving certificate (i.e. the Abitur).

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1. Introduction

In addition to skills and competences, tasks play a major role in employment opportunities for labour market entries. To produce output or offer services, firms require employees to perform certain tasks. To perform the required tasks, employees need a special set of skills and competencies. To distinguish between task and skills, Autor (2013) states, 'A task is a unit of work activity that produces output. A skill is a worker's stock of capabilities for performing various tasks' (186). Given the relationship between tasks and skills, a firm's task structure defines a firm's demand for skills. To meet this demand, firms can

either hire employees from the external labour market or train future employees by themselves.

The task-based approach expounds on how different tasks develop over time and affect the demand for skills. Autor, Levy, and Murnane (2003) distinguished five tasks according to their substitution or complementation potential relating to computerisation. Technological change leads to a decline in the demand for (cognitive and manual) routine tasks, whereas the demand for non-routine tasks, namely analytic and interactive tasks, increases, while the demand for non-routine manual tasks remains unaffected (e.g. Autor, Levy, and Murnane 2003; Acemoglu and Autor 2011).

For Germany, Spitz-Oener (2006) shows that between 1979 and 1999, there was a rise in the share of analytic and interactive tasks within occupation. Furthermore, Bachmann, Cim, and Green (2018) calculated that between 1975 and 2014, the employment share of routine jobs shrank from 69% to 48%, whereas the share of non-routine manual and cognitive jobs increased from 12% to 20% and from 19% to 32%, respectively. Concerning the relationship between the educational degrees and tasks, we know that employees with a vocational education and training (VET) degree perform less analytic and interactive task than employees with a university degree (Rohrbach-Schmidt 2019, 127). The reverse picture emerges when we examine routine and non-routine manual tasks (ibid.).

Tasks are also related to training; previous studies show that depending on the task they perform, employees participate in continuing training differently (Ehlert 2020; Görlitz and Tamm 2016; Mohr, Troltsch, and Gerhards 2016). However, so far, there has been minimal discussion on the relevance of VET tasks. It remains unclear whether firms' task composition induces not only the demand for employees and the wages firms pay, but also their training decisions. The question that arises is whether an increasing demand for analytic and interactive tasks distracts firms from covering their demand for skilled labour via VET, or whether an increasing demand for non-routine tasks increases the requirements for future apprentices. My study aims to close this research gap by examining the relationship between tasks and VET.

Between 2011 and 2019, the number of youngsters entering the German VET diminished by approximately 15% (BIBB 2020b). Different, partly contradictory developments drove this shrinkage. First, the number of school-leavers has been decreasing over time (Autorengruppe Bildungsberichterstattung 2018). Second, more school-leavers entered the tertiary instead of the VET system. Third, at the firm level, induced by the two former trends, we observe rising problems in filling vacant apprenticeship positions. Fourth, partly due to these problems, firms withdraw from offering VET, implying the shrinking participation of firms in the VET system. Last, the mismatch of occupations offered by firms and demanded by school-leavers challenges the German VET system (BIBB 2020b).

From these named drivers of declining participation rates of youngsters in VET, I concentrate on the decreasing share of firms offering VET. I state that knowing the mechanism behind firms' decisions for or against VET plays a key role. Deepening the understanding of firms' decision to participate in VET becomes important in being able to take countermeasures against the withdrawal of firms from VET. To extend the discussion on VET and disclose additional drivers of VET decisions, I first investigate whether firms' task composition is associated with the decision to provide VET.

In light of the rising problems of school-leavers with lower school-leaving certificates in starting an apprenticeship (cf. Kleinert and Jacob 2012) and increasing numbers of apprentices with a university entrance certificate (BIBB 2020b), school-leaving certificates need to be the focus of research on firms' training decisions. Firms act as gatekeepers; they decide how many and which youngsters begin an apprenticeship, thereby defining their opportunities. To uncover a possible source for the development of the composition of apprentices according to their school-leaving certificate, I examine the school-leaving certificate of newly hired apprentices considering firms' task composition. I focus my analyses on school-leavers with lower secondary certificates and those with a university entrance certificate since there is a considerable change in the share of these groups in the VET system.

As a data source, I use the BIBB Establishment Panel on Training and Competence Development (BIBB Training Panel). My study contributes to a deeper understanding of the reasons firms train and who they train. Further, I generate new insights into the discussion on the future of VET by highlighting an additional mechanism that drives the observable upskilling of the German labour market (Baethge and Wolter 2015). Knowing how tasks and training decisions interact might help assess future developments in the training market.

2. Theoretical framework

2.1. *The task-based approach*

I use a task-based approach to enhance the explanations about firms' training decisions.¹ Autor, Levy, and Murnane (2003) conceptualised a model of how computers and technologies substitute or complement tasks and affect employment shares and wages. They distinguished five tasks: routine cognitive, routine manual, non-routine manual, analytic, and interactive tasks. Autor, Levy, and Murnane (2003) argue that the adoption of computer technology induced a decline in the demand for cognitive and manual routine tasks, since these tasks can be automated or outsourced easily. On the contrary, non-routine tasks are important because they are not easily automatable; instead, they are complemented by new technologies. In contrast, technological change does not affect non-routine manual tasks.

Theoretically, each skill group can perform all tasks. Böckerman, Laaksonen, and Jari (2018) show with Finish firm-level data that ‘a substantial share of medium-educated work in abstract occupations’ (14). Nevertheless, high-skilled employees are more productive than unskilled and medium-skilled employees. They have a comparative advantage, particularly in performing complex tasks such as analytic and interactive tasks (Autor 2013). For example, firm-level analyses by Bresnahan, Brynjolfsson, and Hitt (2002) for the United States show that firms that introduced new technology have a higher demand for skilled employees.

Numerous studies have investigated the effect of technological change on shifts in job tasks and skill demand (e.g. Acemoglu and Autor 2011; Autor and Handel 2013; Spitz-Oener 2006). The substitution of routine tasks by computers and automation does not lead to the disappearance of entire occupations, but to changes in their task content (e.g. Bonin, Gregory, and Zierahn 2015). On the grand scale, replacement is a threat to about 15% of German employees (Dengler and Matthes 2018). The literature illustrates the polarisation of skill demand – the growing demand for high- and low-skilled employees accompanied by the declining demand for medium-skilled employees – on the individual (e.g. Bachmann, Cim, and Green 2018), occupational (e.g. Goos et al. 2009), and industry level (e.g. Michaels, Natraj, and Van Reenen 2014).

2.2. The German education and VET system

High stratification and standardisation combined with a strong school-to-work linkage characterise the German education system (Allmendinger 1989). A pronounced path dependency structures the educational careers of youngsters. After primary education, children and their parents have to choose among three options for secondary education (see Figure 1). The first option, the

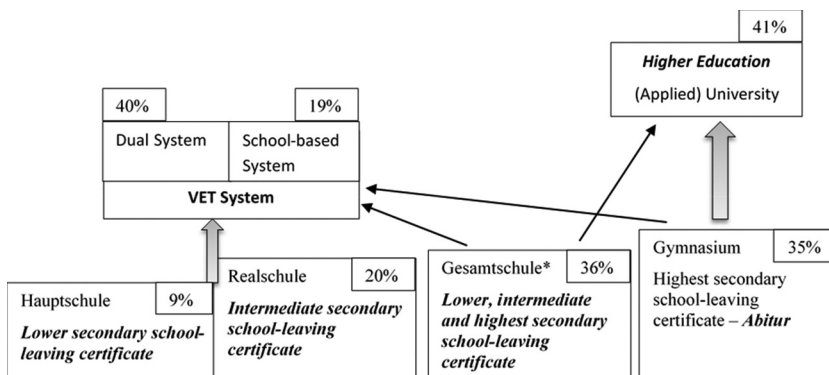


Figure 1. German education system. Source: DESTATIS 2020; BIBB 2020b; Own image and calculations. Note: * The term ‘Gesamtschule’ subsumes schools offering more than one educational path including ‘Waldorfschulen’ (private schools following the ideas of Rudolf Steiner).

'Hauptschule', includes about 9% of all pupils who attended secondary education in 2019/2020 (cf. [Figure 1](#)). This type of school leads to the lowest secondary school-leaving certificate and implies about five to six years of schooling. The second option, the 'Realschule', comprises about 20% of all pupils, leads to an intermediate secondary school-leaving certificate (cf. [Figure 1](#)), and implies six years of schooling. The third option, the 'Gymnasium', encompasses 35% (cf. [Figure 1](#)), leads to the highest school-leaving certificate, the Abitur, and implies eight to nine years of schooling. Last, about 36% of all pupils who attended secondary education attend a school combining the three options (cf. [Figure 1](#)) and enables pupils to achieve a lower or intermediate secondary school-leaving certificate as well as an Abitur.

Depending on the school-leaving certificate, graduates show differences in their skills. In line with the human capital theory (Becker 1964), graduates with an Abitur, which implies two to three additional years of schooling, acquire more human capital than graduates with a lower or intermediate secondary certificate. At the age of 15, students attending a Gymnasium have significantly higher reading, calculating, and natural science competencies than their counterparts in other types of schools (Reiss et al. 2019).

The school-leaving certificate determines the educational path by enabling youngsters to follow an academic path and enter higher education, or limits them to the vocational path. The Abitur acts as a university entrance certificate. About 41% of youngsters advancing to higher education after general schooling enter an (applied) university (cf. [Figure 1](#)). Most school graduates leaving the school without an Abitur do not directly enter the labour market but enter the VET system. The German VET system consists of dual training and a full-time school-based system. The full-time school-based system mostly covers health care or nurturing occupations, and comprises about 20% of youngsters advancing to higher education after general schooling (cf. [Figure 1](#)). As firms only play a minor role in this system, I do not include the school-based system in my analyses, and from here on, VET only implies the dual system.

The dual system encompassed about 40% of youngsters advancing to education after general schooling (cf. [Figure 1](#)) and combines in-company training with additional vocational schooling. The market organises access to the dual system by firms acting as gatekeepers and deciding on the youngsters to hire as future apprentices. The hiring decision strongly relies on the school-leaving certificate. Research has shown that 'in Germany [the] type of school degree is crucial in the transition process' (Protsch and Dieckhoff 2011, 86), even though no minimum school-leaving certificate is required to start an apprenticeship in the dual system.²

2.3. VET and school-leaving certificates

Theoretically, the association between the school-leaving certificate and VET can be explained using the signalling theory (Spence 1973). Firms have

incomplete information about the productivity and skills of apprenticeship applicants. To meet the lack of information, firms use signals to anticipate which applicants satisfy their expectations. Being easily observable and costly to achieve makes school-leaving certificates suitable signals for screening applicants for an apprenticeship.

Human capital theory (Becker 1964) predicts that the more time individuals have invested in education, the more productive they become. Regarding the decision to hire an apprentice, this assumption implies that youngsters with a higher school-leaving certificate have invested more in their human capital and hence are more productive apprentices than youngsters with lower secondary certificates. Given firms' interest in increasing the most productive apprentices, firms tend to prefer higher school-leaving certificates.

Another theoretical approach to explain the link between school-leaving certificates and VET is the queuing theory (Thurow 1975). Firms order applicants according to their employability, whereby they sort suitable youngsters at the beginning of the labour queue. The school-leaving certificates facilitate firms to judge the employability of VET applicants whereas a higher certificate implies higher employability. Applicants with high school-leaving certificates have a better position in the labour queue and hence firms hire them more likely.

To assess the relevance of the different school-leaving certificates, I present their distribution and development within the VET system in Figure 2. Examining the share of school-leaving certificates of apprentices starting their training in the dual system in 2017, we observe that, about 42% of them hold an intermediate secondary certificate. About 29% of apprentices started their training in the dual system with an Abitur, 25% with a lower secondary certificate, and 4% without a certificate.

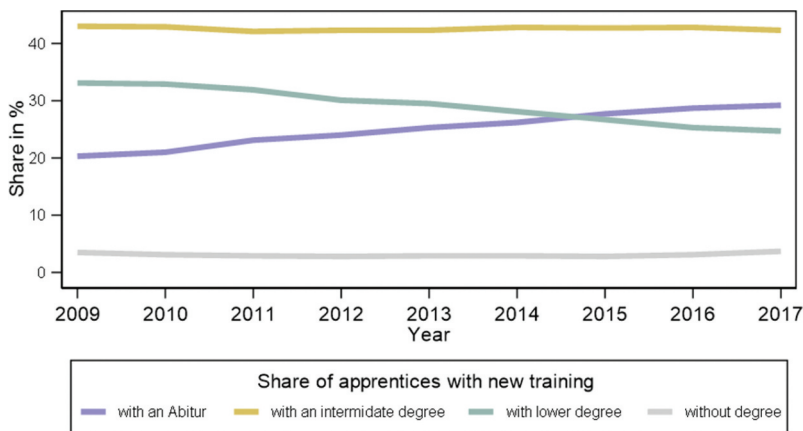


Figure 2. Share of school-leaving certificates of apprentices starting VET. *Source:* BIBB 2020b; own image.

In some occupations such as those in *digital and print media design* or in *insurance and financial services*, the share of youngsters starting an apprenticeship with an Abitur exceeds 65% and 70%, respectively (BIBB 2020a). In contrast, in other occupations such as *butchers* (9%) or *hairdressers* (7%), the share of apprentices with an Abitur is fairly low, but the share of apprentices with a lower secondary certificate is quite high (51% each) (BIBB 2020a).

Occupational differences in the share of school-leaving certificates can be related to differences in task demand. Occupations differ in their task structure (e.g. Rohrbach-Schmidt 2019) and hence require different skills. These differences already manifest in training occupations, and affect the demand for apprentices. Firms who conduct training for occupations calling for high shares of analytic and interactive tasks need apprentices with high skills, usually those with an Abitur. In sum, occupations with a high demand for analytic and interactive tasks such as those in *digital and print media design* and in *insurance and financial services* imply a high share of apprentices with an Abitur, whereas occupations with a high demand for routine or manual tasks such as *butchers* and *plumbers* imply low shares of apprentices with an Abitur.

There is a clear pattern in the development of the shares of apprentices' school-leaving certificates since 2009: the share of Abitur rises (2009: 20%; 2017: 29%), the share of lower secondary certificates declines (2009: 33%; 2017: 25%), the share of intermediate secondary certificates and the share of apprentices with no certificate oscillate around 42–43% and around 3%, respectively (cf. Figure 2).

Comparing the developments of the shares of apprentices' school-leaving certificates with the development of tasks of German male full-time workers aged 18–65 (cf. Figure 3) one detects similarities. Similar to the share of apprentices with a lower secondary certificate, the share of routine and non-routine manual tasks declines over time. In contrast, the share of apprentices with an Abitur and the share of non-routine (cognitive) (i.e. analytic and interactive) tasks increased. The assumption that both trends are not random but correlated seems obvious. The rising demand for non-routine (cognitive) tasks induces firms to preferably hire apprentices with high skills, namely with an Abitur. On the other hand, diminishing demand for routine and non-routine manual tasks reduces firms' demand for school-leavers with a lower secondary certificate.

The growing share of school-leavers with an Abitur who want to start an apprenticeship affects the probability of finding an apprenticeship. School-leavers compete with each other for VET positions, with graduates with an Abitur displacing those with an intermediate or lower secondary certificate (cf. Beicht and Walden 2018).

The lower the school-leaving certificate, the more problematic (i.e. lengthier and more uncertain) the transition into an apprenticeship becomes (e.g. Beicht and Friedrich 2008). A considerable amount of literature describes the problems of school-leavers with a lower secondary certificate in finding an apprenticeship

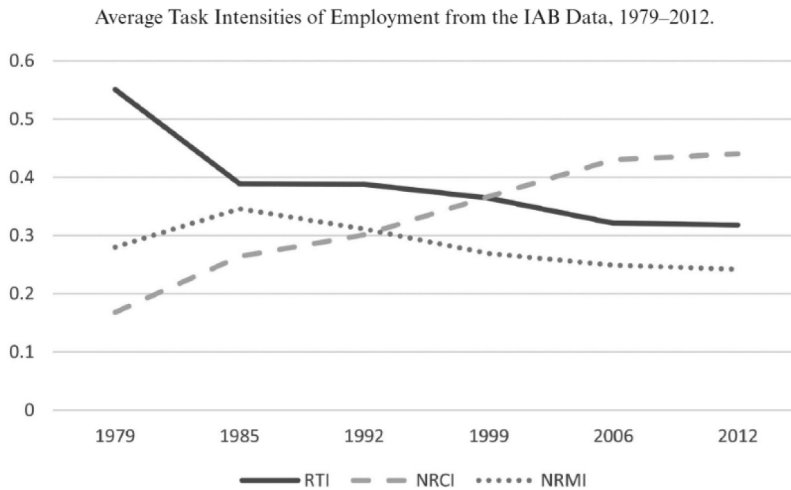


Figure 3. Development of tasks in Germany. *Source:* Bachmann et al. 2018, 13. *Population:* Male full-time workers aged 18-65.

(e.g. Solga 2002; Protsch and Dieckhoff 2011). Kleinert and Jacob (2012), for example, state that between 1975 and 2005, the problem of finding an apprenticeship for school-leavers with a lower secondary certificate rose substantially.

On the contrary, Troltsch and Walden (2012) state that between 1983 and 2010, the chances of school-leavers with a lower secondary certificate finding an apprenticeship temporarily not worsened. Nevertheless, occupational choices for school-leavers with a lower secondary certificate narrowed down and the segmentation of the dual system increased (Troltsch and Walden 2012). A recent study by Mohr and Weis (2019) points out that so far, typical occupations for school-leavers with lower secondary certificates have changed into occupations with a majority of school-leavers with an intermediate secondary certificates or an Abitur. This development implies diminishing occupational choices for school-leavers with lower secondary certificates. The authors identified increasing cognitive demands as a driver of the transformation.

3. The effect of tasks on VET decisions

Firms decide whether to participate in VET, and if they do, which apprentices to hire. They make these decisions against the background of the task to be performed in the firm. To derive my hypothesis, I connect firms' decisions concerning VET to their task composition.

Firms rely on high-skilled employees to perform non-routine tasks because, as stated before, these employees perform analytic and interactive tasks more productively. In particular, firms with a high share of non-routine tasks have a lower need for medium-skilled employees trained via VET. These firms most likely withdraw from VET, a phenomenon observable in the German VET system

(cf. BIBB 2020b). I deduce that firms with high shares of analytic or interactive tasks have a lower probability of providing VET. In contrast, medium-skilled employees typically perform routine and especially manual tasks to a greater extent than high-skilled employees (e.g. Rohrbach-Schmidt 2019). Firms with a high share of routine or manual tasks can use VET to meet their demand for skilled employees. I hypothesise that a high share of routine or manual tasks is associated with a higher probability of offering VET (H1).

According to Autor (2013), medium-skilled employees will not disappear; instead, they perform non-routine, that is, analytic and interactive tasks, to a greater extent. So, ‘many middle-skill jobs will continue to demand a mixture of tasks from across the skill spectrum’ (Autor 2015, 26). Following this argumentation, VET will not become obsolete as the tasks of medium-skilled employees change. Reallocating employees to analytic and interactive tasks enhances firms’ productivity (Egger and Grossmann 2005). Theoretically, reallocation imposes additional training costs. Hiring apprentices and training them to perform non-routine tasks instead of training incumbent employees who perform routine or manual tasks could be a cheaper and more rewarding option. During the training phase, firms do not have to pay full wages to the apprentices and they can use the training period as screening to find the apprentices with the highest ability to perform non-routine tasks. Hence, firms with high shares of analytic or interactive tasks also show interest in participating in VET, even though, as argued above, to a lower extent.

Egger and Grossmann (2005) theoretically explained why analytical and social (i.e. interactive) abilities are crucial to perform non-routine tasks. Following this argument, school-leavers with an Abitur have comparative advantages and are more productive in performing analytic and interactive tasks. I deduce that firms with a high share of analytic or interactive tasks who offer VET more likely hire and in greater number apprentices with an Abitur. Nevertheless, the possibility of youngsters with an Abitur leaving the firm after the apprenticeship to attain further training in an (applied) university might discourage firms³ from hiring school-leavers with an Abitur. Firms lose their investments when graduated apprentices leave the firm to study. Additionally, the supply of youngsters with an Abitur interested in VET is limited because the share of youngsters entering university is increasing. Moreover, whether school-leavers with an Abitur are interested in occupations with high shares of routine and manual tasks is questionable. Hence, firms rely on apprentices without an Abitur to perform routine and manual tasks. Thus, I hypothesise that firms with high shares of routine or manual tasks have a lower probability of hiring apprentices with an Abitur, and even if they do, they hire fewer of them (H2).

Compared with 15-year-old students attending a Gymnasium, those at other types of schools show higher variances in reading, calculating, and natural science competencies (cf. Reiss et al. 2019), making it more difficult for firms to predict their competences. Particularly, for firms with high shares of analytic

or interactive tasks, taking the risk of hiring an applicant with low competences who may not meet the firm's requirements plays an important role in their selection of apprentices. In particular, a lower secondary certificate signals a school graduate's low ability (cf. Kohlrausch 2013) and thereby low productivity, especially in performing non-routine tasks. Instead of the insecure hiring of school-leavers with a lower secondary certificate, firms might withdraw from VET or accept unfilled training positions. I argue that firms with high shares of analytic or interactive tasks have a low probability of hiring graduates with a lower secondary certificate, and even if they do so, they hire fewer of them. For firms with high shares of routine or manual tasks, productivity in performing non-routine tasks is delineated as less decisive, whereas other skills such as dexterity are more important. I hypothesise that these firms more likely hire school-leavers with a lower secondary certificate and more of them (H3).

4. Data, variables, and methodology

4.1. Data

This study uses data from the BIBB Training Panel, which covers approximately 2,000 to 3,500 firms per year. The survey, based on a random sample, is representative of German firms with at least one employee subjected to social security contributions (cf. Gerhards, Mohr, and Troltsch 2012). As they include a special module of items on employees' job tasks, I combine three of the seven waves of the BIBB Training Panel, namely the data sets of 2012, 2015, and 2016 (Gerhards et al. 2016; Gerhards, Mohr, and Troltsch 2017, 2018). Together, the data sets included 9,196 observations. Keeping only firms that participated for more than one year, I end up with 4,438 observations in the final data set.

4.2. Variables

I specify three types of dependent variables: first, a dummy indicating whether a firm offers VET or not; second, dummies indicating whether a firm hires apprentices with an Abitur or a lower secondary certificate⁴; and third, shares of newly hired apprentices with an Abitur or lower secondary certificate.

My main independent variables include the firms' task composition. The measurement for low- (performing tasks usually requires no formal qualification), medium- (performing tasks usually requires VET), and high-skilled employees (performing tasks usually requires a university degree) was carried out separately. The implementation of tasks is based on considerations of Autor, Levy, and Murnane (2003). The survey collected two items each for analytic, interactive, routine, and manual tasks depending on the frequency (frequently, sometimes, or never⁵) the different skill groups performed each task.

4.3. Methodology

To measure the task share of a firm, I assign each collected task item to either analytic, interactive, routine, or manual tasks following the approach of Autor, Levy, and Murnane (2003). Table A1 in [Appendix 1](#) contains the wording of each item and its mapping to the task category. I calculate an index for each task comprising the share of the respective task in relation to all tasks performed in a firm.

The average task composition of a firm is rather stable over time; the deviation only lies within 0.04 (analytic, interactive, and manual tasks) and 0.05 (routine tasks) (cf. Table A2 in [Appendix 1](#)). This variation proves insufficient for a fixed effects model. To account for differences within a firm and additional model differences between firms, I estimate hybrid models (cf. Schunck 2013).⁶ For individual- and firm-level data of different topics, these models proved to be appropriate in comparing differences between individuals or firms and simultaneously account for differences within an individual or firm (e.g. Dieleman and Templin 2014; Lancee and Sarasin 2015; Pike and Robbins 2020). To avoid collinearity, as three task variables can perfectly predict the value of the fourth one, I always estimate separate models for analytic and interactive or routine and manual tasks. Overall, I calculate eight separate models.

To supplement the task shares, I add the following control variables: logarithmic business volume, logarithmic investments, logarithmic number of newly hired apprentices (only in the models evaluating the school-leaving certificate of newly hired apprentices), logarithmic number of employees, the share of medium-skilled employees (to account for firms' employment structure), industry, region (east vs. west), whether the firm has a staff or work council, a year dummy (to capture the influence of aggregated time series trends), and dummies for training occupations indicating whether a firm offers training in the respective occupation (to account for occupational specificity).

Hybrid models allow for a causal interpretation of the results. However, this statement only applies if the observed and unobserved firm effects are uncorrelated (cf. Schunck and Perales 2017). In other words, when time-variant unobserved variables affect the observed variables, the predicted random effects are biased. In my analyses, educational and economic characteristics of the region are conceivable influences. The regional labour markets not only induce the chances of youngsters entering VET (cf. Weßling, Hartung, and Hillmert 2015) but also shape their occupational aspirations (Flohr, Menze, and Protsch 2020). In line with this, the number of youngsters applying for VET differs between federal states and districts (BIBB 2020b). Further, the share of youngsters with lower-secondary certificates and Abitur varies among federal states (DESTATIS 2020), inducing differences in the supply of apprentices. In Germany, regional labour markets also differ in their share of unemployment, population, and other conditions (cf. Blien and Hirschenauer 2018). Since the

data set only allows for differences between Eastern and Western Germany, I am not able to control for the named spatial differences. It is likely that these unobserved characteristics correlate to some extent with my observed variables and bias my coefficients. Hence, a causal interpretation is not advisable. However, the direction and significance of the estimated coefficients provide crucial insights into how tasks and VET are interwoven.

5. Results

5.1. Descriptive results: characteristics of firms

Table 1 presents the key characteristics of the data set. With an average share of 80%, medium-skilled employees represent the majority of, on average, 14 employees in a firm. Firms offering VET were oversampled in the data set. In 2016, 20% of German firms offered VET (BIBB 2019), whereas 60% of the firms in my analytical sample offered VET. Oversampling is advantageous because it ensures a sufficient number of cases to investigate firms' decisions concerning the school-leaving certificate of the apprentices they hire.

To display the variation of school-leaving certificates of newly hired apprentices, I use a box plot diagram (see [Figure 4](#)). The emerging development of the share of newly hired apprentices with a lower secondary certificate and an Abitur reflects what we know from the literature and official statistics (cf. Chapter 2.2). Looking at the third quartile (i.e. 75% percentile) in the box plot, the share of newly hired apprentices with a lower secondary certificate declined considerably between 2012 and 2016. Starting at about 1.0 (2012), the third quartile shrinks to 0.2 (2016) implying that in 2016, in 75% of all firms, the share of newly hired apprentices with a lower secondary certificate did not exceed

Table 1. Firm characteristics.

	2012	2015	2016
Observations	491	2,021	1,926
Share of medium-skilled employees (mean)	0.8	0.8	0.8
Number of employees (mean)	13.9	12.9	15.8
Firms offering VET (in %)	26.8	21.1	24.8
Firms offering VET (in %; not weighted)	63.8	64.4	60.0
Region, share of West-German firms (in %)	79.6	79.8	79.2
Share of firms with staff/work council (in %)	28.9	13.0	33.1
Industry: (Shares in %)	4.0	2.7	3.3
Agriculture/Mining/Energy	11.9	9.9	10.2
Manufacturing	8.9	10.6	9.4
Construction Industry	14.4	19.3	19.0
Trade & Repairing	19.3	22.4	22.4
Business-related services	17.5	17.5	15.7
Other, mainly personal services	12.1	9.8	13.1
Medical services	12.0	7.8	6.9
Public services and education			
Business volume (mean) in €	5.6 M	7.7 M	24 M
Investments (mean) in €	303.5 K	388.8 K	234 K

Source. BIBB Training Panel 2012, 2015, and 2016; weighted values.

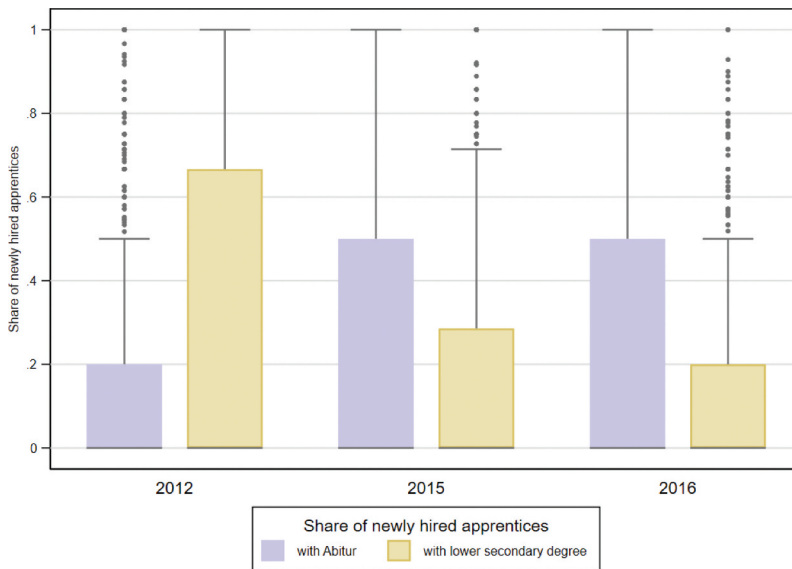


Figure 4. Box plot of school-leaving certificate of newly hired apprentices. *Source:* BIBB Training Panel 2012, 2015, and 2016; weighted values.

20%. Contrary to this development, the share of newly hired apprentices with an Abitur increases. The third quartile increased from 0.3 (2012) to 0.4 (2016). Accordingly, in 2016, 75% of German firms had up to 40% newly hired apprentices with an Abitur.

In the three observation periods, we observe a balanced task share within firms (cf. Figure 5). Most of the employees performed manual and interactive tasks (27% in 2016), and slightly less carried out routine and analytic tasks (23% in 2012). As expected, according to the task-based approach, the share of analytic and interactive tasks increases over time, even though only slightly, about one to two percentage points. Correspondingly, the share of routine and manual tasks slightly falls from 0.24 and 0.28, respectively, in 2012, to 0.23 and 0.25, respectively, in 2016.

5.2. Multivariate results: the correlation of tasks and VET

The descriptive results show that approximately 20% of the firms participate in VET (cf. Table 1). Concerning the decision whether to train, task share plays a role. Table 2 shows that high shares of manual tasks (H1) significantly correlate with an increase in the probability of providing VET by approximately 13%. It is reasonable to assume that firms with high shares of manual tasks use mainly VET to meet their demand for skilled labour (cf. Rohrbach-Schmidt 2019). In contrast, firms with a high share of routine tasks showed the opposite correlation. An increasing share of routine tasks is accompanied by a decreasing probability of approximately 13% (AME share of routine tasks, between

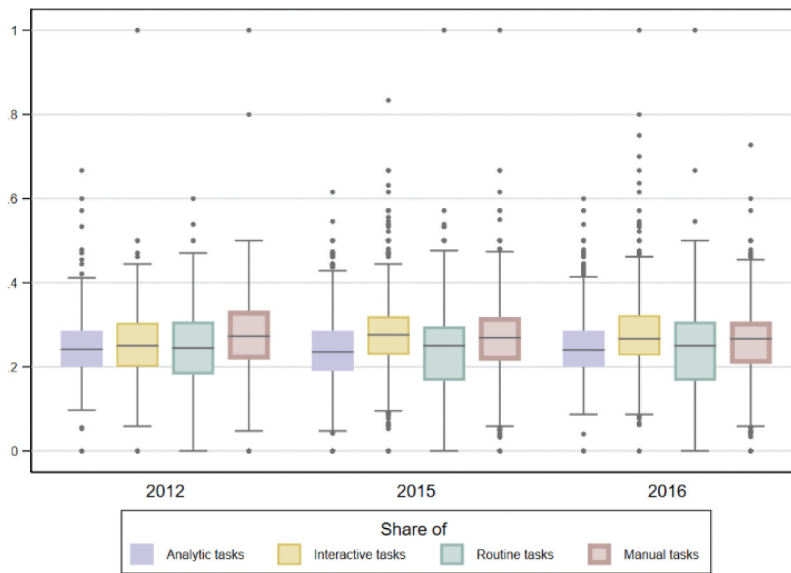


Figure 5. Task shares of employees within firms. *Source:* BIBB Training Panel 2012, 2015, and 2016; weighted values.

expressed as a percentage; cf. Table 2) to offer VET. Since VET involves training costs (cf. Gehret et al. 2019; Schönfeld et al. 2020), accepting them for routine tasks might not be worthwhile. It is likely that hiring unskilled or externally trained medium-skilled employees to meet the demand for labour is more efficient. Contrary to my assumptions, firms with high shares of analytic or interactive tasks do not participate significantly less likely in VET. I find no significant correlation between those tasks and the probability of firms to provide VET (cf. Table 2).

In addition to the correlation between firms' task share and training decisions, the distribution of tasks might also be linked to the kind of apprentices that firms hire, if they hire apprentices. Figure 6 depicts the coefficients⁷ of task shares on the probability of hiring and the share of hired school-leavers with an Abitur or lower secondary certificate. To illustrate the significance of the coefficients, I added confidence intervals; when they do not traverse the dashed line, the coefficient is significant. Table A3 in Appendix 1 shows the full regression results.

Starting with newly hired apprentices with an Abitur, we see that firms with a higher share of interactive tasks are significantly more likely hire them as apprentices (cf. Figure 6). This finding suggests that firms anticipate the two or three additional years of training for graduates with an Abitur with a higher ability to perform interactive tasks. Or maybe the Abitur signals better developed interactive skills. In contrast, the share of analytic tasks does not significantly relate to the decision on whether to train youngsters with an Abitur. Extra schooling turns out to be immaterial for analytic tasks. This finding may indicate

Table 2. Coefficients and robust standard errors of logistic hybrid models on the decision to provide VET.

<i>Variables</i>	<i>Coefficient</i>	<i>AME</i>	<i>Coefficient</i>	<i>AME⁺</i>
Share of analytic tasks, between	-0.690	-0.032		
Share of analytic tasks, within	1.329	0.062		
Share of interactive tasks, between	1.218	0.057		
Share of interactive tasks, within	-0.271	-0.013		
Share of routine tasks, between			-2.761**	-0.133**
Share of routine tasks, within			-0.246	-0.012
Share of manual tasks, between			2.762*	0.133*
Share of manual tasks, within			-0.644	-0.031
Log. number of employees, between	1.866***	0.087***	1.768***	0.085***
Log. number of employees, within	0.116	0.005	0.112	0.005
Share of medium-skilled employees, between	6.856***	0.319***	6.536***	0.315***
Share of medium-skilled employees, within	-0.245	-0.011	-0.217	-0.010
Region (<i>Reference = West</i>)	-1.796***	-0.084***	-1.762***	-0.085***
Staff/Work council (<i>Reference = No</i>)	0.353	0.016	0.351	0.017
Industry (<i>Reference = Manufacturing</i>)				
Agriculture/Mining/Energy	-1.507**	-0.070**	-1.474**	-0.071**
Construction Industry	-1.087**	-0.051**	-1.082**	-0.052**
Trade & Repair	0.178	0.008	0.379	0.018
Business-related services	-3.007***	-0.140***	-2.673***	-0.129***
Other, mainly personal services	-1.640***	-0.0764***	-1.360***	-0.066***
Medical services	-8.039***	-0.374***	-7.494***	-0.362***
Public service and education	-3.379***	-0.157***	-3.064***	-0.148***
Log. Business volume, between	-0.147	-0.007*	-0.120	-0.006
Log. Business volume, within	-0.033	-0.002	-0.040	-0.002
Log. investments, between	0.330***	0.015***	0.315***	0.0152***
Log. investments, within	0.017	0.001	0.018	0.001
Year (<i>Reference = 2012</i>)				
2015	-0.249	-0.0116	-0.203	-0.010
2016	-0.558**	-0.0260**	-0.503*	-0.024*
Constant	-6.635***		-6.651***	
Observations	6,494	6,494	6,491	6,491

*** p < 0.01, ** p < 0.05, * p < 0.1.

Source. BIBB Training Panel 2012, 2015, and 2016, unweighted estimations.

Note: ⁺ AME means average marginal effects, hence the effects of a variable on the dependent variable when all other independent variables are kept constant.

a mismatch between the supply and demand of school-leavers with an Abitur. Firms with high shares of analytic tasks may hire more apprentices with an Abitur, but not enough of such students are interested in the respective apprenticeship. As expected, a high share of routine tasks is associated with a lower probability of hiring apprentices with an Abitur (H2). The same holds true for manual tasks; however, the coefficient is not significant, whereas high shares of manual tasks significantly correlate with a lower share of newly hired apprentices with Abitur.

The coefficient for apprentices with a lower secondary certificate supports H3. The higher the share of routine tasks, the higher the probability of firms hiring apprentices with a lower secondary certificate (H3) (cf. Figure 6). The same applies to manual task shares. Turning to the results concerning the number of apprentices with lower secondary certificates, they suggest that high shares of routine or manual tasks induce high numbers of newly hired apprentices with lower secondary certificates (cf. Figure 6).

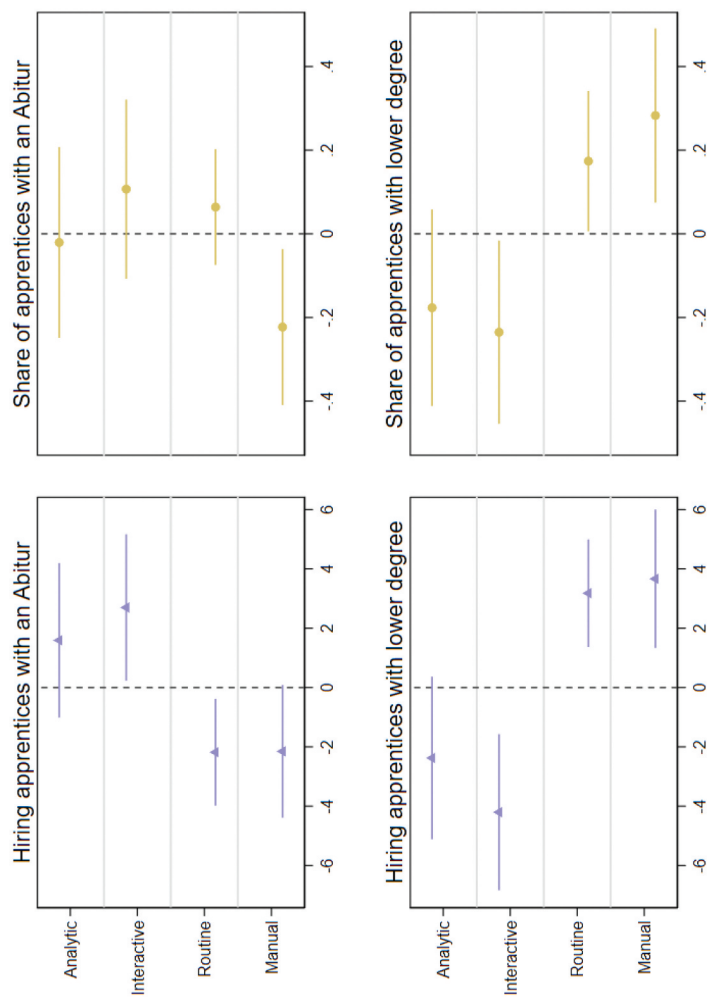


Figure 6. Coefficients and their confidence intervals of task shares on the probability to hire apprentices with the respective school-leaving certificate, and share of hired apprentices with the respective school-leaving certificate. Source: BIBB Training Panel 2012, 2015, and 2016, unweighted estimations/Note: The full regression tables can be found in Appendix Table A2.

Concluding my multivariate findings, they suggest that a firm's task composition affects the decision on training. The share of routine and manual tasks turns out to be decisive. Additionally, a high share of interactive tasks induces firms to count on apprentices with an Abitur.

6. Conclusion

This study examined the connection between tasks and firms' VET decisions. For my analyses, I used three waves of the BIBB Training Panel and applied hybrid models. The results revealed that, in my data, firms' task composition correlates with their decisions concerning VET. Firms with a high share of routine tasks are less involved in VET. This finding is probably an expression of the fact that VET is not available for free but comes along with costs (cf. Schönfeld et al. 2020). Investing in the training of apprentices might not be worthwhile when they perform routine tasks after their training because unskilled workers who yield lower wages could also carry out these tasks. In light of analysing the BIBB Training Panel, to meet the demand for employees performing routine tasks, hiring unskilled or externally trained medium-skilled employees is a more efficient option. On the other hand, a high share of manual tasks increases firms' probability of providing VET. Keeping in mind that medium-skilled employees typically perform manual tasks, this finding is not surprising.

Concerning the connection of task shares and the type of school graduates firms hire as future apprentices, I found in my sample that firms with high shares of interactive tasks have a higher probability of hiring apprentices with an Abitur. I argued that the two additional years of training of graduates with an Abitur increases their ability to perform interactive tasks and signal this extension to firms. Examining whether firms with high shares of analytic or interactive tasks train their apprentices to carry out non-routine tasks to a greater extent than those with a low share of non-routine tasks is a promising agenda for further analyses. So far, different studies have shown that VET graduates with an Abitur achieve higher returns to education than those without an Abitur (e.g. Friedrich and Hirtz 2021). Considering that firms with high shares of analytic or interactive tasks more likely hire applicants with an Abitur, and given the premise that they better enable their graduates to perform non-routine tasks might be a part of the explanation why VET graduates with an Abitur earn higher wages. Scrutinising this assumption enriches our knowledge of wage differences.

According to my analysis, school-leavers with lower secondary certificates are more likely to be hired by firms with high shares of routine or manual tasks. Given the risk of a further decline in routine tasks, the problem of finding an apprenticeship among school-leavers with a lower secondary certificate might continue to worsen over time. Knowing that obtaining a VET degree attenuates the risk of being unemployed or marginally employed (Giesecke, Ebner, and

Oberschachtsiek 2019), firms hiring and educating school graduates with lower secondary certificates are particularly important in opening employment opportunities for youngsters with a lower secondary school-leaving certificate. Given the threat of rising problems for school-leavers with a lower secondary certificate entering VET it seems crucial to enable them to perform interactive and analytic tasks as far as possible (e.g. by updating school curricula). Moreover, more specific career advice considering the task structure might help youngsters with lower secondary certificates to find firms willing to hire them. In light of the shrinking numbers of school-leavers and the rising number of youngsters entering a university, integrating school-leavers with a lower secondary certificate in the VET system might be crucial to firms if they want to avoid unfilled training positions and meet their skill demands.

This study contributes to the understanding of firms' decision to participate in VET and how technical change and VET are connected through the firms' task composition. I showed that within the VET system, higher-skilled apprentices have better chances of being trained for analytic and interactive tasks. Changing task demands likely contribute, besides, for example, stigmatisation, to the rising problems of lower-skilled school-leavers finding an apprenticeship. The results suggest that, within the VET system, technological change induces upskilling: firms train school-leavers with an Abitur to perform non-routine tasks, and hire unskilled employees to perform routine tasks. The issue of technological change influencing VET via tasks is intriguing, and could be explored in further research. However, the development in Switzerland – where the share of youngsters starting an apprenticeship and the number of firms providing VET remains stable whereas tasks shift comparable to Germany (e.g. Aapli 2020) – illustrates that increasing shares of analytical and interactive tasks not necessarily imply low participation in VET. A detailed comparison between Germany and Switzerland to uncover possible institutional factors reinforcing or inhibiting the effects of tasks on VET could be assessed by further studies.

Notes

1. Different approaches theoretically explain why firms provide VET. For an overview, see Wolter and Ryan (2011).
2. In addition to the school-leaving certificate, other factors such as grades, migration status, gender, family background (e.g. Beicht and Walden 2015) as well as an internship (e.g. Kohlrausch and Solga 2012) or performance in the job interview influence the probability of entering the VET system.
3. More than one out of five youngsters entering university obtained a VET degree before (Autorengruppe Bildungsberichterstattung 2018, 157).
4. The BIBB Training Panel only queries the school-leaving certificates for newly hired as opposed to all apprentices.
5. In 2015 and 2016, the items were measured with a 5-level scale. I combined the categories to achieve comparability.

6. I use the stata command xthybrid, cf. Schunck and Perales (2017).
7. I only illustrate the between effects because the within effects hardly show any significant influence.

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Appendix 1.

Table A1. Task categories and corresponding questionnaire items.

Analytic tasks
Completing and extending expert knowledge continually
Improving existing or test new procedures
Interactive tasks
Informing Customers and patients
Convincing others and mediating compromises
Interactive tasks
Informing Customers and patients
Convincing others and mediating compromises
Manual tasks
Using tools or operating machines
Using specific manual skills and finger dexterity
Routine tasks
Tasks are predetermined in each detail
Tasks are repetitive in each detail

Table A2. Decomposed mean and standard deviation of task shares between 2012 and 2016.

		Mean	Std.Dev.	Min	Max
<i>Analytic</i>	Overall	0.26	0.07	0	0.8
	Between		0.07	0	0.8
	Within		0.03	0.05	0.54
<i>Interactive</i>	Overall	0.27	0.09	0	1
	Between		0.08	0	1
	Within		0.03	-0.1	0.65
<i>Routine</i>	Overall	0.22	0.1	0	1
	Between		0.1	0	1
	Within		0.04	-0.12	0.66
<i>Manual</i>	Overall	0.26	0.09	0	1
	Between		0.09	0	1
	Within		0.03	-0.03	0.56

Source: BIBB Training Panel 2012, 2015 and 2016.



Table A3. Coefficients of models on the probability to hire apprentices and on the share of hired apprentices with the respective school-leaving certificate.

Variables	Abitur		Lower secondary certificate	
	Probability	Share	Probability	Share
Share of analytic tasks, between	1.592	-0.021	-2.375*	-0.177
Share of analytic tasks, within	0.028	0.022	3.502	-0.530*
Share of interactive tasks, between	2.698**	0.107	-4.203***	-0.235**
Share of interactive tasks, within	1.052	0.154	-2.496	-0.156
Share of routine tasks, between				
Share of routine tasks, within				
Share of manual tasks, between				
Share of manual tasks, within				
Log. number of employees, between	0.007	0.019**	-0.355***	3.179***
Log. number of employees, within	-0.614	-0.009	1.320	-0.955
Share of medium-skilled employees, between	-0.249	-0.018	0.893	3.664***
Share of medium-skilled employees, within	-1.140***	-0.072**	-0.336	0.774
Log. number of newly hired apprentices, within	1.392***	-0.142***	1.604***	-0.350***
Log. number of newly hired apprentices, between	2.295***	-0.132***	1.420***	1.298
Region (<i>Reference = West</i>)	-0.066	-0.030**	-1.646***	0.955
Staff/Work council (<i>Reference = No</i>)	0.290	-0.014	-0.483***	-0.349
Industry (<i>Reference = Manufacturing</i>)				
Agriculture/Mining/Energy	0.114	0.046	-1.019**	1.602***
Construction Industry	-0.940**	-0.050	0.801**	-0.126***
Trade & Repair	0.061	0.022	0.066	-0.187***
Business-related services	1.071***	0.140***	-0.712*	-0.007
Other, mainly personal services	0.988***	0.099***	-0.460	-0.218**
Medical services	-0.755	0.113*	-0.760	-0.007
Public service and education	-0.704	0.133**	-2.009***	0.033
Log. Business volume, between	0.103*	0.003	-0.013	-0.004
Log. Business volume, within	-0.071	0.004	-0.004	0.172**
Log. investments, between	0.010	-0.002	-0.010	-0.010***
Log. investments, within	-0.007	-0.005	0.065	0.008
Year (<i>Reference = 2012</i>)				
2015	-0.0426	-0.0179	-0.173	-0.002
2016	-0.0416	-0.00216	-0.0836	-0.004
Training occupations (dummy for 93 occupations)				
Constant	-4.643***	0.734***	3.351***	0.0109
Observations	3,166	1,709	3,166	0.00358
				0.924***
				1,278

*** p < 0.01, ** p < 0.05, * p < 0.1.