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The Importance of Mittelstand Firms for Regional Apprenticeship Activity – Lessons for Policy

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The Importance of Mittelstand Firms for Regional Apprenticeship Activity

Lessons for Policy

Vera Jahn

Zusammenfassung / Abstract

Politicians frequently emphasize the importance of Mittelstand firms for the economy, thereby particularly referring to their enormous engagement in training apprentices. However, there is yet almost no empirical evidence on the question whether Mittelstand firms are in fact excessively active in training apprentices. This paper contributes to the literature by studying whether the relative importance of owner-managed SMEs has an effect on firms' apprenticeship activity. Using a cross section of West German NUTS-3-regions, we find a significantly positive relation between the relative importance of Mittelstand firms and apprenticeship activity on the regional level. However, on the national level an increase in the share of Mittelstand firms turns out to be without effect on apprenticeship activity.

JEL-Klassifikation / JEL-Classification: C21; D23; I21

Schlagworte / Keywords: apprenticeship, Mittelstand firms, owner-management, SMEs, Germany, regional spillovers

1 Introduction

In many countries owner-managed small and medium sized enterprises (SMEs) are seen as superior form of organizing business. This view is particularly prevailing in Germany, where this kind of enterprise is referred to as *Mittelstand*. German politicians frequently stress the importance of owner-managed SMEs for the German economy by arguing "the German Mittelstand is the engine of the German economy" and "the Mittelstand is Germany's economic backbone" (Federal Ministry of Economics and Technology 2013, Federal Chancellor Angela Merkel 2009, Ministry of Economic Affairs, Energy and Industry of the State of North Rhine-Westphalia 2014). As a consequence of the deeply rooted belief in the important role of Mittelstand firms, German politics has launched various political programs promoting the German Mittelstand on the regional and the national level (see e.g. Bavarian Ministry of Economic Affairs and Media, Energy and Technologie (2009) and Federal Ministry of Economic Affairs and Energy (2014)). Due to the well performing German economy, there has recently been an increasing international attention in German owner-managed SMEs (see e.g. UK Trade and Invest et al. (2014)). Many countries are interested in the German Mittelstand model and some even aim at emulating it (see e.g. Kirchfeld and Randow (2010), Blackstone and Fuhrmans (2011), Fear (2014)). It is argued that Mittelstand firms essentially contributed to the resilience of the German economy (Girotra and Netessine 2013, Berghoff 2006). The German Mittelstand is also said to be responsible for a large share of aggregate output and employment and to be overly innovative (Federal Ministry of Economics and Technology 2013).[1]

German politics also often claims Mittelstand firms to play a decisive role in the apprenticeship system by employing a large proportion of apprentices in Germany (Federal Ministry of Economics and Technology 2013, Ministry of Economic Affairs, Energy and Industry of the State of North Rhine-Westphalia 2014). Apprenticeship training is economically highly relevant as it helps to meet firms' demand for skilled labour (Federal Ministry of Economics and Technology 2014) which is essential in the light of the prevailing demographic trends. Moreover, apprenticeship training might contribute to minimize youth unemployment (Winkelmann 1996, Shackleton 1997) and thus reduces social spending for the unemployed (Franz et al. 2000).

The existing literature provides various theoretical explanations why Mittelstand firms might be highly engaged in training apprentices. The employed arguments are typically based on the assumption that firms train apprentices in order to retain

[1] Berlemann and Jahn (2014) find a significantly positive relation between the regional importance of Mittelstand firms and regional innovation activity for German NUTS-3-regions.

productive apprentices as skilled employees after graduation. Thus, firms' training efforts are seen as an investment in future skilled human capital, a view which is referred to as *investment motive* (Becker 1993, Acemoglu and Pischke 1999). In this context, firms might use apprenticeships to gain information about potential future employees in order to minimize the risk of retaining unproductive workers (Franz et al. 2000, Krämer 2003, Wagner 1998). The existing literature discusses the two dimensions of Mittelstand firms (owner-management, SMEs) separately. The first strand of the literature explains why owner-managed firms might be highly active in training apprentices. In owner-managed firms owners make strategic decisions at their own risk. If these decisions e.g. concerning human resources are wrong, they have to bear the resulting costs themselves. Therefore, especially owner-managed firms might use apprenticeships to gather information about potential employees in order to minimize the risk of employing unproductive workers. Moreover, owner-managed firms usually are long-term oriented (Institut für Mittelstandsforschung Bonn 2013, Kets de Vries 1993[2]), which likely increases the incentive to train apprentices. The second strand of the literature argues why SMEs might engage excessively in the apprenticeship system. Due to the attractiveness of large employers, trainees might complete their apprenticeships in small firms and then switch ot other employers afterwards, thereby counteracting the investment motive of the training firms (Hamel 2006, Krämer 2003). Therefore, SMEs may train a relatively large number of apprentices in order to compensate quitting graduates. Additionally, SMEs often have flat hierarchies that might simplify collecting information about potential employees during apprenticeships. According to Fama and Jensen (1983), owner-management especially makes sense in small noncomplex firms. Therefore, one might in fact expect owner-managed SMEs to train a relatively large number of apprentices, as politicians often claim.

However, there is yet almost no empirical evidence on the question whether owner-managed SMEs are in fact overly engaged in the German apprenticeship system. This is likely due to the fact that official statistics often do not report on the owner and governance structure of enterprises and thus impede the identification of owner-managed firms. This paper aims at filling this gap in the empirical literature by using a unique dataset that allows us to quantify owner-managed SMEs on the macro level. We analyze the relationship between the relative importance of owner-managed SMEs and firms' apprenticeship activity on the regional level (NUTS-3) in a cross section approach. The relative importance of owner-managed

[2]Kets de Vries (1993) refers to family firms, coinciding ownership and management within the family.

SMEs is measured by the share of Mittelstand firms in all economically active firms in a region. In order to measure firms' apprenticeship activity, we use the share of apprentices in all employees subject to social insurance contributions on the regional level.[3] We focus our analysis on West Germany.[4] Controlling for a large number of additional variables and various types of spatial dependencies between regions, we detect a significantly positive impact of the relative importance of owner-managed SMEs on firms' apprenticeship activity on the regional level. This effect is quite plausible, as regions with a higher relative importance of Mittelstand firms might attract potential trainees from other regions and thus train a larger number of apprentices relative to all employees. However, since the pool of potential apprentices in Germany is limited, German regions compete for potential trainees, leading the regional advantage of a higher relative importance of Mittelstand firms to disappear when other regions show a higher relative importance of owner-managed SMEs as well. Therefore, political promotion of Mittelstand firms tends to be a reasonable instrument in order to increase apprenticeship activity in a particular region but not on the national level.

The remainder of this paper is organized as follows. The second section delivers an overview of the German apprenticeship system. Section three outlines the estimation approach and introduces the employed datasets. Section four presents the empirical results. The final section summarizes the main results and draws some conclusions.

2 Institutional Background

The German system of apprenticeship training is often recognized as exemplary compared to the training systems of other developed countries (Beckmann 2002) as it provides theoretical and practical knowledge of high quality (Federal Ministry of Economics and Technology 2009). German apprenticeship training takes place in public vocational schools, teaching theoretical knowledge, and private firms, training apprentices in practical skills. Therefore, the German system is also referred to as *dual vocational training system* (Biavaschi et al. 2012, Troltsch and Walden 2011). Creating graduates with theoretical and practical knowledge, the German apprenticeship system helps to meet the firms' demand for skilled labour, necessary

[3] Section 3.2 explains both measures in more detail.

[4] The East German apprenticeship system differs from the West German one due to historical reasons (Troltsch et al. 2009, Troltsch and Walden 2011, Wagner 1998). Therefore, we exclude East German regions from our analysis. For further details see Section 3.1.

to produce product and services of high quality (Federal Ministry of Economics and Technology 2014, Federal Ministry of Economics and Technology 2009). Thereby, the apprenticeship system might contribute to a relatively low youth unemployment rate in Germany (Winkelmann 1996, Shackleton 1997, Federal Ministry of Economics and Technology 2014).

Firms' participation in the apprenticeship system is voluntary (Winkelmann 1996). However, once decided to participate, firms are subject to the laws of apprenticeship training. The Chambers of Commerce and Industry or Crafts first check whether firms meet the official training standards to train apprentices (Federal Ministry of Education and Research 2013, Federal Ministry of Justice and Consumer Protection 2013a, Bundesausschuss für Berufsbildung 1972, Federal Ministry of Justice and Consumer Protection 2013b, Federal Ministry of Justice and Consumer Protection 2009). Granted the official permission to train apprentices, firms and trainees sign a temporary contract for the duration of the apprenticeship including the payment of a reduced wage (Federal Ministry of Education and Research 2013, Federal Ministry of Justice and Consumer Protection 2013a).

Vocational schools and training firms provide job-related skills, covering approximately 350 occupations (Biavaschi et al. 2012, Troltsch and Walden 2011). At the end of the training, apprentices pass an official job-related exam that is provided by the Chambers of Commerce and Industry or Crafts (Federal Ministry of Education and Research 2013, Federal Ministry of Justice and Consumer Protection 2013a, Federal Ministry of Justice and Consumer Protection 2013b). This official exam aims at ensuring a high training quality and should prevent enterprises from teaching firm-specific instead of mainly general knowledge (Beckmann 2002, Biavaschi et al. 2012). According to the investment motive, firms might have an incentive to provide firm-specific knowledge in order to tie graduates to the training firms (Biavaschi et al. 2012).

3 Methodology and Data

3.1 Methodology

Based on a unique dataset of German enterprises, we can examine for the first time whether the relative importance of owner-managed SMEs has an impact on firms' apprenticeship activity on the macro level. For this purpose, we regress firms' apprenticeship activity on the share of owner-managed SMEs and numerous control variables on the regional level. Since the regional share of owner-managed SMEs

is available only for the year 2008, we have to concentrate on the examination of the referring cross section.[5] Due to considerable historical differences between the East and the West German apprenticeship system (Troltsch et al. 2009, Troltsch and Walden 2011, Wagner 1998), we focus our estimation on West German regions. In the German Democratic Republic training was often outsourced from enterprises into central training centres. Additionally, apprenticeships that were not outsourced mainly took place in large enterprises, dominating the East German economic structure (Wagner 1998). In the course of German reunification, firms primarily had to adjust to the changing economic structures, neglecting the supply of apprenticeships. In order to ensure a sufficient supply of training positions, especially underrepresented SMEs have been subsidized (Troltsch et al. 2009, Wagner 1998). Therefore, we exclude East German regions form our estimation and conduct our analysis only for West German NUTS-3-regions.[6] Our empirical approach thus consists of estimating the following regression

$$\text{Apprenticeship}_r = \alpha + \beta\,\text{OMSME}_r + \gamma\,\text{X}_r + \epsilon_r \tag{1}$$

with *Apprenticeship* measuring firms' apprenticeship activity, $OMSME$ measuring the relative importance of owner-managed SMEs and X being a vector of control variables. The index r denotes the region, an observation comes from, ϵ is the error term and α, β and γ are the parameters to be estimated. In our baseline model we estimate the regression using the OLS technique and neglect possible spatial correlation.[7]

3.2 Data

In line with most of the related literature (see e.g. Franz et al. 2000, Stöger and Winter-Ebmer 2001), we use the share of apprentices in all employees subject to social insurance contributions to measure firms' apprenticeship activity.[8] The referring data on the NUTS-3-level were extracted from the *INKAR* database of the Federal Institute for Research on Building, Urban Affairs and Spatial Development.

[5] Since no clear instrument variable is available for owner-managed SMEs, we therefore have little possibilities to control for endogeneity. However, there is neither a credible theoretical argument for reverse causality nor empirical evidence pointing in this direction.

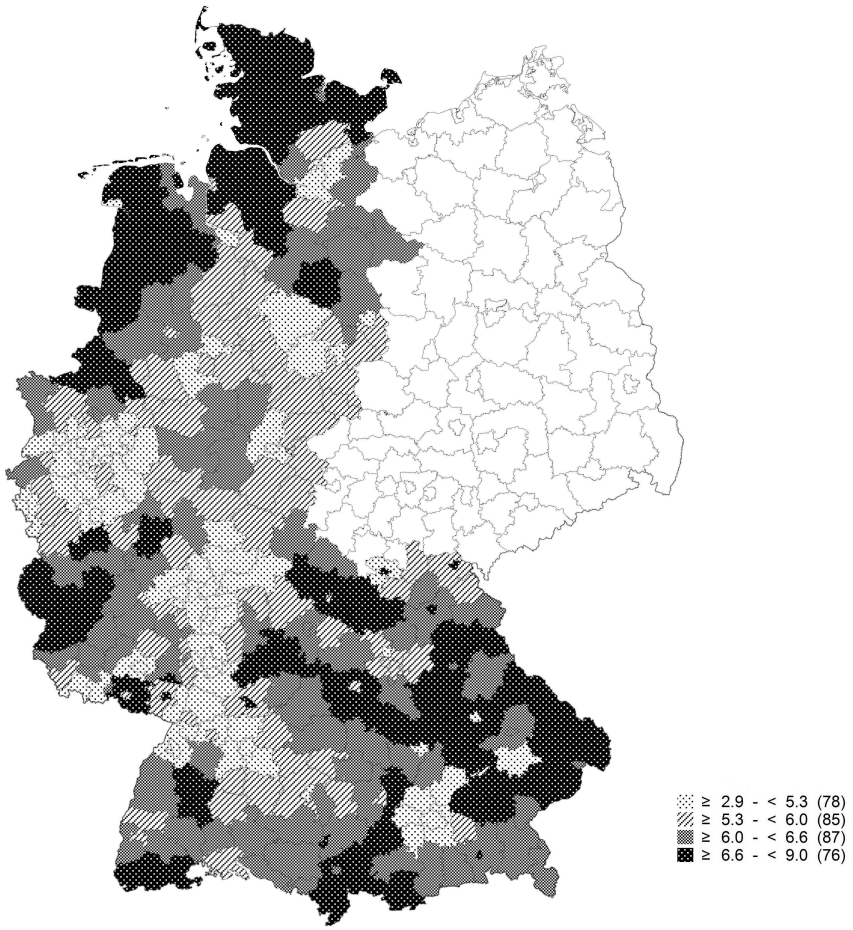
[6] According to the territorial boundaries of 31.12.2008, Germany consists of 326 West German regions and 87 East German regions on the NUTS-3-level.

[7] When conducting regressions on the NUTS-3-level, we might be confronted with spatial dependencies as a consequence of commuting behavior and spillover effects. In the first step of our analysis we refrain from taking spatial correlations into account. However, after presenting the results of our baseline regression, we turn to a detailed analysis of spatial dependencies.

[8] Since employees subject to social insurance contributions include apprentices, a quota between zero and 100 percent emerges.

Regional apprenticeship activities vary from 2.9 to 8.9 percent, with a mean of 5.88 percent. Figure 1 shows the regional quotas of apprentices in West Germany. While most central regions turn out to have relatively low apprenticeship activities, the north-western and south-eastern regions mainly show relatively high quotas of apprentices.

Figure 1: Apprenticeship activity by NUTS-3-regions in West Germany in percent, 2008



In order to measure the regional share of owner-managed SMEs in all firms, we employ a unique dataset of *Creditreform*. *Creditreform* is the largest German company information service, collecting data on all economically active firms in Germany. The database contains 3,195,389 economically active enterprises located in West Germany at the end of the year 2008.[9] The *Creditreform* database allows us to quantify owner-managed SMEs on the regional level. More precisely, it includes information on the legal form, the owners and the chief operating officers of an en-

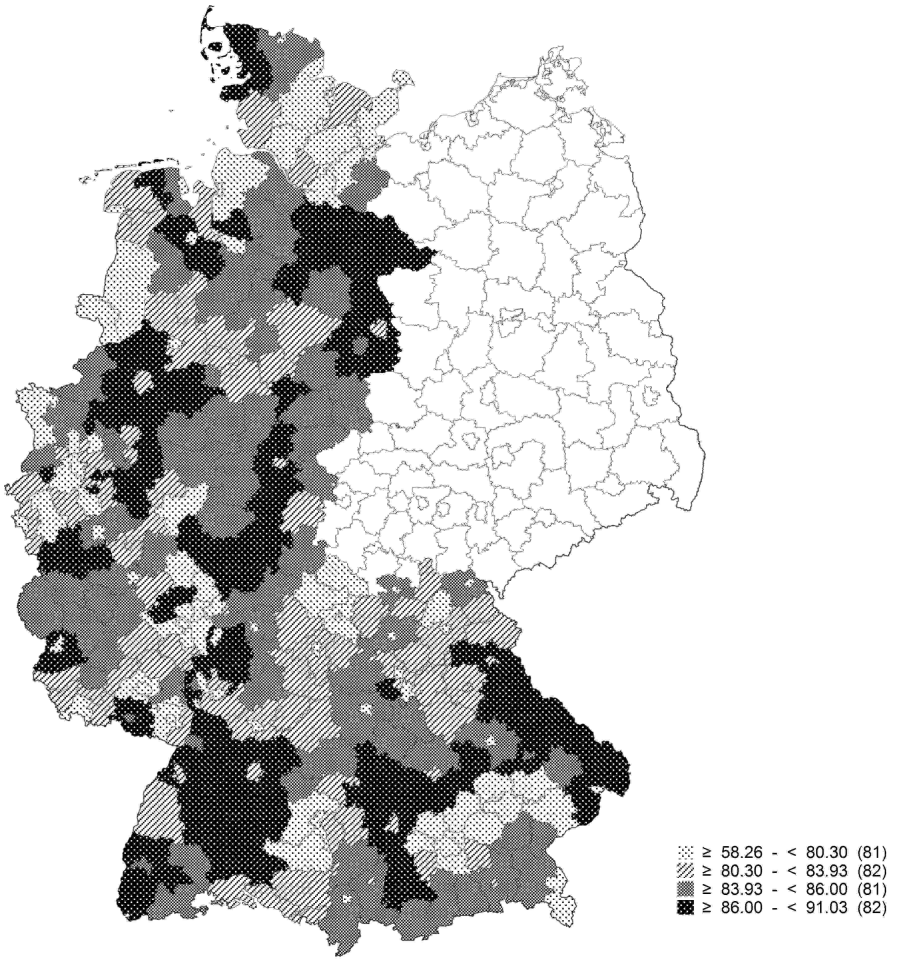
[9]For a small number of enterprises, no information on the location was available. Thus, we dropped these observations form our sample.

terprise. Moreover, the database reports the companies' turnover and the number of employees which are subject to social insurance contributions. Using this information, we can adequately identify owner-managed SMEs. We consider firms to be owner-managed whenever the chief operating officers of an enterprise also own (at least parts of) the enterprise. However, as the advantage of owner-managed firms tends to diminish with an increasing number of decision makers, we restrict the maximum number of chief operating officers, which are considered to be classified as owner-managed firms, to four. Since we are interested in owner-managed SMEs only, we then apply the definition of SMEs to the identified owner-managed firms. We thereby apply the values used in the definition of the *Institut für Mittelstandsforschung Bonn* and classify SMEs as firms with less than 500 employees or an annual turnover of less than 50 million Euro.[10] By applying this procedure, we identify 2,602,830 West German firms, respectively 81.46 percent of total West German enterprises, as owner-managed SMEs. In order to obtain the relative importance of owner-managed SMEs on the regional level, we divide the number of owner-managed SMEs by the total number of firms on the NUTS-3-level.[11] Regional shares of owner-managed SMEs vary from 58.3 to 91.0 percent, with a mean of 82.7 percent. Figure 2 shows the regional quotas of owner-managed SMEs in West Germany. The relative importance of owner-managed SMEs varies more widely across regions than firms' apprenticeship activity. Especially small urban regions seem to have relatively small quotas of owner-managed SMEs.

[10]However, according to this definition, only a few owner-managed enterprises do not meet the SME-criteria.

[11]The same variable has been used in Berlemann and Jahn (2014) in order to analyze the influence of the regional share of owner-managed SMEs on regional innovative activity.

Figure 2: Quotas of owner-managed SMEs by NUTS-3-regions in West Germany in percent, December 31, 2008



Besides the regional share of owner-managed SMEs in all enterprises, various additional factors might have an impact on firms' apprenticeship activity. According to the existing literature, regional unemployment rates might affect firms' engagement in the apprenticeship system (Askilden and Nilsen 2005, Schweri and Wolter 2002, Troltsch and Walden 2011, Blatter et al. 2012, Mühlemann et al. 2007). Referring to the investment motive, firms might train a larger number of apprentices when they expect skilled labour to be scarce in the future. However, whenever firms' expectations about the future are based on the current labour market situation, today's labour market might determine firms' engagement in the apprenticeship system as well (Askilden and Nilsen 2005, Schweri and Wolter 2002). In periods with a tight labour market for skilled workers, firms might also train a larger number of apprentices in order to substitute skilled employees by trainees. Apprentices might take over some tasks in the production process usually handled by semi-skilled or skilled workers (Busemeyer et al. 2012, Backes-Gellner and Mohrenweiser 2010). In order

to control for regional labour market tightness, we include the share of the unemployed in the workforce in percent by NUTS-3-regions into the regression equation. We expect a negative impact of the unemployment rate on firms' apprenticeship activity. The referring data were also extracted from the aforementioned *INKAR* database.

Additionally, the number of potential apprentices per region might influence firms' contribution to the apprenticeship system positively because a relatively large supply of potential trainees might improve the matching between enterprises and candidates (Mühlemann and Wolter 2006, Blatter et al. 2012). Therefore, we employ the regional number of graduates and leavers of secondary schools per enterprise as control variable. Data on school graduates and school leavers on the regional level were provided by the Statistical Office of Lower Saxony. In order to calculate the regional supply of potential trainees per enterprise, we use the total number of firms on the NUTS-3-level from the aforementioned *Creditreform* database.

Moreover, firms' engagement in the apprenticeship system might vary with the industries, the enterprises are active in (Blatter et al. 2012, Mühlemann and Wolter 2006, Bellmann and Neubäumer 1999, Stöger and Winter-Ebmer 2001, Franz et al. 2000, Beckmann 2002). Hence, we include the share of firms of an industrial sector[12] in all enterprises per region in percent into the regression equation. Data were extracted from the *Creditreform* database as well.[13]

Furthermore, firms' contribution to the apprenticeship system might also vary with the occupations, the apprentices are trained in (Blatter et al. 2012). Therefore, we also control for the share of employees of different occupational categories[14] in all employees subject to social insurance contributions by NUTS-3-regions in percent. The referring data were provided by the Federal Employment Agency on request.[15] Since employees subject to social insurance contributions include apprentices, we thus consider the occupations of the employees that might train the apprentices as well as the occupations, apprentices are trained in. However, in most cases, occupations of trainers and trainees should be the same.

For a detailed description and some descriptive statistics of the employed variables see Table 1 and Table 2.

[12]Table A.1 in the Appendix shows the referring industrial sector classification (NACE Rev. 2, one digit).

[13]However, for roughly 5.7 percent of the enterprises in the *Creditreform* database (183,202 cases) no sector classification is available. The referring firms are summarized in the group 'No sector'.

[14]Due to data availability, we employ the German occupation classification from 1988, shown in Table A.2 in the Appendix.

[15]For a small number of employees no detailed information on the occupation is available. The referring employees are summarized in the group 'No occupation'.

Table 1: Description of employed variables

Variable	Description	Source
Apprenticeship	Share of apprentices in all employees subject to social insurance contributions at place of work by NUTS-3-regions in percent, West Germany, 2008[a]	*INKAR* database (2010) of the Federal Institute for Research on Building, Urban Affairs and Spatial Development
OMSME	Number of owner-managed SMEs relative to all enterprises by NUTS-3-regions in percent, West Germany, December 31, 2008. Due to data availability, firms are localized by headquarters.	*Creditreform* database (2008)[b]
Unemployment	Share of the unemployed in the workforce by NUTS-3-regions[c] in percent, West Germany, 2008	*INKAR* database (2010)
Potential	Number of graduates and leavers of secondary schools[d] in the school year 2007/08 per enterprise by NUTS-3-regions, West Germany, 2008	Statistical Office of Lower Saxony (2011), *Creditreform* database (2008)[b]
A to U	Share of enterprises of the referring industrial sector[e] in all enterprises by NUTS-3-regions in percent, West Germany, 2008. Whenever a firm is active in various sectors, we report the industrial sector in which a company generates its largest turnover.	*Creditreform* database (2008)[b]
No sector	Share of enterprises without sector classification in all enterprises by NUTS-3-regions in percent, West Germany, 2008.	*Creditreform* database (2008)[b]
I.II.01.09 to V.90.93	Share of employees of the referring occupational category[f] in all employees subject to social insurance contributions at place of work by NUTS-3-regions in percent, West Germany, June 30, 2008.	Federal Employment Agency[b]
No occupation	Share of employees without information about occupational category, non-agricultural family workers, labourers with occupation still to be specified and labourers not further specified in all employees subject to social insurance contributions at place of work by NUTS-3-regions in percent, West Germany, June 30, 2008.	Federal Employment Agency[b]

[a] The value for Flensburg was missing (0.0) in the original data. In consultation with the Federal Institute for Research on Building, Urban Affairs and Spatial Development, we added the missing value (7.2).
[b] Special analysis on request.
[c] The working population is recorded by place of work.
[d] In Bavaria including commercial colleges.
[e] Industrial sectors according to NACE Rev. 2, one-digit-level (see Table A.1).
[f] Occupational categories according to the German occupational classification from 1988 (see Table A.2). Shares of I.II.01.09 to V.90.93 and 'No occupation' do not add to 100 percent due to anonymization.

Table 2: Descriptive statistics of employed variables

Variable	Min	1st Quantile	Median	Mean	3rd Quantile	Max	Width	Standard deviation
Apprenticeship	2.9000	5.3000	5.9500	5.8800	6.5000	8.9000	6.0000	0.9222
OMSME	58.3000	80.3000	83.9000	82.7000	86.0000	91.0000	32.7000	5.0180
Unemployment	1.9000	4.4000	6.3000	6.8200	8.6000	18.3000	16.4000	2.9390
Potential	0.0726	0.2210	0.2550	0.2590	0.2970	0.5210	0.4484	0.0652
A	0.1370	0.8610	1.9000	2.4200	3.4300	10.2000	10.0630	1.9600
B	0.0000	0.0329	0.0682	0.0927	0.1240	0.7520	0.7520	0.0921
C	2.8800	5.2100	6.6100	6.9000	8.1900	20.9000	18.0200	2.2490
D	0.0380	0.2310	0.4060	0.6000	0.7380	6.9200	6.8820	0.6696
E	0.0622	0.2210	0.2870	0.2920	0.3550	0.8680	0.8058	0.1069
F	5.4400	9.7700	11.5000	11.3000	13.2000	17.0000	11.5600	2.5310
G	15.0000	21.4000	22.9000	22.8000	24.5000	31.0000	16.0000	2.3440
H	1.5800	3.0100	3.3800	3.6300	4.0400	15.4000	13.8200	1.2090
I	2.7200	4.8800	5.5400	5.9000	6.7200	13.0000	10.2800	1.6480
J	0.8310	1.7500	2.2800	2.5000	3.0400	9.7800	8.9490	1.1160
K	1.8700	3.1200	3.4400	3.4500	3.8100	5.7800	3.9100	0.5859
L	1.8400	3.1600	3.7600	3.9300	4.4900	10.7000	8.8600	1.1970
M	6.7600	10.7000	12.3000	12.9000	14.9000	23.1000	16.3400	3.0470
N	3.0100	4.2600	4.8400	5.0400	5.5000	11.8000	8.7900	1.1900
O	0.0561	0.2500	0.3580	0.4230	0.5160	1.4300	1.3739	0.2563
P	0.4600	0.9190	1.0700	1.1300	1.3000	2.3900	1.9300	0.3095
Q	1.8800	3.1900	3.8100	3.9100	4.5100	7.2500	5.3700	0.9856
R	0.9080	1.5100	1.7200	1.8000	1.9700	3.7200	2.8120	0.4523
S	2.3400	3.9200	4.7300	5.1300	5.7100	16.5000	14.1600	1.8920
T	0.0000	0.0077	0.0217	0.0297	0.0446	0.1640	0.1640	0.0305
U	0.0000	0.0000	0.0000	0.0309	0.0000	2.7200	2.7200	0.2018
No sector	0.0460	2.9400	5.0800	5.8000	7.6200	17.3000	17.2540	3.8470
I.II.01.09	0.3000	1.0000	1.3000	1.6400	1.9000	11.1000	10.8000	1.0990
III.14.15	0.1000	0.8000	1.4000	1.9100	2.4000	16.5000	16.4000	1.7840
III.19.24	0.1000	1.0000	1.8000	2.2400	2.8000	11.6000	11.5000	1.6450
III.25.30	2.6000	6.1000	7.2000	7.3300	8.3000	20.3000	17.7000	2.0320
III.31	1.3000	2.1000	2.4000	2.5100	2.8000	6.2000	4.9000	0.6587
III.32	0.1000	0.9000	1.6000	2.1900	2.9000	22.7000	22.6000	2.1560
III.39.43	1.0000	2.1000	2.7000	2.8900	3.3000	8.7000	7.7000	1.1510
III.44.47	0.6000	1.6000	2.4000	2.5500	3.2700	6.9000	6.3000	1.1950
III.50	0.2000	0.5000	0.8000	0.9050	1.2000	3.5000	3.3000	0.5707
III.51	0.3000	0.7000	0.8000	0.8820	1.0000	3.3000	3.0000	0.3043
III.52	0.2000	1.0000	1.5000	1.5500	1.9000	5.4000	5.2000	0.7334
III.53	0.5000	1.4000	2.0000	2.3000	2.8000	18.3000	17.8000	1.5630
III.54	0.1000	0.4000	0.6000	0.7310	0.9000	5.0000	4.9000	0.4734
IV.60.61	0.5000	1.4000	1.9000	2.2700	2.7700	12.1000	11.6000	1.4330
IV.62.63	1.3000	3.4000	4.0000	4.1400	4.7000	14.3000	13.0000	1.3060
V.68	4.4000	7.3200	8.1000	8.2000	8.9000	15.1000	10.7000	1.4170
V.69.70	1.3000	2.6200	3.0000	3.4300	3.7000	17.4000	16.1000	1.6400
V.71.74	3.7000	6.2000	7.2000	7.4900	8.4000	16.5000	12.8000	1.8400
V.75.78	9.0000	16.9000	18.2000	19.5000	21.4000	38.7000	29.7000	4.0770
V.79.81	0.6000	1.0000	1.2000	1.3400	1.5000	5.2000	4.6000	0.5241
V.82.83	0.2000	0.4000	0.5000	0.6820	0.7000	11.4000	11.2000	0.7499
V.84.85	3.0000	6.2000	7.6000	7.6500	8.7000	15.3000	12.3000	1.9940
V.86.89	2.2000	5.1000	6.0000	6.1500	7.1000	11.4000	9.2000	1.4950
V.90.93	2.7000	4.8000	5.5500	5.8000	6.3800	15.6000	12.9000	1.6260
No occupation	0.3000	0.7000	0.9000	1.0100	1.1000	6.3000	6.0000	0.5478

N = 326

4 Results

In Table 3 we report the results of our baseline regression approach, explaining firms' apprenticeship activity (*Apprenticeship*) by the relative importance of owner-managed SMEs ($OMSME$) and numerous control variables on the NUTS-3-level in the 2008 cross section. The second column displays the coefficients, estimated using the OLS technique, the third column the resulting standard errors and the fourth column the referring p-values. We report White-corrected standard errors. The regression explains 64.6 percent of the observed variation in firms' apprenticeship activity. The variable of central interest, the relative importance of owner-managed SMEs, turns out to have no significant impact on firms' apprenticeship activity. However, the employed control variables show a significant influence on firms' apprenticeship activity with coefficients having the expected signs.

In order to check the stability of the results of our OLS regression, we test for possible outliers and multicollinearity. Four regions might be classified as outliers, *Salzgitter*, *Krefeld*, *Neustadt an der Weinstraße* and *Baden-Baden*. However, regressions without these potential outliers lead to similar outcomes as in the analysis including all 326 West German regions, at least with regard to direction and significance of the $OMSME$-coefficient.[16] Therefore, we keep all regions in our sample even within the following empirical analyses. Furthermore, an examination of bivariate correlations and variance inflation factors does not detect any multicollinearity problems.[17]

[16] Regression results without outliers are available from the author on request.

[17] Due to the considerable size of the correlation matrix, we do not show it here. The correlation matrix is instead available from the author on request. The variance inflation factors are presented in Table A.3 in the Appendix.

Table 3: Determinants of Apprenticeship

Explanatory variables	Coefficients	Standard errors	p-values
(Intercept)	-1.0476	2.4603	0.6706
OMSME	0.0113	0.0122	0.3566
Unemployment	-0.0367	0.0156	0.0197
Potential	2.2785	0.8185	0.0058
A	0.0078	0.0342	0.8200
B	0.7124	0.3546	0.0455
C	0.0661	0.0346	0.0572
D	0.0892	0.0589	0.1311
E	-0.6372	0.2751	0.0213
F	0.0170	0.0295	0.5643
G	-0.0462	0.0285	0.1059
H	0.0908	0.0396	0.0225
I	0.0654	0.0297	0.0284
J	-0.0223	0.0588	0.7053
K	0.1419	0.0703	0.0445
L	-0.0269	0.0600	0.6543
N	-0.0591	0.0364	0.1055
O	0.0576	0.1648	0.7269
P	0.3709	0.1454	0.0113
Q	0.1444	0.0866	0.0967
R	0.0273	0.1103	0.8047
S	0.0341	0.0326	0.2961
T	1.4110	1.0344	0.1737
U	-0.1009	0.1149	0.3804
No sector	0.0364	0.0233	0.1196
I.II.01.09	-0.0103	0.0277	0.7113
III.14.15	-0.0095	0.0184	0.6042
III.19.24	-0.0393	0.0246	0.1107
III.25.30	0.0938	0.0272	0.0007
III.31	0.1875	0.0535	0.0005
III.32	0.0184	0.0191	0.3385
III.39.43	0.1133	0.0416	0.0069
III.44.47	0.2309	0.0520	0.0000
III.50	0.2699	0.0705	0.0002
III.51	-0.3004	0.1140	0.0089
III.52	-0.0761	0.0520	0.1442
III.53	-0.0272	0.0217	0.2107
III.54	0.0024	0.1076	0.9822
IV.60.61	-0.0612	0.0354	0.0853
IV.62.63	0.0414	0.0400	0.3019
V.68	0.1654	0.0311	0.0000
V.69.70	0.0626	0.0298	0.0362
V.71.74	0.0000	0.0223	0.9993
V.79.81	0.0731	0.0790	0.3556
V.82.83	0.0673	0.0391	0.0865
V.84.85	0.0858	0.0290	0.0034
V.86.89	-0.0340	0.0342	0.3210
V.90.93	-0.0106	0.0299	0.7227
No occupation	-0.0430	0.0632	0.4972
N	326		
adj. R^2	0.646		
F-value	13.3 (0.0000)		

While using data on the NUTS-3-level allows us analyzing the relation between the relative importance of owner-managed SMEs and firms' apprenticeship activity on the basis of 326 observations, this comes at the price that the underlying data might exhibit spatial correlations, leading OLS in many cases not to deliver best linear unbiased estimators. Since spatial dependencies usually violate the assumptions of the general linear model, OLS regressions often are expected to be biased (Keilbach 2000, Lerbs and Oberst 2012, Dormann et al. 2007, Gleditsch and Ward 2007, Eckey et al. 2007). Therefore, it is necessary to examine whether our baseline model suffers from serious spatial correlations and to control for the relevant form of spatial interaction, if necessary. Three types of spatial dependencies might occur in linear regressions.

First, the independent variables might exhibit spatial correlations. As an example, firms' apprenticeship activity of the referring region might not only depend on the situation on the local labour market but perhaps also on the labour market tightness of neighboring regions. In the presence of spatially lagged explanatory variables, a spatial lag model of the form

$$Y = \alpha + \theta\, WX + \beta\, X + \epsilon, \quad \epsilon \sim N(0, \sigma^2) \tag{2}$$

should be implemented. Y is the dependent variable, X is a vector of independent variables and ϵ is a normally distributed error term. W is the contiguity matrix, describing the spatial arrangement of the observed regions. θ is the vector of coefficients of the spatial lags of the independent variables. The parameters to be estimated are α, θ and β.

Second, the dependent variable might be autocorrelated in space. In our research context, firms' apprenticeship activity of a region might be influenced by firms' apprenticeship activities in neighboring regions. In the presence of spatial autocorrelation in the dependent variable, a spatial lag model of the type

$$Y = \rho\, WY + \alpha + \beta\, X + \epsilon, \quad \epsilon \sim N(0, \sigma^2) \tag{3}$$

should be used. The parameters to be estimated are ρ, α and β.

Third, the error term might exhibit spatial autocorrelation. In this case, firms' apprenticeship activity of the referring region might be affected by unobserved characteristics that neighboring regions have in common. In the presence of spatially autocorrelated residuals, a spatial error model of the form

$$Y = \alpha + \beta X + u, \;\; u = \lambda W u + \epsilon, \;\; \epsilon \sim N(0, \sigma^2) \tag{4}$$

should be implemented. u is the spatially dependent and ϵ the normally distributed error term. The parameters to be estimated are α, β and λ.

However, the three described types of spatial dependencies might also occur in combination. The spatial Durbin model includes a spatially autocorrelated dependent variable together with spatially lagged explanatory variables. The Manski model combines all three forms of spatial correlations (Elhorst 2010).

In the following, we examine whether and which of the described types of spatial dependence turn out to exist in our data. We thereby follow the general-to-specific approach, starting with the OLS model and then test whether the model needs to be extended with spatial interaction terms (Elhorst 2010). In order to test for spatial correlations, we first have to define the contiguity matrix. We use a row standardized contiguity matrix of style *queen*, including only regions next to the one under consideration, since this type of contiguity matrix is recommended in the literature (see e.g. Dormann et al. 2007, Keilbach 2000, Eckey et al. 2007). Using row standardization we control for different numbers of neighbors by equalizing a neighbor's impact on the referring region to the average of all neighbors' influences (Keilbach 2000). In order to check whether our dataset exhibits spatial interactions, we first use a Moran's I-test (Anselin 1988, Keilbach 2000). This test shows a small but highly significant Moran's I-value of 0.1228, identifying positive spatial autocorrelation in the OLS residuals.[18] This result is likely due to the fact that the OLS baseline regression does not explicitly control for spatial dependencies, and thus they are reflected in the residuals. In order to extend the OLS baseline model by spatial correlations, we estimate a model with spatially lagged explanatory variables (Elhorst and Vega 2013). However, the extended model suffers from serious multicollinearity problems and therefore should not be used.[19] Hence, we apply Lagrange-Multiplier-tests to discover whether a spatial error model or a model with a spatially autocorrelated dependent variable might be adequate to capture the existing spatial interactions (Eckey et al. 2006). Lagrange-Multiplier-tests detect both models to be potentially appropriate and thus robust Lagrange-Multiplier-tests should be used. The robust tests support the spatial lag model, showing a smaller p-value for RLMlag (Anselin 2005, Anselin and Florax 1995, Elhorst et al. 2010).[20] Therefore, we estimate a model with spatial interaction in the dependent variable using the Maximum-Likelihood-technique. However, this spatial lag model might suffer from omitted variable bias since it does not account for spatially lagged independent variables. In this case, the spatial Durbin model would be appropriate,

[18] Figure A.1 shows the Moran scatterplot of the OLS residuals.

[19] The variance inflation factors of the extended model are available from the author on request.

[20] The referring results are shown in Table A.4 in the Appendix.

extending the spatial lag model by spatial correlations in the explanatory variables (see e.g. Elhorst et al. 2010). Thus, we estimate a spatial Durbin model and contrast it with the spatial lag model using a Likelihood-Ratio-test. The Likelihood-Ratio-test, especially adapted to spatial models, detects the spatial Durbin model to better describe the underlying data (Anselin 2003, Elhorst 2010, Angulo and Mur 2011). Therefore, we reject the spatial lag model in favor of the spatial Durbin model. As a major strength of the model, the spatial Durbin model leads to unbiased coefficient estimates even when the data generating process follows another spatial regression equation (LeSage and Pace 2009), unless the true data generating process is of the Manski type (Elhorst 2010).[21] In order to check whether the spatial Durbin model or the Manski model is appropriate to capture the existing spatial dependencies, we estimate a Manski model. The only difference between the spatial Durbin model and the Manski model is the spatially lagged error term. Since λ turns out to be highly significant, we reject the spatial Durbin model in favor of the Manski model (Elhorst and Vega 2013). At the end, the Manski model qualifies as the adequate spatial model to capture the underlying spatial interactions.[22]

The results of the Manski model are shown in Table 4. The Manski model fits the data very well, showing a Nagelkerke pseudo R squared of 0.8154. ρ turns out to be significant, indicating a considerable spatial autocorrelation of firms' apprenticeship activity.

[21] Although the Kelejian-Prucha model nests the spatial lag model as well, we refrain from estimating a Kelejian-Prucha model because it produces biased estimates when the true data generating process follows another spatial regression specification (LeSage and Pace 2009, Elhorst 2010).

[22] Results of the spatial lag model, the spatial Durbin model and the Likelihood-Ratio-test are available from the author on request.

Table 4: Manski model

	Direct effects	p-values	Indirect effects	p-values	Total effects	p-values
OMSME	0.0249	0.0619	-0.0523	0.1310	-0.0273	0.3736
Unemployment	0.0029	0.9140	-0.0430	0.4030	-0.0401	0.3824
Potential	2.0832	0.0022	3.5922	0.0800	5.6755	0.0093
A	0.0011	0.9960	-0.0079	0.8980	-0.0069	0.9003
B	0.1853	0.5744	1.2505	0.2300	1.4358	0.1783
C	0.0955	0.0031	0.1376	0.2030	0.2331	0.0326
D	0.0181	0.7540	0.2103	0.1900	0.2284	0.1304
E	-0.1704	0.5581	-1.2008	0.1650	-1.3711	0.1222
F	0.0836	0.0043	-0.0692	0.3980	0.0144	0.9090
G	-0.0296	0.2430	-0.0228	0.7750	-0.0524	0.5304
H	0.0608	0.1076	0.0260	0.8040	0.0868	0.4147
I	0.0648	0.0465	-0.0749	0.4540	-0.0101	0.9006
J	-0.1009	0.1045	-0.0716	0.6840	-0.1725	0.2821
K	0.1065	0.1060	0.1878	0.2660	0.2943	0.0811
L	0.0450	0.3884	0.0435	0.7950	0.0886	0.6100
N	0.0730	0.0624	0.0464	0.6270	0.1194	0.2063
O	-0.2084	0.1680	-0.3045	0.4570	-0.5129	0.1883
P	0.3141	0.0197	0.2183	0.6520	0.5324	0.2713
Q	0.1300	0.0530	-0.4045	0.0550	-0.2745	0.1917
R	-0.0584	0.5663	0.2857	0.3190	0.2273	0.4184
S	0.0721	0.0128	0.0598	0.5100	0.1319	0.1501
T	0.5015	0.6250	4.7489	0.1260	5.2504	0.0872
U	-0.0067	0.9671	-0.4988	0.3410	-0.5055	0.3209
No sector	0.0540	0.0190	-0.0188	0.7510	0.0352	0.6359
I.II.01.09	0.0489	0.1593	0.3101	0.0300	0.3590	0.0188
III.14.15	-0.0522	0.0132	0.0339	0.6580	-0.0183	0.8159
III.19.24	-0.0382	0.1608	0.0629	0.4800	0.0247	0.7879
III.25.30	0.0379	0.0748	-0.0155	0.7980	0.0224	0.7793
III.31	0.1031	0.0452	0.0809	0.6620	0.1840	0.3275
III.32	-0.0397	0.0526	0.1076	0.1160	0.0679	0.3508
III.39.43	0.0270	0.4497	0.2895	0.0150	0.3165	0.0123
III.44.47	0.1728	0.0004	0.3395	0.0320	0.5123	0.0032
III.50	0.2110	0.0025	0.0373	0.8490	0.2484	0.2842
III.51	-0.1770	0.1396	0.3541	0.3990	0.1771	0.6794
III.52	-0.0496	0.3746	0.0703	0.6930	0.0207	0.8985
III.53	-0.0732	0.0015	-0.0797	0.2660	-0.1529	0.0472
III.54	0.0814	0.2170	0.0009	0.9810	0.0823	0.6843
IV.60.61	-0.0572	0.0917	0.1521	0.1730	0.0949	0.4211
IV.62.63	0.0637	0.0555	-0.0309	0.8210	0.0328	0.7287
V.68	0.1131	0.0000	0.2168	0.0270	0.3299	0.0018
V.69.70	0.0504	0.0749	-0.0819	0.5040	-0.0314	0.8088
V.71.74	-0.0413	0.0500	-0.0440	0.4810	-0.0853	0.2147
V.79.81	0.0528	0.3982	-0.3030	0.2120	-0.2502	0.3451
V.82.83	0.0500	0.3317	-0.3423	0.2200	-0.2923	0.3090
V.84.85	0.0565	0.0124	0.1874	0.0300	0.2439	0.0090
V.86.89	-0.0250	0.4088	-0.1631	0.0940	-0.1881	0.0788
V.90.93	-0.0235	0.4519	0.0455	0.6750	0.0220	0.8429
No occupation	-0.0778	0.2210	0.2700	0.2780	0.1922	0.4632
N	326					
Nagelkerke	0.8154					
ρ	0.4053(0.0004)					
λ	$-$ 0.5522(0.0002)					

According to LeSage and Pace (2009), Gleditsch and Ward (2007) and Elhorst (2014), the regression coefficients of models containing a spatially lagged dependent variable, like the Manski model, should not be interpreted because they ignore feedback effects. Feedback effects result from the spatial autocorrelation of the explained variable and describe impacts that affect the dependent variable of a region, pass on to neighboring regions and back to the referring region (Elhorst 2014, Gleditsch and Ward 2007, LeSage and Fischer 2008). We therefore calculate direct, indirect and total effects of the independent variables, taking feedback effects into account. Direct effects measure the impact of a particular independent variable on the dependent variable of the same region. Indirect effects, also referred to as spillover effects, describe the influence of a single explanatory variable on the explained variables of all other regions. Using an alternative interpretation, indirect effects measure the change in the dependent variable of the referring region due to an increase in a particular explanatory variable in all other regions. Total effects are the sum of the direct and indirect impacts (LeSage and Pace 2009, Elhorst et al. 2010, LeSage and Fischer 2008).[23] Total effects measure the overall impact of a single explanatory variable of the referred region, within and across regions. Changing perspectives, total effects describe the overall impact on the dependent variable of a particular region due to nationwide changes in a single independent variable. Total effects might therefore be interpreted as national impacts, taking effects within and across regions into account.

The variable of central interest, the relative importance of owner-managed SMEs, turns out to have a significantly positive direct impact on firms' apprenticeship activity. An increase in the regional share of owner-managed SMEs significantly raises firms' apprenticeship activity in the same region. However, the indirect effect of $OMSME$ is negative, indicating apprenticeship activities in surrounding regions to fall when the share of owner-managed SMEs in the referring region raises. An increasing relative importance of owner-managed SMEs in the referring region might potentially attract apprentices from other regions. Using the alternative interpretation, an increase in the quotas of owner-managed SMEs in surrounding regions has a negative influence on the apprenticeship activity of the referring region. Although the indirect effect is insignificant, it cancels out the direct impact, leading to a non-significant total effect. Thus, a relatively large share of owner-managed SMEs is a relative regional advantage that disappears when the relative importance of owner-managed SMEs in surrounding regions also increases. This effect is quite

[23]The Manski model does not impose any restictions on the magnitude of the direct and indirect effects. Therefore, the ratio between the direct and indirect effects may differ across explanatory variables. This flexibility makes the Manski model an attractive spatial model (Elhorst 2014).

plausible, as all regions tend to compete for the same pool of potential apprentices.

Additionally, we neither find a significant direct nor indirect impact of the regional unemployment rate on firms' apprenticeship activity. The total effect turns out to be insignificant as well. Possibly, firms' expectations about the future supply of skilled labour as a reason to train apprentices according to the investment motive is not only based on the current labour market situation. The supply of potential trainees however seems to influence firms' apprenticeship activity significantly positive, both within and across regions. Moreover, the number of apprentices relative to all employees turns out to vary with the economic sectors, firms are active in. Figure A.2 in the Appendix shows the direct effects in relation to the reference sector M. According to the employed industrial sector classification (see Table A.1), the reference sector M includes professional, scientific and technical activities. Apprenticeship activities that differ significantly (at least on the 90-percent confidence level) from the apprenticeship activity in the reference sector are highlighted in dark gray, non-significant variations are coloured in light gray. Furthermore, the number of apprentices relative to all employees seems to vary with the occupational categories, apprentices are trained in. Figure A.3 shows the direct effects in relation to the reference occupational category V.75.78. According to the employed occupational classification (see Table A.2), the reference professional category V.75.78 includes managers, administrative officials and office clerks. Apprenticeship activities that vary significantly (at least on the 90-percent confidence level) from the apprenticeship activity in the reference ocupational category are coloured in dark gray, non-significant differences are marked in light gray.

5 Summary and Conclusion

As a consequence of the deeply rooted belief in the importance of Mittelstand firms for the German economy, German policymakers on the regional as well as on the national level launch numerous political programs to support Mittelstand firms. Politicians often emphasize the important role of owner-managed SMEs by stating that Mittelstand firms excessively engage in the German apprenticeship system. However, there has been almost no empirical evidence on the question whether Mittelstand firms are in fact excessively active in training apprentices yet. Based on a unique dataset of German enterprises, we examine for the first time the relationship between the relative importance of owner-managed SMEs and firms' apprenticeship activity on the NUTS-3-level. Taking numerous control variables and various types

of spatial dependencies between regions into account, we find a significantly positive impact of the relative importance of owner-managed SMEs on apprenticeship activity on the NUTS-3-level. Thus, regions with a higher relative importance of Mittelstand firms are overly successful in attracting trainees and especially train a larger number of apprentices relative to all employees than other regions. However, since the pool of potential apprentices in Germany is somewhat limited, German regions compete for potential trainees. This competition leads the relative regional advantage of a higher relative importance of Mittelstand firms to disappear when other regions show a higher relative importance of owner-managed SMEs as well. Thus, our empirical results lead to different policy implications on the regional and on the national level. Whereas political promotion of the local Mittelstand seems to be a reasonable instrument in order to increase firms' apprenticeship activity in a particular region, promoting Mittelstand firms on the national level does not significantly increase firms' apprenticeship activity. In order to examine wether national promotion of Mittelstand firms could at least have an influence on firms' apprenticeship activity by attracting potential trainees from neighboring countries, a cross-border analysis would be necessary. Since such an analysis was infeasible with our data sources, we have to leave this issue open for further research.

References

Acemoglu, Daron and Jörn-Steffen Pischke, "Beyond Becker: Training in Imperfect Labour Markets," *Economic Journal*, 1999, *109* (453), F112–F142.

Angulo, Ana M. and Jesús Mur, "The Likelihood Ratio Test of Common Factors under Non-Ideal Conditions," *Investigaciones Regionales*, 2011, *21*, 37–52.

Anselin, Luc, *Spatial econometrics methods and models*, Dordrecht: Kluwer Acad. Publ, 1988.

_ , "An Introduction to Spatial Regression Analysis in R," 2003.

_ , "Exploring Spatial Data with GeoDaTM: A Workbook," 2005.

_ **and Raymond J. G. M. Florax**, "Small Sample Properties of Tests for Spatial Dependence in Regression Models: Some Further Results," in Luc Anselin and Raymond Florax, eds., *New directions in spatial econometrics*, Berlin: Springer, 1995, pp. 21–74.

Askilden, Jan Erik and Øivind Anti Nilsen, "Apprentices and Young Workers: A Study of the Norwegian Youth Labour Market," *Scottish Journal of Political Economy*, 2005, *52* (1), 1–17.

Bavarian Ministry of Economic Affairs and Media, Energy and Technologie, "Wegweiser zu Fördermöglichkeiten für Existenzgründer und Mittelstand in Bayern," München 2009.

Becker, Gary Stanley, *Human capital: A theoretical and empirical analysis, with special reference to education*, 3 ed., Chicago: The Univ. of Chicago Press, 1993.

Beckmann, Michael, "Firm-sponsored Apprenticeship Training in Germany: Empirical Evidence from Establishment Data," *LABOUR*, 2002, *16* (2), 287–310.

Bellmann, Lutz and Renate Neubäumer, "Ausbildungsintensität und Ausbildungsbeteiligung von Betrieben: Theoretische Erklärungen und empirische Ergebnisse auf der Basis des IAB-Betriebspanels 1997," in Doris Beer, Bernd Frick, Renate Neubäumer, and Werner Sesselmeier, eds., *Die wirtschaftlichen Folgen von Aus- und Weiterbildung*, München und Mering: Rainer Hampp Verlag, 1999, pp. 9–42.

Berghoff, Hartmut, "The End of Family Business? The Mittelstand and German Capitalism in Transition, 1949-2000," *The Business History Review*, 2006, *80* (2), 263–295.

Berlemann, Michael and Vera Jahn, "Governance, Firm Size and Innovative Capacity: Regional Empirical Evidence for Germany," *Helmut Schmidt University Working Paper Series*, 2014, *No. 150.*

Biavaschi, Constanza, Werner Eichhorst, Corrado Giulietti, Michael J. Kendzia, Alexander Muravyev, Janneke Pieters, Nuría Rodríguez-Planas, Ricarda Schmidl, and Klaus F. Zimmermann, "Youth Unemployment and Vocational Training," *IZA Discussion Paper Series*, 2012, *No. 6890.*

Blackstone, Brian and Vanessa Fuhrmans, "The Engines of Growth," *The Wall Street Journal*, 2011, *June 27.*

Blatter, Marc, Samuel Mühlemann, Samuel Schenker, and Stefan C. Wolter, "Hiring Costs of Skilled Workers and the Supply of Firm-Provided Training," *IZA Discussion Paper Series*, 2012, *No. 6344.*

Bundesausschuss für Berufsbildung, "Empfehlung über die Eignung der Ausbildungsstätten," 1972.

de Vries, Manfred F. R. Kets, "The Dynamics of Family Controlled Firms: The Good and the Bad News," *Organizational Dynamics*, 1993, *21* (3), 59–71.

Dormann, Carsten F., Jana M. McPherson, Miguel B. Araújo, Roger Bivand, Janine Bolliger, Gudrun Carl, Richard G. Davies, Alexandre Hirzel, Walter Jetz, W. Daniel Kissling, Ingolf Kühn, Ralf Ohlemüller, Pedro R. Peres-Neto, Björn Reineking, Boris Schröder, Frank M. Schurr, and Robert Wilson, "Methods to account for spatial autocorrelation in the analysis of species distributional data: a review," *Ecography*, 2007, *30* (5), 609–628.

Eckey, Hans-Friedrich, Reinhold Kosfeld, and Matthias Türck, "Räumliche Ökonometrie," *Wirtschaftswissenschaftliches Studium (WiSt)*, 2006, *35* (10), 548–554.

_ , _ , and _ , "Regionale Entwicklung mit und ohne räumliche Spillover-Effekte," *Jahrbuch für Regionalwissenschaft*, 2007, *27* (1), 23–42.

Elhorst, J. Paul, "Applied Spatial Econometrics: Raising the Bar," *Spatial Economic Analysis*, 2010, *5* (1), 9–28.

_ , *Spatial Econometrics. From Cross-Sectional Data to Spatial Panels* SpringerBriefs in Regional Science, Berlin and Heidelberg and s.l: Springer Berlin Heidelberg, 2014.

_ **and Halleck Vega**, "On spatial econometric models, spillover effects, and W," *ERSA conference papers*, 2013, *No. ersa13p222.*

_ **, Jakob de Haan, and Harry Seldadyo**, "Geography and governance: Does space matter?," *Papers in Regional Science*, 2010, *89* (3), 625–640.

Fama, Eugene F. and Michael C. Jensen, "Separation of Ownership and Control," *Journal of Law and Economics*, 1983, *26* (2), 301–325.

Fear, Jeffrey, "The Secret Behind Germany's Thriving 'Mittelstand' Businesses Is All In the Mindset," *The Conversation*, 2014, *April 28.*

Federal Chancellor Angela Merkel, "Mittelstand - Rückgrat der Sozialen Marktwirtschaft," 2009.

Federal Ministry of Economic Affairs and Energy, "Central Innovation Programme for SMEs. Boosting Innovation," Berlin 2014.

Federal Ministry of Economics and Technology, "Mittelstand: Leistung durch Vielfalt," Berlin 2009.

_ , "German Mittelstand: Engine of the German Economy: Facts and Figures About Small and Medium-sized German Firms," Berlin 2013.

_ , "A successful SME policy for growth in Europe," 2014.

Federal Ministry of Education and Research, "Ausbildung und Beruf. Rechte und Pflichten während der Berufsausbildung," 2013.

Federal Ministry of Justice and Consumer Protection, "Ausbilder-Eignungsverordnung (AusbEignV)," 2009.

_ , "Berufsbildungsgesetz (BBiG)," 2013.

_ , "Gesetz zur Ordnung des Handwerks (Handwerksordnung, HwO)," 2013.

Franz, Wolfgang, Viktor Steiner, and Volker Zimmermann, *Die betriebliche Ausbildungsbereitschaft im technologischen und demographischen Wandel*, Baden-Baden: Nomos-Verl.-Ges, 2000.

Girotra, Karan and Serguei Netessine, "Extreme Focus and the Success of Germany's Mittelstand," *Harvard Business Review*, 2013, *February 12.*

Gleditsch, Kristian Skrede and Michael D. Ward, "An Introduction to Spatial Regression Models in the Social Sciences," 2007.

Hamel, Winfried, "Personalwirtschaft," in Hans-Christian Pfohl and Ulli Arnold, eds., *Betriebswirtschaftslehre der Mittel- und Kleinbetriebe*, Berlin: E. Schmidt, 2006, pp. 233–260.

Institut für Mittelstandsforschung Bonn, "Der deutsche Mittelstand: Ein Konglomerat verschiedenartiger Unternehmen," *IfM Standpunkt*, 2013, *No. 1.*

Keilbach, Max C., *Spatial knowledge spillovers and the dynamics of agglomeration and regional growth*, Heidelberg: Physica-Verl, 2000.

Kirchfeld, Aaron and Jana Randow, "Germany's Mittelstand Still Thrives," *Bloomberg Businessweek Global Economics*, 2010, *September 30.*

Krämer, Werner, *Mittelstandsökonomik: Grundzüge einer umfassenden Analyse kleiner und mittlerer Unternehmen*, München: Vahlen, 2003.

Lerbs, Oliver and Christian Oberst, "Explaining the Spatial Variation in Homeownership Rates: Resulst for German Regions," *CESifo Working Papers*, 2012, *No. 3777.*

LeSage, James and Manfred M. Fischer, "Spatial Growth Regressions: Model Specification, Estimation and Interpretation," *Spatial Economic Analysis*, 2008, *3* (3), 275–304.

_ **and Robert Kelley Pace**, *Introduction to spatial econometrics*, Boca Raton and FL: CRC Press, 2009.

Ministry of Economic Affairs, Energy and Industry of the State of North Rhine-Westphalia, "Daten und Fakten," 2014.

Mühlemann, Samuel and Stefan C. Wolter, "Regional Effects on Employer Provided Training: Evidence from Apprenticeship Training in Switzerland," *CESifo Working Papers*, 2006, *No. 1665.*

_ **, Jürg Schweri, Rainer Winkelmann, and Stefan C. Wolter**, "An Empirical Analysis of the Decision to Train Apprentices," *LABOUR*, 2007, *21* (3), 419–441.

Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, "Working and Learning in a Changing World. Part II - Codebook," *FDZ-Datenreport. Documentation of Labour Market Data*, 2010, *02/2010.*

Schweri, Jürg and Stefan C. Wolter, "The Cost and Benefit of Apprenticeship Training: The Swiss Case," *Konjunkturpolitik*, 2002, *48* (3-4), 347–367.

Shackleton, J. R., "Training in Germany: a view from abroad," *Education and Training*, 1997, *39* (8), 303–308.

Stöger, Klaus and Rudolf Winter-Ebmer, "Lehrlingsausbildung in Österreich: Welche Betrieben bilden Lehrlinge aus?," *Working Paper, Department of Economics, Johannes Kepler University of Linz*, 2001, *No. 0110.*

Troltsch, Klaus and Günter Walden, "Apprenticeship training in Germany – still a future-oriented model for recruiting skilled workers?," *Journal of Vocational Education & Training*, 2011, *63* (3), 305–322.

_ , _ , and Susanne Zopf, "Im Osten nichts Neues?," *BIBB Report. Forschungs- und Arbeitsergebnisse aus dem Bundesinstitut für Berufsbildung*, 2009, *No. 12/09.*

UK Trade and Invest, GE Capital, Nabarro, and GSK Stockmann und Kollegen, "Meet the Mittelstand. How German Mid-size Companies Went Global," 2014.

Wagner, Karin, "The German Apprenticeship System after Unification," *Social Science Research Center Berlin Discussion Paper Series*, 1998, *FS I 98 - 301.*

Winkelmann, Rainer, "Employment Prospects and Skill Aquisition of Apprenticeship-Trained Workers in Germany," *Industrial & Labor Relations Review*, 1996, *49* (4), 658–672.

Appendix

Table A.1: Industrial sector classification (NACE Rev. 2, one digit)

A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organisations and bodies

Source: Federal Statistical Office (2008).

Table A.2: Relevant section of the German occupational classification from 1988

I.II.01.09	Mixed crop and animal producers; lifestock and fish farmer; agricultural production manager and advisors; farm hands, mixed crop and livestock farm labourers; gardeners, horticultural and nursery growers; forestry workers and huntspersons; miners; mineral exploitation and quarry workers; mineral and stone processing plant operators
III.14.15	Chemical worker; plastic products machine operators
III.19.24	Metal furnace and rolling-mill operators; moulders, casters; metal moulders non cutting deformation; metal-cutters; metal surface processors and finishers; metal connectors
III.25.30	Smiths; thinsmiths, plumbers and pipe fitters; locksmiths and fitters; mechanics; toolmakers, instrument mechanics; precious fitters and related occupations
III.31	Electricians
III.32	Assemblers and metal plant operators otherwise undisclosed
III.39.43	Bakers, pastry-cooks and confectionery makers; butchers, fish-processing-machine operators and related food preparers; cooks and other food makers; beverage and semiluxury food makers; other food makers
III.44.47	Bricklayers and concreters; carpenters, roofers, scaffolders; road, maintenance and civil engineering building experts; building construction labourers
III.50	Cabinetmakers, carpenters, joiners and other wood-product makers
III.51	Painters, wallpaperers, varnishers and surface finishers
III.52	Products testers, packagers and loading agents
III.53	Labourers no further specified
III.54	Machine operators and related occupations
IV.60.61	Engineers; chemists, physicists, mathematicans
IV.62.63	Technicians; science technicians
V.68	Sellers and salespersons
V.69.70	Banking, building society and insurance experts; other service agents, clerks and related occupations
V.71.74	Surface transport occupations; water- and air traffic occupations; communication traffic occupations; stock, loading and transport occupations
V.75.78	Entrepreneurs, managers, consultants, accountants and related clerks; legislators, senior and administrative officials; calculators, bookkeepers, computing and data processing professionals; office clerks and hands
V.79.81	Attendance and protective services workers; soldiers, police officers, firefighters, safety and health inspectors; judges, lawyers, legal professionals and executory officers
V.82.83	Authors, editors, interpreters, librarians and related clerks; artists and related occupations
V.84.85	Medical doctors, pharmacists; remaining health care occupations
V.86.89	Social welfare, care occupations; teachers and teaching professionals; humanities and natural scientists, otherwise undisclosed; religious professionals, associated professionals and assistants
V.90.93	Hairdressers, barbers, beauticans and related workers; hotel and restaurant occupations; housekeeping occupations; launderers and cleaners

Source: Federal Employment Agency (1988) and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research (2010).

Table A.3: Variance inflation factors

OMSME	5.1840	I.II.01.09	2.1560
Unemployment	3.2000	III.14.15	2.0870
Potential	2.8200	III.19.24	2.8120
A	5.4450	III.25.30	3.1920
B	1.8130	III.31	1.6140
C	8.1030	III.32	3.0340
D	2.5150	III.39.43	3.0470
E	1.3560	III.44.47	4.9900
F	6.4160	III.50	2.6610
G	5.9210	III.51	2.0440
H	3.0210	III.52	2.2000
I	3.9710	III.53	1.9050
J	6.1360	III.54	1.7210
K	2.0400	IV.60.61	3.5840
L	5.0050	IV.62.63	3.3820
N	2.7420	V.68	2.2290
O	2.2480	V.69.70	3.0300
P	2.7390	V.71.74	2.4520
Q	6.6690	V.79.81	1.9820
R	2.7170	V.82.83	1.8980
S	3.8900	V.84.85	3.5670
T	1.3200	V.86.89	2.8560
U	1.3500	V.90.93	3.9030
No sector	9.9330	No occupation	1.8830

Figure A.1: Moran scatterplot of OLS residuals

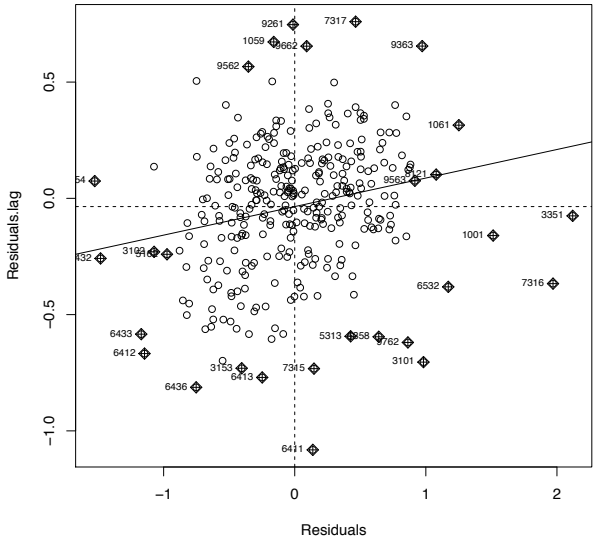


Table A.4: Lagrange-Multiplier-tests

	Lagrange Multiplier	p-value
LMerr	10.6000	0.0011
LMlag	47.6400	0.0000
RLMerr	7.3410	0.0067
RLMlag	44.3800	0.0000

Figure A.2: Direct effects of the industrial sectors, firms are active in, relative to the reference sector M

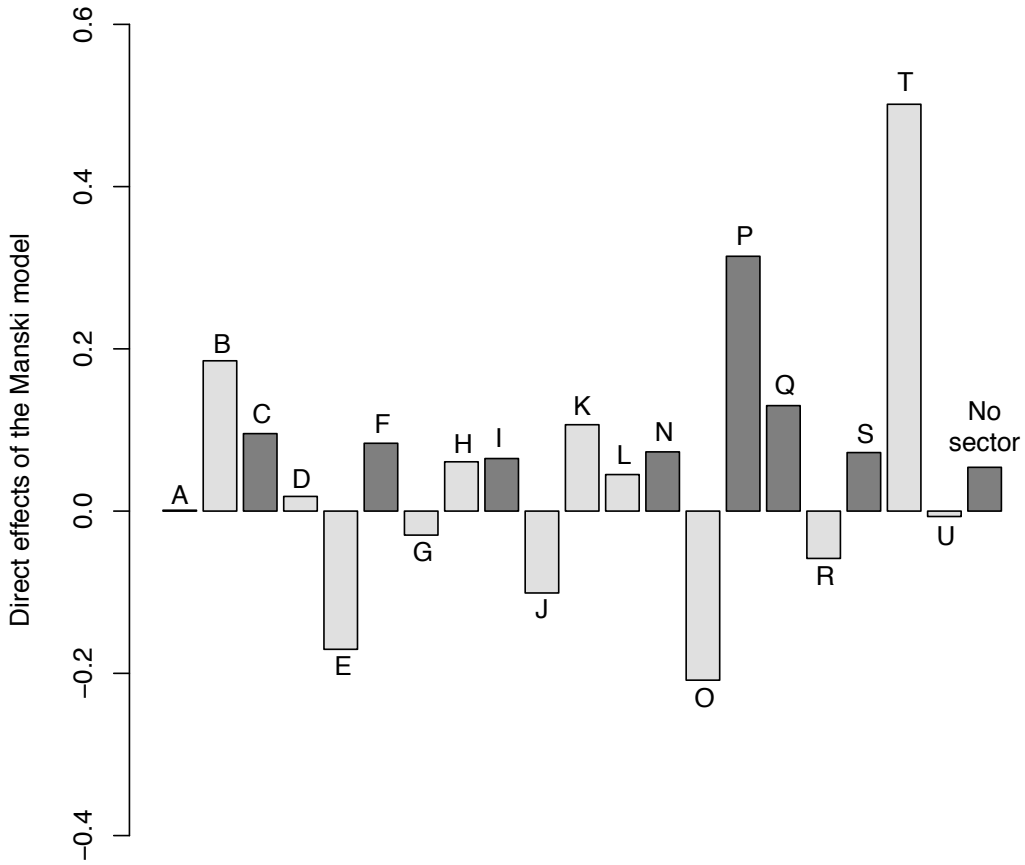
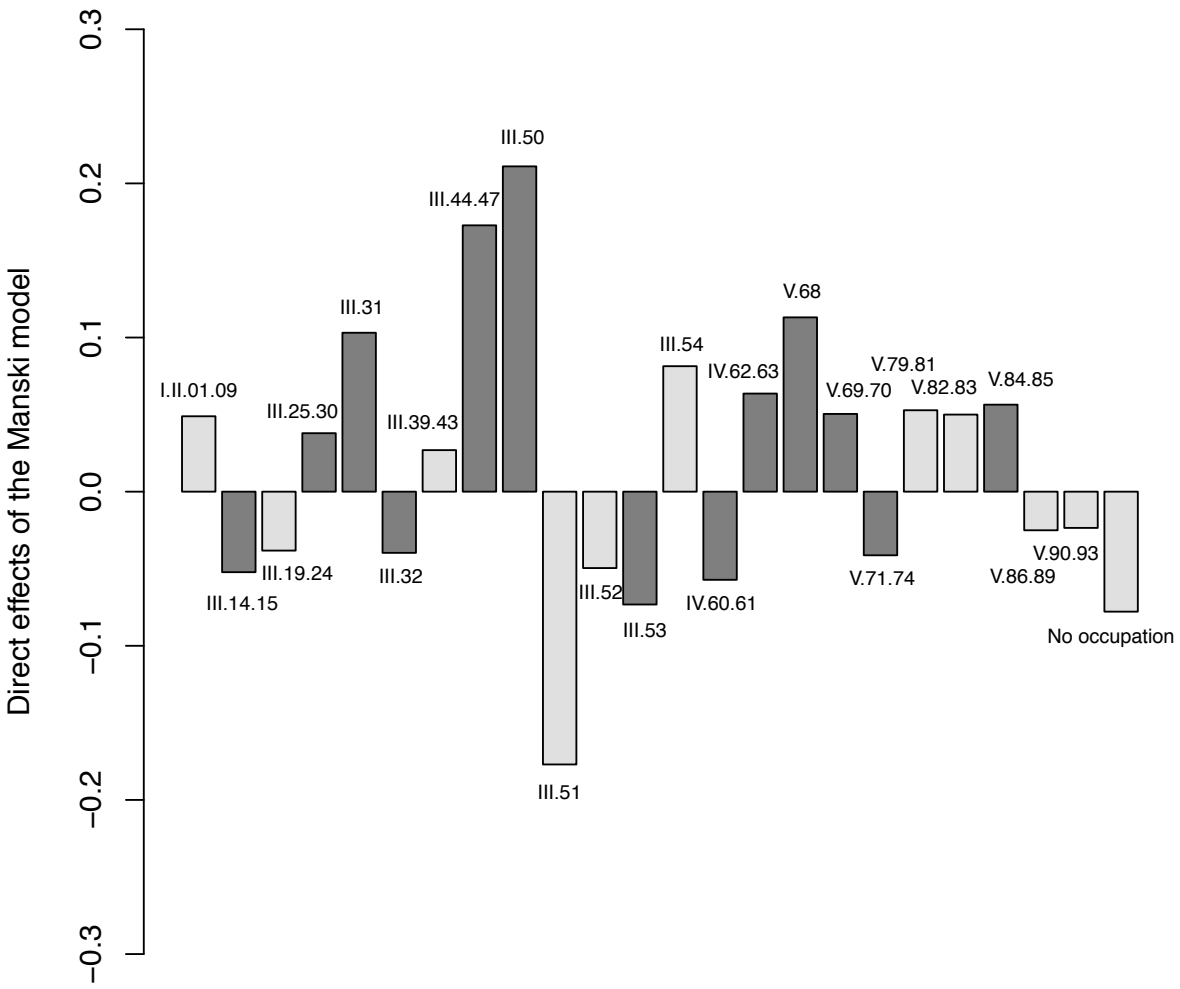


Figure A.3: Direct effects of the occupations, apprentices are trained in, relative to the reference occupational category V.75.78



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