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Segmented Labour Markets and SBTC: Evidence from an Occupational Skill Classification

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NIW Diskussionspapier #1

Segmented Labour Markets and SBTC: Evidence from an Occupational Skill Classification

Purpose
To show mutual cross fertilisation of segmentation theory and SBTC/SBOC literature, especially with respect to the system of vocational education, and highlight the empirical importance of alternative qualification measures like occupations for policy and research purposes.

Design/methodology/approach
Literature with potential infringing implications is gathered. By means of a two-stage cluster analysis we provide a qualification-related occupational classification which is tested for signs of segmentation and skill-biased demand.

Findings
The relationship between segmented labour markets and SBTC/SBOC enriches the explanations for polarised employment growth. Within the primary segment, internal labour markets enable adaption to technological progress and organisational change while there are impediments in craft-specific labour markets. Furthermore, multidimensional measures of qualification show a more sophisticated picture of structural change of qualifications than the vocational education.

Research limitations/implications
Literature review and conclusions should only invite more research. The data impose several restrictions on 'usual' empirical segmentation research due to its cross-sectional nature on the micro-level. Matched employer-employee data would augment our analysis.

Practical implications
Monitoring labour markets must rely on more indicators than formal (vocational) education only. Modularisation of vocational training would facilitate provision of further training and internal labour market careers.

Originality/value
Possible theoretical contributions from segmentation theory and SBTC/SBOC literature are explored. Two-stage cluster analysis for occupations is conducted and a new qualification-related classification of occupations is provided.

Keywords: Segmented labour markets, technological change, organisational change, qualification, occupations, cluster analysis

JEL classification: C19, I21, J24, J42, J62

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1. Introduction

Recent literature related to skill-biased technological change (SBTC) emphasises tasks as a measure for the structural change of qualifications in the last decades (Autor et al., 2003; Spitz-Oener, 2006; Goos & Manning, 2007). However, for monitoring purposes tasks are a hardly applicable measure. In contrast, using formal education suffers from several supply side effects – especially cohort effects – or lacking differentiation. The task concept by Autor, Levy and Murnane (ALM, 2003), though, implicates more differentiated affection of mid- and unskilled workers by technological and organisational change than suggested by usual measures like the vocational education, necessitating alternative approaches which draw on theory on the one hand and are applicable for monitoring and policy purposes on the other. We suggest a compromise by using occupations. Our theoretical framework also considers segmentation theory in order to relate to institutional impacts of the prevailing education system like training adverse mobility patterns. The main focus here is on the role of the German Dual System of Vocational Education (DSVE) by constituting its own labour market segment(s). We hypothesise about the emphasis of formal abilities in contrast to the more ambivalent workplace requirements induced by the changing work environment. Additionally, there might be quasi-institutional impediments for vocational further training due to high inter-firm/within-occupation mobility of Dual System graduates. We also trace secondary segment formation.

After introducing relevant theoretical contributions from SBTC and segmentation literature in section 2, we conduct a cluster analysis of occupations as a starting point for the further empirical analysis (section 3). By means of the classification, SBTC can be confirmed for the selected time period and the distribution of several qualification characteristics over the classes is examined (section 4). Segmentation is discussed by descriptive analysis and mobility behaviour is analysed by means of probit analysis (section 5). Section 6 concludes.

2. Theory

Studying change in the demand for qualifications today is mainly an issue of skill-biased technological change (SBTC) and skill-biased organisational change (SBOC), respectively. More than two decades ago, segmentation theory with its strong focus on (quasi-)institutional factors already discussed the obvious changing demand for qualification. At the end of the 1970s, crowding out of the mid- and unskilled on 'their' workplaces by the high skilled became a central issue. In fact, crowding out took place in the 1970s and afterwards related to the growing participation in higher education as it was also found in Germany (e. g. Blossfeld, 1983). However, changing workplace requirements resulting from technological and organisational change which were revealed by recent work for the time span from 1979 to 1998/99 (Spitz-Oener, 2006) were not considered as the (demand) driving factor. In the following, we want to outline possible mutual fertilisation between SBTC/SBOC and segmentation literature.

2.1 Skill-biased technological and organisational change

Until recently, SBTC literature used very rough skill measures to address these questions. The task concept which Spitz-Oener (2006) applies to assess changing occupational task structures was developed by Autor, Levy and Murnane (ALM, 2003) who suggest five different technology-sensitive categories. At first, complementary tasks are of analytic or interactive nature and, above all, 'non-routine'. Secondly, tasks which are potentially substitutable by new technologies are of cognitive as well as manual nature but primarily they follow some routine processes. Essentially, the routine character allows formulating repeated algorithms of those tasks being therefore easily processed by machines. Finally, the category of non-routine manual tasks is an important extension in comparison with other concepts like white collar/blue collar. Non-routine tasks are not subject to labour

saving technological progress leading to a more sophisticated picture of structural change of qualifications where the bottom end might exhibit nonnegative employment trends (the tasks constitute an order of qualifications with analytic tasks performed by high-skilled workers at the top and non-routine manual tasks by least-skilled workers). The ALM hypothesis predicts ambiguous employment prospects for the mid-skilled and even refines the theoretical predictions for unskilled work. Thus we can formulate **hypothesis 1**: *If tasks are ranked by their technology-sensitiveness they will reflect qualification requirements.*

The task concept is in line with several attempts to provide a more sophisticated grasp of 'skill'. While Nelson/Phelps (1966) or Bartel/Lichtenberg (1987) hypothesise about the high-skilled's capability to implement new technologies and Caselli (1999) or Duranton (2004) model actual adoption behaviour of high and low learning cost workers, 'high' and 'low' are too abstract terms to trace employment trends adequately. Furthermore, Krueger/Kumar (2004) propose the distinction between "general" and skill-specific "vocational" education, the former enabling technology adoption more than the latter. Though the attraction of vocationally educated may be less costly for firms in the short run they face the risk of lagging technological competitiveness in the long run. Based upon the task concept several studies connected technological change and polarisation of employment trends in the US, UK, and Germany (Autor et al., 2003; Spitz-Oener, 2006; Goos & Manning, 2007; Dustmann et al., 2007). It is therefore important for applied labour market research and policy oriented labour market monitoring to find more adequate measures for qualification then formal vocational education. Hence, **hypothesis 2** states that *an occupational classification which reflects tasks on the one hand and other (usual) qualification measures should map structural change of qualifications more sophisticated*. It should be expected that SBTC is one main driving factor. But certainly, one reason why additional concepts are sought after stems from another kind of skill-bias which is strongly related to technological change and also has ambiguous implications for the type of skills demanded: organisational change.

Above and beyond improvements in the production technology in general, the impact of ICT induces special advancement in the firm's organisation of work,[1] again changing occupational requirements. Lindbeck/Snower (2000), as a prominent work, describe how increasing availability of information enables more customised production. To the workers who interact directly with the customers this would mean a higher responsibility because by selling less standardised products they have to communicate customer responses to the production. Additionally, because this kind of work organisation requires better technological understanding, transferring practical knowledge between different tasks ('intertask learning') becomes more important than the specialisation on one specific task ('intratask learning'). Corresponding organisational measures which aim at confronting workers with other tasks would be job rotation and/or team work. Another important contribution in this context is the work by Egger/Grossmann (2005) who incorporate a comparable task concept into the firm's choice of organisational measures. As non-routine tasks were extended (a consequence from increasing high-skilled labour supply), production workers are reallocated to non-production, organisational activity which is productivity-enhancing on the one hand but also costly because the respective workers have to be trained not only once and formal but rather continuously and informal.[2] One further **hypothesis (3)** is therefore: *Occupations with an emphasis on non-*

[1] Meanwhile, empirical literature found isolated as well as superadditive effects of organisational change on skill-biased labour demand (Caroli & Van Reenen, 2001; Piva et al., 2005; Bauer & Bender, 2004; Bellmann & Pahnke, 2006) but mutual influence and – at least partial – endogeneity of organisational measures are undisputed (Bresnahan et al., 2002; Falk, 2002).

[2] Alternatively, Mortensen/Pissarides (1998) provide a model which compares adoption costs (purchase of new technologies, organisational adjustment including worker training) with job creation costs. In this context, relatively high adoption costs induce external labour adjustment, i. e. replacement, by higher-skilled workers, and vice versa.

routine tasks exhibit higher participation rates in further training. Furthermore, Egger/Grossmann (2005, p. 199) assume that "non-routine tasks require a wider spectrum of abilities" whereby these unobservable social skills are a potential source for inequality[3] which formal education cannot measure. In turn, (formal) vocational education has important implications for labour market segmentation.

2.2 Segmentation, DSVE and SBTC/SBOC

The German labour market is known as strongly occupationally shaped; established and maintained by the Dual System of Vocational Education (DSVE). At the same time, labour supply through the DSVE suffers from lagging adaption of vocational schools' curricula to technological standards and the rising demand for 'organisational', social abilities. We have reason to believe that this matching problem is especially present in Germany where two thirds of the labour force graduated from the DSVE.[4] Empirically, this conjecture is supported the study by Blechinger & Pfeiffer (2000) who find that increasing PC use at the workplace promotes skill obsolescence and that adjustment (by cohorts) is deferred.

As an important labour market institution, the DSVE also affects the functioning of the labour market. Therefore, segmentation theory, especially the concept of the tripartite labour market by Lutz and Sengenberger (1974) may provide an adequate theoretical framework. Comparable to the conventional Dual Labour Market Hypothesis (Doeringer & Piore, 1971; Piore, 1975), their concept consists of an internal labour market (ILM) segment as well as a secondary segment; but Lutz and Sengenberger add a 'craft-specific' labour market segment whose members depart mainly from the DSVE. The craft-specific labour markets (multiple as the number of occupations functioning like this) are primary segments with working conditions of usually high quality comparable to the ILM segment.

ILM jobs exhibit a bundle of 'good' workplace characteristics like promotion of vocational further training, advancement prospects, employment stability, high wage profiles, protection against external competition and other favourable working conditions. In a queue of job applicants, high skilled workers would enjoy top positions because their former education indicates trainability to the employer who wants to minimise her expected investment costs (Thurow, 1975). Education itself would not influence individual productivity because work place productivity is given by the firm's production technology. From a 'neoclassical' point of view, most of the functioning of ILM is due to implicit contracts. ILM, on the one hand, provide opportunities for firm-specific human capital investments and produce rent-sharing for both parties binding them for future periods. The resulting higher rates of human capital investments overcome occupational borders and make employed workers functionally flexible for, e. g., reallocation to non-routine tasks like in the Egger/Grossmann (2005) model. Numerical flexibility is limited insofar that both parties have rents to lose when breaking the relationship. While Lutz (2006) argues that ILM erode because step-by-step on-the-job training would not fulfil the high skill requirements and the smaller number of hierarchies lowers promotion incentives, we turn the argument the other way round and conclude, that only in ILM an adequate incentive structure exists which can meet the needs for human capital adaption.

[3] Egger/Grossmann (2005) refer to wage inequality what we take as an indicator for employment prospects.

[4] Not counted those who attended to an academic track after graduating in the Dual System.

The craft-specific labour market, on the other hand, relies on the standardised vocational education which does not necessitate sizeable on-the-job training at firm entry.[5] Hence, Dual System graduates are mobile across firms since their education is applicable occupation-wide. This functioning has important implications in times of technological and organisational change as is shown in the following. The incentives for the firm to engage in human capital investments are low because of weak ties and additionally there is insecurity about the investment's nature since in a technologically dynamic environment it is not guaranteed that a unique but successful production technology would not be imitated by competitors. On the supply side, another problem – a catch-up situation – arises for workers whose human capital is outdated: They face high sunk costs of their initial education which often lasts for three years and are therefore strongly immobile between occupations. Therefore, insecurity on both sides might lead to underinvestment. Comparing the decline in the applicability of apprenticeship training by changing the employer and changing the occupation, Blechinger and Pfeiffer (2000) find a lower risk when choosing the first alternative. However, this incentive structure is dynamically inefficient in regard to the firm's (technology adoption) and the worker's (employment stability) needs. The last implication is that intertask learning (as described by Lindbeck & Snower (2000)) or ongoing informal training for organisational activities (Egger & Grossmann, 2005) rather occur in ILM than in the craft-specific segment because of its investment character. The craft-specific segment lays emphasis on the workers' specialisation and therefore intratask learning rather than to encourage generalisation and transfer of knowledge and abilities. In conclusion, we derive **hypothesis 4**: *Dual System education promotes high inter-firm mobility as a potential explanation for lower participation in vocational further training and other investments.*

Another attribute of occupations with Dual System emphasis is that of certificate monopolies. If attraction of workers mainly relies on a certain vocational education lowering search and training costs, certificate monopolies will arise. Employers use signalling effects from the graduation and are therefore setting minimum requirements protecting certificate holders from lower skilled competitors. Brauns et al. (1999) even found some resistance against competitors with tertiary education. We conclude these arguments with **hypothesis 5**, which states that *there are occupation classes with emphasis on Dual System education protecting their incumbents from external competition.*

There are also implications from technological and organisational change for the secondary segment. The secondary segment is characterised by high numerical flexibility and strong exchange with unemployment. Movements between any primary and the secondary segment are limited to downward mobility of primary segment dismissals which is their alternative to unemployment. Although it should be expected, that organisational change promotes integration via team work or job rotation, it is easy to imagine that there are functions or occupations not being subject to integration. Either these workers do not possess appropriate transferring abilities or they fulfil functions which do not need to be integrated because they are not concerned with core production. Affected workers will lose contact to (rare) mobility ladders and since segregation from core production processes takes place[6] upward mobility will decrease even stronger. Low training requirements, in turn, increase numerical flexibility and job insecurity. Summed up, organisational measures possibly uncover marginal work where job training is low and employers increasingly exploit secondary segment (numerical) flexibility. The last **hypothesis 6** suggests *coincidence of increasing organisational segregation in the secondary segment.*

[5] We neglect differentiation of the firm size. It is also plausible to consider larger firms to demand more adjustment, e. g. to their complex organisational structures or product variety, than smaller ones (Blossfeld & Mayer, 1988).

[6] See also Egger/Grossmann (2005) and Falkinger/Grossmann (2003).

3. An occupational classification of qualification characteristics

Following the first two hypotheses, firstly we develop an occupational classification of qualification characteristics. For this purpose, data and the two-stage cluster analysis are described before dealing with descriptive statistics.

3.1 Data

We use Microcensus data from 1998 to 2004 (even years) where 3-digit-occupations ("Klassifikation der Berufe 1992", KldB 92) are reported. Data are restricted to the West German civil labour force population from the age of 15 to 64 excluding working students under the age of 27 and running apprenticeships. Due to low sample size we pooled a few occupations which were similar in vocational education distribution according to the occupation data base "Berufe im Spiegel der Statistik" (www.pallas.iab.de), ending up with 288 occupations.

Table 1: Assigned values 'years of schooling'

Vocational education \ General education	No school education, no response	Lower secondary school ("Volksschule", "Hauptschule")	intermediate secondary school ("Realschule")	Certificate of aptitude for university of applied sciences ("Fachhochschulreife")	Upper secondary school ("Abitur")
No vocational education, vocational preparatory class; no response	8	9	10	12	13
Semi-skilled vocational education ("Anlernausbildung"), internship	9	10	11	13	14
Apprenticeship	11	12	13	14	15
Master craftsman/Technician	14	15	16	16	17
University of applied sciences	16	16	16	17	17
University degree	18	18	18	18	18
Dissertation	20	20	20	20	20

In order to obtain clusters of occupations with similar qualification characteristics the following variables were used: years of schooling, position in the firm hierarchy and vocational further training. Years of schooling reflect individual general and vocational education to overcome formal education tracks. Table 1 shows the values we assigned for schooling on the individual level. Occupation data are yield by calculating means for every year and occupation and by taking averages over the years in order to rule out possible business cycle fluctuations. The concept of schooling years also allows us to include individuals who did not report general or vocational educations.

The position in the firm hierarchy is reported in 2000 and 2004. We assigned values (weights) from 1 to 4 (Table 2), calculated weighted sums of the frequencies at the occupational level and took the average over the years. This variable reflects social abilities or responsibility associated with the position in the firm hierarchy. At last, we include vocational further training intensity. This variable results from multiplying the relative frequency of further training (during the last four weeks) within

an occupation with the relative frequency of vocational purpose in 2004. Microcensus waves are not directly comparable during the time span. We used 2004 data where the most differentiated questions were asked.

Table 2: Assigned values 'position in the firm hierarchy

low status (=1)	Qualified tasks (=2)	Intermediate status (=3)	High status (=4)
Family helper		Self-employed with 1-4 employees	Self-employed with >4 emloyees
Trained on-the-job workers	Skilled workers, foreman	Master craftsman	
Clerk with executive tasks	Clerk with ordinary tasks	Clerk with own responsibilities, master craftsman	Clerk with own responsibilities in intermediate/higher position with decision making
Ordinary service	Intermediate service		Higher intermediate, higher service

Source: Microcensus, IdZA data service center.

3.2 Two-stage cluster analysis

At first, we standardised (z-transformed) cluster variables for scale comparability. First stage cluster analysis was performed with Ward's minimum variance (Ward, 1963) method using squared Euclidean distance as similarity measure. Ward's method is agglomerative and hierarchical, i. e. once two clusters are merged they will remain together at higher levels of aggregation. As a stopping-rule, one can calculate the pseudo-F by Calinski and Harabasz (1974) (Table 3) suggesting 3 clusters. Instead we decided – in these terms – for the fourth best solution with 5 clusters due to cluster characteristics as outlined below. Looking at the preceding groupings of the agglomeration schedule, especially low-skill occupations which are those of very interest to us remained separated.

Table 3: Calinski/Harabsz' pseudo-F

# Cluster	Calinski/Harabasz pseudo-F	
1		
2	369.14	(3)
3	414.48	(1)
4	381.23	(2)
5	348.59	(4)
6	339.96	(7)
7	346.29	(5)
8	344.00	(6)
9	334.77	(8)
10	323.72	(9)
11	317.40	(10)
12	315.34	(11)
13	315.24	(12)
14	313.68	(14)
15	315.12	(13)
Mean	341.35	

Source: own calculations. Number in brackets is the rank of the pseudo-F.

The 5-cluster solution fulfils stability criteria like repeating cluster assignment when dividing the sample in a half and carrying out cluster analysis separately. In addition, comparison with related methods like median linkage and centroid linkage proved stability. Results are reported in Table 4

where the Rand index values regularly exceed the critical value of 0.7. At last, within-variance should be smaller than total variance for each cluster variable. This homogeneity criterion can be confirmed by the reported F-values in Table 5 where no cell exceeds the critical value 1.

Table 4: Rand index values for the 5-cluster solution

Method	Ward's-Linkage	Median-Linkage	Centroid-Linkage
Ward's-Linkage	/		
Median-Linkage	0.7712	/	
Centroid-Linkage	0.8065	0.8950	/
Mean		0.9121	

Source: own calculations.

Table 5: Homogeneity (F-value) of the 5-cluster-solution

	Cluster #				
cluster variable	1	2	3	4	5
schooling years	0.13	0.27	0.23	0.04	0.03
occupational status	0.19	0.16	0.05	0.08	0.09
probality of further training	0.17	0.52	0.64	0.05	0.09

Source: own calculations.

Finally, using the cluster centroids generated by the hierarchical clustering as starting points, the occupations were re-clustered using the iterative k-means algorithm to fine-tune cluster membership. The reasons are twofold. Firstly, a small extent of re-clustering indicates cluster stability. Secondly, and more important, iterative methods like k-means take into account moving centroids. In other words, if in the course of agglomeration the centroid changes insofar as two early merged clusters have relatively less in common at a later stage, than k-means revises agglomeration.[7] Only 20 of 288 occupations have been re-clustered confirming the stability of the 5-cluster solution.

4. Tracing SBTC in the occupational classification

One central goal of using clustered occupations was to provide a measure for qualification-related monitoring purposes. Examining how the cluster variables shaped the cluster solution gives a first impression of potential skill-biases in several respects. Finally, using an approximation of the task concept by ALM, technological (and organisational) change as influential factor is assessed.

As mentioned above, we decided for a 5-cluster solution for non-technical reasons. In fact, we intended to differentiate the mass of graduates from the DSVE that represents two thirds of the labour force (Table 6) and now disperses over several occupation classes. This will help us to compare DSVE performance between different levels of, e. g., general schooling. Except for class 1 which has an explicit academic setting, most neighbouring classes have at least one cluster variable in common while they differ in others at the same time.

[7] As far as we reviewed existing literature, moving centroids have not been taken into account before (see Feser, 2003; Gittleman & Howell, 1995)

Table 6: Vocational education level by qualification class 2004

qualification class	no response	no vocational education[1]	vocational training[2]	tertiary education
	shares (in %)			
1	0.4	2.1	13.8	83.7
2	0.8	6.5	72.6	20.2
3	0.7	11.2	81.5	6.7
4	0.5	16.5	80.8	2.2
5	0.7	39.6	58.1	1.6
Total	0.6	16.3	67.0	16.1

1 including vocational preparatory class, internship, semi-skilled vocational education
2 including master craftsman, technician
Source: Microcensus, scientific use file 2004, own calculations.

Table 7: Vocational further training by qualification class 2004

qualification class	participation in further training, share (%)	vocational purpose, share (%)	Probability of vocational further training
1	33.4	96.4	0.32
2	25.4	94.5	0.24
3	15.6	91.7	0.14
4	8.0	90.4	0.07
5	4.1	82.8	0.03
Total	16.0	93.2	0.15

Source: Microcensus, scientific use file 2004, own calculations.

Table 8: General education level by qualification class 2004

qualification class	no response	no school education	lower secondary school	intermediate secondary school	upper secondary school[1]
	shares (in %)				
1	0.9	0.1	2.7	6.4	89.8
2	1.2	0.2	17.9	37.1	43.6
3	1.1	0.5	35.7	40.9	21.8
4	0.9	2.1	63.0	24.9	9.1
5	0.9	6.3	67.9	18.0	6.9
Total	1.0	1.9	39.8	28.2	29.0

1 "Fachhochschulreife" and "Abitur" together
Source: Microcensus, scientific use file 2004, own calculations.

Qualification class 2 has an exceptionally high individual probability of vocational further training (0.24 compared to a total of 0.15, Table 7) and a relatively high share of upper secondary school graduates (Table 8). In Classes 3 and 4 prevails the DSVE but regarding school education, they differ from each other: Two thirds of Class 3 have reached at least intermediate school level, whereas two thirds in class 4 have attended at most lower secondary school. By contrast, the two bottom classes 4 and 5 differ in vocational education although exhibiting similar school education. Furthermore, vocational further training is for both classes only marginal. Summed up,

- Only the first class is congruent with standard education measures ("academics");
- Despite the common vocational education, Dual System graduates differ a lot in any other qualification respect;

- School education is the bracket for the two bottom classes, whereas vocational education is comparable for classes 2 to 4;
- Vocational further training is the most continuous qualification measure of all cluster variables.

Concerning hypothesis 4 (Dual System education induces a mobility pattern which is adverse to further training provision), the variety in regard of other qualification variables suggests a more differentiated view. However, referring to Krueger/Kumar (2004), higher levels of general skills – indicated by general schooling – are accompanied by higher adoption rates – indicated by further training participation – for given vocational education (in classes 2 to 4). This might be one explanation for the differing training intensity between occupation classes which are strongly dominated by the Dual System type of vocational education. Later, in section 5.2 when assessing the actual mobility pattern, we readdress to hypothesis 4.

The potential impact of technological change can be traced by applying the task-based approach by ALM (2003). For this purpose, we reconstruct those 5 categories using the question for the mostly performed task in the Microcensus waves 2000 and 2004 (see Table 9). The intensity of ICT-complementary tasks increases with qualification class while potentially substitutable tasks are concentrated in classes 3 and 4 (table 10). Non-routine manual tasks exhibit the maximum share of all cells with 72.5% in the bottom occupations. Furthermore, in order to verify the assumption of skill-biased technological change, regression analysis of occupational employment growth is conducted later on. To conclude, hypothesis 3 (reallocated non-routine tasks are more training intensive) is valid since, firstly, non-routine tasks in class 5 have a manual focus and are therefore not reallocated to the organisational sector (yet). Secondly, the training intensity is near zero for the production sector as it is suggested in the Egger/Grossmann (2005) model.

Table 9: Application of the ALM task concept for the Microcensus

non-routine analytic	DEVELOPING, CONSTRUCTING PRODUCTS, PLANS, IDEAS
	INTERPRETING THE LAW, USING IT; CERTIFYING
non-routine interactive	BUY/SELL, ADVISE, CASH
	ADS, MARKETING/PR
	MANAGEMENT
	EDUCATION, TEACHING
	ADVISING, INFORMING
	ARTIST, JOURNALIST
routine cognitive	BOOKKEEPING
	MEASURING, CHECKING; TESTING, CONTROLLING DUE TO A STANDARDIZED PROCEDURE
routine manual	INSTALL, ADJUST, CHECK MACHINES
non-routine manual	PRODUCE, CARPETING,
	REPAIR, RENOVATE, IMPROVE
	HOTELS; PREPARING AND SERVING MEALS
	MEDICAL/SOCIAL HELP, CARE; TREAT MEDICALLY/COSMETICALLY
	DRIVING, LOADING, SORTING, DELIVERING
	WASTE MANAGEMENT
	SECURITY, POLICE, MILITARY

Source: Microcensus, IdZA data service center.

Table 10: Distribution of task categories by qualification class 2004

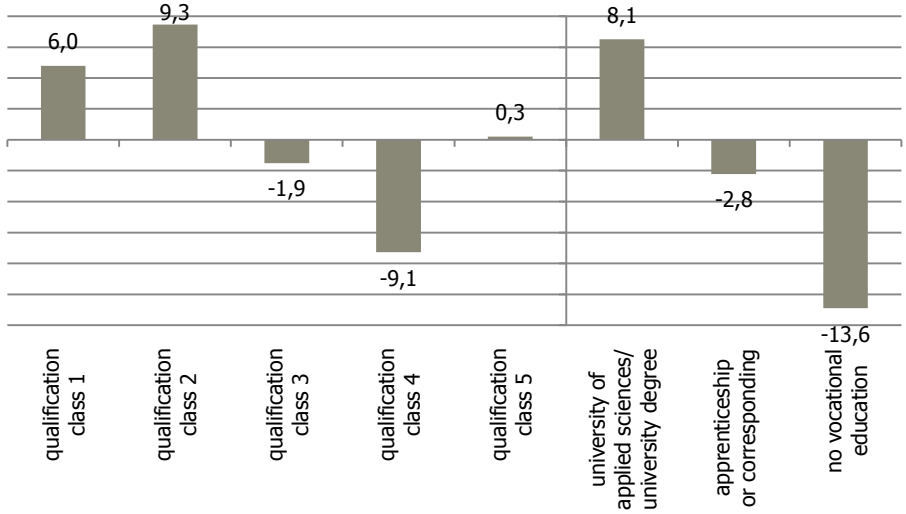
	qualification class					
task category	1	2	3	4	5	total

non-routine analytic	24.8	11.2	6.2	1.3	0.4	7.4
non-routine interactive	48.4	41.1	24.7	22.1	11.1	27.5
routine cognitive	9.9	19.7	38.3	7.4	2.1	18.0
routine manual	1.9	4.1	3.7	20.1	13.9	8.6
non-routine manual	15.0	24.0	27.1	49.1	72.5	38.5

Source: Microcensus, scientific use file 2004, own calculations.

We can insofar confirm hypothesis 1 (ALM hypothesis), that technology-sensitive tasks reflect the average level of qualification requirements within occupations.[8] Turning to hypothesis 2, leads us to an examination of occupational employment growth from 1998 to 2004. In the course of 7 years, the classes developed very differently (Figure 1). Beginning with upper qualification classes, stronger growth in the second class is surprising in regard to slightly weaker growth of the top class. From classes 2 to 4 a kind of monotonous SBTC emerges. However, the bottom class (5) develops better than its higher ranked neighbours (3, 4). Reviewing employment growth by vocational education, existing polarisation trends would not have been visible. Hence, hypothesis two which proposed a more differentiated picture of qualification-related employment growth is confirmed, too.

Figure 1: Employment growth 1998-2004 by "qualification" (in %)



Microcensus, scientific use files 1998 and 2004, own calculations.

In order to verify our assumption for the most hypotheses to be concerned with (ALM-type) SBTC, we estimate occupational employment growth for the time span 1998 to 2004 using robust estimators (Table 11). Besides the shares of mostly performed tasks within an occupation, we control for industry (24 industries) and firm size shares (3 size groups) in the initial year. Special treatment was necessary for income growth which is calculated by using fitted values of a preceding income regression at the occupational level. In addition, we restrict to full-time employment due to possible differences in earnings functions but include a variable measuring the 1998 to 2004 difference of the share of part-time. At last, in order to cover supply-side influences of occupational employment growth, the ratio of workers younger than 35 to those of at least 50 years is included. Estimated coefficients of task shares behave as expected in presence of ALM-type SBTC. Choosing routine

[8] See also Goos and Manning (2007) for the UK at the 3-digit-level and Spitz-Oener (2006) for Germany at the 2-digit-level, each for the time span from 1979 to 1998/9.

cognitive tasks as a reference category, all other but routine manual tasks make occupational employment growth significantly better off.

Table 11: OLS regression of occupational employment growth

Independent variable	Coefficient	t-Value
non-routine analytic tasks (%)*	0,2584	2,63
non-routine interactive tasks (%)*	0,3726	4,49
routine manual tasks (%)*	0,2320	1,55
non-routine manual tasks (%)*	0,2085	2,72
income change 1998-2004 (%)	-0,7739	-2,17
difference in part-time share 1998/2004	-1,7512	-5,07
age ratio: under 35 to 50 years and older	0,0220	2,97
Observations	287	
R squared	0,429	

Source: Microcensus Scientific Use Files 1998 and 2004. Dependent variable: occupational employment growth 1998-2004 (%). Heteroscedasticity robust estimators. Income change calculated by using fitted values of a preceding income regression. Variables without year indication are 1998 values. * Reference category: routine cognitive tasks (%). Further control variables: 23 industry shares and 2 firm size shares.

5. Labour Market Segments

With the occupational classification at hand we are now able to apply standard indicators for qualification-related, segmented labour markets. Due to a lack of objective measures, we have to collect evidence from several investigations around the issue of employment opportunities. The pattern of inter-firm and inter-occupational mobility is investigated being an important factor for participation in further training. Demand side factors like the firm size or capital intensity would provide appropriate indicators for ILM but are either not in the data (capital intensity) or only roughly measured (firm size). Thus, we concentrate on the supply side effect of qualification on labour market segmentation in multivariate analysis of mobility patterns.

A number of empirical studies about labour market segmentation in (West) Germany rejected the hypothesis of three segments as suggested by Lutz and Sengenberger (1974). For example, Blien (1986) finds it hard to separate ILM and the craft-specific labour market, whereas Blossfeld and Mayer (1988) split up the secondary segment along (dichotomised) firm size. Following the presented theory, to distinguish between craft-specific and ILM is difficult since the majority of certificate holders who have a higher probability to get corresponding entry jobs graduated in the DSVE.[9]

Our intention is not to test the tripartite labour market hypothesis (again) but to make use of its theoretical framework describing the institutional (DSVE) and quasi-institutional (ILM) labour market structures and augment its implications by considering skill-biased labour demand due to technological and organisational changes as presented in section 2. The main difference between former studies and our analysis is probably the explorative character – existing segments are not presumed. Contrarily, we want to analyse whether occupational groups with common qualification characteristics exhibit segmentation features which might explain why there are groupings at all due to mutual influences of education and qualification.

[9] This is an adaption to German particularities since Doeringer and Piore (1971) considered ILM entry jobs to be low-skilled.

5.1 Descriptive Evidence

So far some results may already indicate labour market segmentation. Employment stability, derived from employment growth, would suggest the top two classes displaying primary segment characteristics. Vocational further training intensity adds to this supposition: The intermediate extent of vocational further training in class 3 is quite distinguished from neighbouring classes 2 and 4. While the former shows a training intensity which can be expected in ILM, the latter is almost negligible. Thus, the bottom classes can be described as excluded from those opportunities provided by vocational further training.

The hierarchical position in the company serves as a measure for organisational inclusion and is subject to hypothesis 6 (organisational change promotes segregation and secondary segment formation). Two thirds of the employees in class 5 occupations fulfil functions which are excluded – potentially caused by organisational change – showing a secondary segment typical segregation (table 12). Class 4 with its distinguishing focus on an established position might belong to a craft-specific labour market because of its initially higher status. To sum up, we can observe exceptionally high organisational exclusion of the bottom qualification class. If these occupations would represent a secondary segment, hypothesis 6 is true. Fortunately, we can shed further light on qualification class 5 by means of the results by Bauer/Bender (2004) who defined 'unskilled workers' in a quite similar way.[10] They found stronger and more unambiguous negative effects on unskilled employment growth (resulting from higher job destruction and separation rates) of organisational decentralisation measures than of IT investments.

Table 12: Position in the firm hierarchy by qualification class 2004

qualification class	low status	qualified tasks	intermediate status	high status
	shares (in %)			
1	1.5	4.7	26.9	66.9
2	3.7	10.0	51.7	34.5
3	12.0	27.4	46.4	14.2
4	24.9	54.4	15.9	4.8
5	65.3	27.1	5.7	1.9
Total	22.7	25.9	31.0	20.3

Microcensus, scientific use file 2004, own calculations.

Furthermore, we calculate unemployment by lastly held occupation (Table 13).[11] It is no surprise that unemployment declines with qualification but the distance between classes 3 and 4 is unambiguous and increasing with the cyclical slowdown. Unemployment in class 5 as a secondary segment candidate can be explained by absence of wage flexibility if it cannot absorb primary segment layoffs.[12] At low wage levels, in contrast to the US, collectively agreed wages or implicit minimum wages like social welfare impede wage flexibility. The high unemployment rate for former class 4 workers possibly results from low willingness to downshift average job quality like a look at the pattern of occupation changes in the next section will also suggest.

[10] They aggregated categories suggested by Blossfeld (1985), whereas their bottom qualification shares most of the occupations which the cluster analysis also merged.

[11] Due to the restricted labour force concept applied, unemployment rates are lower than usual.

[12] See Falkinger/Grossmann (2003).

Table 13: Unemployment by qualification class 2004

qualification class	1998	2000	2002	2004
1	1.4	1.3	1.0	1.3
2	2.1	1.8	1.7	2.3
3	3.0	2.5	2.6	3.7
4	5.3	4.4	5.1	7.0
5	5.9	5.0	5.4	7.3
Total	3.8	3.2	3.4	4.6

Microcensus, scientific use files 1998, 2000, 2002 and 2004, own calculations

5.2 Mobility

Concerning the persistence of segments and the individual prospects, one major concern of segmentation research is (upward) mobility between segments. Consequentially, segmentation will persist if primary segments are hard to enter. Our argumentation behind hypothesis 4 leads us to the conclusion that vocational education in the Dual System induces adverse mobility schemes in terms of human capital adaption or functional flexibility. Since the Microcensus does not report the occupation held before switch in the year before the inquiry, the question whether workers also switched segments when they switched their occupation cannot be addressed. Another restriction imposed by the data is to focus on year-to-year (short run) mobility.

In order to analyse mobility behaviour, a probit analysis was conducted concerning the probability to change the employer rather than the occupation. According to the presented theory, our main interest lies on vocational education as well as openness of the occupational classes under consideration. Age controls for individual risk aversion in respect of the actual (and likely secure) working situation. The binary dependent variable is 1 for the outcome 'change of firm' and 0 for 'change of occupation' and reflects the options under external adjustment pressure. We pooled cross section data for the even years from 1998 to 2004.

Table 14: Pooled probit analysis of the mobility pattern

Independent variable	**Coefficient**	**t-Value**
dsgrad *(Dummy)*	0.0715	3.36
age	0.0054	0.85
age^2	-0.0002	-2.09
qual. class 1 *(Dummy)**	0.1791	4.30
qual. class 2 *(Dummy)**	-0.1156	-3.45
qual. class 3 *(Dummy)**	-0.0793	-2.60
qual. class 5 *(Dummy)**	-0.1477	-4.59
number of observations	33,383	
pseudo R squared	0.024	

Source: Microcensus Scientific Use Files 1998, 2000, 2002 and 2004. Dependent variable: probability of changing the employer compared to a change of occupation. Further control variables: 23 industry and 3 year dummies. * Reference category: qualification class 4.

Results from probit regression are reported in table 14 and confirm some of our theoretical considerations. First of all, a Dual System graduation increases the probability of inter-firm mobility in the last year rather than changing occupation. Squared age reflects risk aversion very well while age enters the equation insignificantly. Regarding the influence of (target) occupation classes relative to occupations of class 4 only employees within the academics class are more likely to change the firm

than into one of these occupations. Conversely, classes 2 and 3 (significantly) prove to be functionally flexible in this respect whereas the same attribute of qualification class 5 is a sign of secondary segment openness. Thus, hypothesis 5 (certificate monopolies) is appropriate regarding class 4 but not classes 2 and 4, given that the tasks to perform in class 4 are not totally substituted by technological and organisational change or reallocated to the organisational sector. The monopoly nature decreases functional flexibility and necessitates numerical flexibility as expressed by the higher probability to change the firm or the high unemployment risk. Additionally, the results for classes 2 and 3 imply that the characteristically high vocational training contributes to blurring occupational borders. This is another confirmation of hypothesis 3 if the results express reallocation processes to organisational activities and non-routine tasks, respectively.

Turning to hypothesis 4, the low intensity of further training in craft-specific labour market segments is accompanied by a training adverse mobility scheme as far as occupation class 4 is concerned. Class 3 seems to be not affected if one disregards vocational education but the relative frequency of an apprenticeship proposes a different direction. Therefore, it will be interesting to pursue further developments of class 3 in order to evaluate the adequacy of the underlying system of vocational education. Presumably, class 2 and 3 involve newer occupations, resulting from reallocation processes, which have not been subject to substantial changes in work place requirements or were even promoted by the progress in production technologies.

6. Conclusions

Despite dealing with similar issues, the theoretical overlaps of segmentation theory and SBTC/SBOC literature have not been explored yet. For example, certain organisational measures – irrespective of underlying technological progress – lead to marginalisation of certain occupations and therefore promote secondary segment formation. Conversely, craft-specific labour markets induce training adverse mobility patterns lowering the functional flexibility of the workers concerned.

Our empirical basis is a classification of 3 digit-occupations using a two-stage cluster analysis. By means of five occupation classes we are able to observe (task-related) polarisation of employment growth in recent years. Furthermore, from the two craft-specific labour markets we suspect in the classification only one exhibits those unfavourable attributes which probably contribute to its large employment losses. The other class shows no signs of adverse institutional effects on occupational employment growth (yet). The hypothesis of increasing segregation could be confirmed more clearly and further secondary segment characteristics of the bottom qualification class were found, too. Additionally, we found evidence for an ILM where rather favourable preconditions with regard to further technological and organisational changes are bundled.

Our policy conclusion resumes the findings concerning the primary labour market segments. We explicitly propose measures aiming for modularisation of vocational education. First, apprenticeship training should increasingly be adjusted to the firms needs in order to raise the incentives for further vocational training after graduation. Second, graduated employees would recognise modules – if certified as further training content – as trustful investment.

Furthermore, empirical research should continue to overcome the veil of formal (vocational) education since there is large heterogeneity in terms of formal and informal skills. Occupations reflect the task structure on the one hand and the institutional effects of the vocational education system on the other hand. The range of our analyses, however, had to cope with data restrictions concerning the investigation of labour market segmentation – in a dynamic perspective as well as in a meso (firm) perspective. Probably, using employer-employee linked data sets would be an empirical en-

richment. Our classification which is also applicable to other statistics like the one from the German Federal Employment Agency[13] can serve as a guide.

Empirical segmentation literature is in general hard to compare because there is neither an acknowledged set of indicators to identify segmented labour markets nor a methodical accord. There is a common sense, however, that the secondary segment must exhibit precariousness of employment in some way. To contribute to this idea, not reported evaluations give us reason to believe that most of the nonnegative development of the bottom qualification class is due to – or at least accompanied by – the so-called 'Mini Jobs', a particular German employment form with reduced contributions to the social security system and facilitated report duties for the employer with an upper bound of 400 Euro and slightly increasing contributions until 800 Euro. Usually, mini jobs are short-term contracts and part-time work and therefore typical precarious work in a secondary segment.

References

Autor, D. H., Levy, F., and Murnane, R. J. (2003): The skill content of recent technological change: an empirical exploration. *The Quarterly Journal of Economics, 118*(4), 1279-1333.

Bartel, A. P., and Lichtenberg, F. R. (1987): The Comparative Advantage of Educated Workers in Implementing New Technology. *Review of Economics and Statistics, 69*(1), 1-11.

Bauer, T. K., and Bender, S. (2004): Technological change, organizational change, and job turnover. *Labour Economics, 11*(3), 265-291.

Bellmann, L., and Pahnke, A. (2006): Auswirkungen organisatorischen Wandels auf die betriebliche Arbeitsnachfrage. *Zeitschrift für Arbeitsmarktforschung*(2), 201-223.

Blechinger, D., and Pfeiffer, F. (2000): Technological Change and Skill Obsolescence: the Case of German Apprenticeship Training. In: H. Heijke and J. Muysken (Eds.), *Education and Training in the Knowledge Based Economy* (p. 243-278). Houndsmill/London: Macmillan Press Ltd.

Blien, U. (1986): *Unternehmensverhalten und Arbeitsmarktstruktur*. Nürnberg.

Blossfeld, H.-P. (1983): Höherqualifizierung und Verdrängung - Konsequenzen der Bildungsexpansion in den Siebziger Jahren. In: M. Haller and W. Müller (Eds.), *Beschäftigungssystem im gesellschaftlichen Wandel* (p. 184-240). Frankfurt am Main: Campus.

Blossfeld, H.-P. (1985): *Bildungsexpansion und Berufschancen: Empirische Analysen zur Lage der Berufsanfänger in der Bundesrepublik*. Frankfurt: Campus.

Blossfeld, H.-P., and Mayer, K. U. (1988): Labor market segmentation in the Federal Republic of Germany: an empirical study of segmentation theories from a life course perspective. *European Sociological Review, 4*(2), 123-140.

Brauns, H., Steinmann, S., Kieffer, A., and Marry, C. (1999): Does Education Matter? France and Germany in Comparative Perspective. *European Sociological Review, 15*(1), 61-89.

Bresnahan, T., Brynjolfsson, E., and Hitt, L. M. (2002): Information Technology, Workplace Organization and the Demand for Skilled Labor: Firm-level Evidence. *Quarterly Journal of Economics, 117*(1), 339-376.

[13] Classification is available from the author upon request.

Calinski, T., and Harabasz, J. (1974): A dendrite method for cluster analysis. *Communications in Statistics, 3*, 1-27.

Caroli, E., and Van Reenen, J. (2001): Skill-biased organizational change? Evidence from a panel of British and French establishments. *Quarterly Journal of Economics, 116*(4), 1449-1492.

Caselli, F. (1999): Technological revolutions. *American Economic Review, 89*(1), 78-102.

Doeringer, P. B., and Piore, M. J. (1971): The theory of internal labor markets. In: P. B. Doeringer and M. J. Piore (Eds.), *Internal labor markets and manpower analysis*. Massachusetts: Lexington.

Duranton, G. (2004): The economics of production systems: Segmentation and skill-biased change. *European Economic Review, 48*(2), 307-336.

Dustmann, C., Ludsteck, J., and Schönberg, U. (2007): Revisiting the German Wage Structure. *IZA Discussion Paper No. 2685*.

Egger, H., and Grossmann, V. (2005): Non-routine tasks, restructuring of firms, and wage inequality within and between skill-groups. *Journal of Economics, 86*(3), 197-228.

Falk, M. (2002): Endogenous organizational change and the expected demand for different skill groups. *Applied Economics Letters, 9*, 419-423.

Falkinger, J., and Grossmann, V. (2003): Workplaces in the Primary Economy and Wage Pressure in the Secondary Labor Market. *Journal of Institutional and Theoretical Economics, 159*, 523-544.

Feser, E. J. (2003): What Regions Do Rather than Make: A Proposed Set of Knowledge-based Occupation Clusters. *Urban Studies, 40*(10), 1937-1958.

Gittleman, M. B., and Howell, D. R. (1995): Changes in the Structure and Quality of Jobs in the United States: Effects by Race and Gender, 1973-1990. *Industrial and Labor Relations Review, 48*(3), 420-440.

Goos, M., and Manning, A. (2007): Lousy and Lovely Jobs: The Rising Polarization of Work in Britain. *The Review of Economics and Statistics, 89*(1), 118-133.

Krueger, D., and Kumar, K. B. (2004): Skill-specific rather than general education: A reason for US-Europe growth differences? *Journal of Economic Growth, 9*(2), 167-207.

Lindbeck, A., and Snower, D. J. (2000): Multitask learning and the reorganization of work: From Tayloristic to holistic organization. *Journal of Labor Economics, 18*(3), 353-376.

Lutz, B. (2006): What follows the era of Internal Labour Markets? Theses, open questions, and theoretical tasks. In: C. Köhler, K. Junge, T. Schröder and O. Struck (Eds.), *Trends in Employment Stability and Labour Market Segmentation* (p. 13-18). Jena.

Lutz, B., and Sengenberger, W. (1974): *Arbeitsmarktstrukturen und öffentliche Arbeitsmarktpolitik*. Göttingen: Verlag Otto Schwartz & Co.

Mortensen, D. T., and Pissarides, C. A. (1998): Technological Progress, Job Creation and Job Destruction. *Review of Economic Dynamics, 1*(4), 733-753.

Nelson, R. R., and Phelps, E. S. (1966): Investment in Humans, Technological Diffusion, and Economic Growth. *American Economic Review, 56*(2), 69-82.

Piore, M. J. (1975): Notes for a Theory of Labor Market Stratification. In: R. C. Edwards, M. Reich and D. M. Gordon (Eds.), *Labor market segmentation* (p. 125-150). Massachusetts: Lexington.

Piva, M., Santarelli, E., and Vivarelli, M. (2005): The skill bias effect of technological and organisational change: evidence and policy implications. *Research Policy, 34*(2), 141-157.

Spitz-Oener, A. (2006): Technical Change, Job Tasks, and Rising Educational Demands: Looking outside the Wage Structure. *Journal of labor economics, 24*(2), 235-270.

Thurow, L. C. (1975): *Generating Inequality: Mechanisms of Distribution in the U.S. Economy*. New York: Basic Books.

Ward, J. H. (1963): Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association, 58*, 236-244.