German labour market reform effects - revisited with a panel data analysis for occupational labour markets »Preliminary version - please do not cite without permission by the author.«

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1 Introduction

In the paper I focus on the several steps of the German labour market reforms (2003-2005) and I analyse changes in the job matching productivity before, during, and after the reform years. Though one of the main objectives of the German labour market reforms was to improve the matching process on the labour market, there are only a few studies that shed light on the direction and the structure of the reform effects on the job matching productivity. Fahr and Sunde (2009) showed a better matching for the aggregated German labour market after the reform steps "Hartz I/II" were in force. Klinger and Rothe (2012) used newer and richer data; therefore they could include the last reform step "Hartz IV" in 2005 and they distinguished between long- and short-time unemployed. All in all, they found either positive effects of the reforms, particularly after introducing reform steps "Hartz I/II" (2003) and "III" (2004). Hereby, Klinger and Rothe (2012) showed stronger reform effects for long-time unemployed. Against all expectations the last reform step "Hartz IV" did not lead to further positive effects. Klinger and Rothe (2012) explain that with statistical effects since the number of unemployed increased sharply in 2005 due to crucial changes in the German mean tested (unemployed) benefits scheme. Hillmann (2009) used newer data as well. She found positive effects of the last reform step and her analysis was different in the construction of the reform dummy for "Hartz IV". Klinger and Rothe (2012) utilized a dummy variable valued zero before 2005 and unity after 2005. Hillmann (2009) assumed an exponentially growing reform effect during the first 12 months after the last reform step "Hartz IV" went in force. Indeed, those studies answer a few questions about the temporal and structural properties of the effects; nevertheless, the political implications seem to remain poor since up to now it is not well known if the reform "reached" the whole labour market or which direction do the effects have in relevant partial labour markets, e.g. in occupational labour market. Another important point is the question if the effects changed during certain (extreme) economic situations like during the financial crisis 2008/2009.

This paper aims to complement previous results by estimations of the parameters of a macroeconomic matching function on the base of detailed, high frequency, and quite recent administrative data for 2000 to 2011, thus it includes the financial crisis 2008/2009. In the first step, earlier work is validated with a more exact and detailed analysis of the timing of the reform effects. In the second step I present analyses for occupational labour markets. Hereby, I use an (German) occupational classification scheme according to Blossfeld (1983) that assigns single occupations to economic sectors and qualification levels, thus two relevant dimensions for economic labour market research and policy. Identification of temporal evolution of the matching productivity is possible by using yearly time fixed effects that can be interpreted as year specific deviations from the average matching productivity in the observation period. To identify the temporal evolution of the matching productivity in occupational labour markets I complement the model with interaction dummy variables that combine yearly and occupational labour market effects; the coefficient sums of interaction and year dummy variables can be interpreted as the "pure" time specific deviations from the averaged occupational labour market specific matching productivity.

My results generally confirm previous results. Additionally the results suggest: the reform effects arise not immediately but with a certain delay; there was a negative devi-

ation from the average augmented matching productivity up to the year 2006. Positive deviations can be observed after 2006 and they get smaller in recent years. Furthermore, there is a (temporal) decrease during the time of recession in 2009 ("crisis dip") – even after controlling for the recession. Generally, the reform "reached" all occupational labour markets and the effects arise faster in the lower qualified occupations. Finally, the matching productivities were not affected in all occupational labour markets during the years of the financial crisis.
The remaining of this paper is organized as follows. In the 2nd section I describe some relevant facts of German labour market reforms, their (theoretical) implications for the matching productivity, the theoretical foundations of the macroeconomic matching function, the interpretation of its parameters, and, finally, information about the occupational labour market structure the analysis will be related to. Details about the utilized data and some descriptive key statistics are presented in the 3rd section. The 4th section contains the empirical strategy and reports and discusses estimation results. The 5th section contains the main conclusions and an outlook to further analysis steps that have to be done to complete this study.

2 Theoretical framework

2.1 *Hartz* reforms, organizational changes, and organizational outcome

In 2002 some crucial pre-conditions for labour market reforms were given: empirical findings show high and persistent unemployment that was independent from the business cycle (Klinger and Rothe, 2012). Furthermore there were discussions about measuring the efforts of the public job placement services that led to doubts about the statistic procedures conducted by the German Federal Employment Service. Therefore, the government stipulated four laws that came into force in three waves. Thereby the government particularly considered working results of an expert commission, the so called *Hartz* commission. Each of that *Hartz* I to IV reform laws consisted of various components refering to the organization and rules for the labour market. The reform laws consist of three elements that shall influence the job-finding rate of unemployed workers (compare, e.g., with Bieber et al., 2005; Jacobi and Kluve, 2007; Klinger and Rothe, 2012).

- Raising effectiveness and efficiency of the Federal Employment Agency: Reorganizing the Federal Employment Agency, promoting competition between public and private placement services into the private sector, or identifying measures of active labour market policy that promised to be more effective. Hereby, the Federal Employment Agency consists of three levels - the head office, regional directorates (Regionaldirektionen), and employment agencies (Agenturen für Arbeit) as well as job centres. Before the reform the head office had strong responsibilities for the operational business of the regional units. After the reform it was clarified that the head office is in charge for targeting and strategy development, the regional directorates are responsible for steering the employment agencies. The latter ones are in charge for the operational business. The employment agencies should operate as branch offices. They are responsible for their own work results. Labor market instruments like training or financial sup-

port for applications are provided in line with clear customer group definitions that distinguish customers who are near to the labour market from customers with a need for counselling, and customers with one or more issues regarding the labour market integration. Particularly, the kind of counselling as well as the usage of labour markt instruments varies over the different customer groups. Generally, the Federal Employment Service should invest only in an unemployed person when the investment is economically useful. This implies that the customer group that is near to the market is hardly provided with instruments as well as the group with one or more issues regarding the labour market integration. Another important topic is the modernization of the information technics. Bieber et al. (2005) reports that there were serious delays in the implementation of the new technic.

- More activation and higher self-responsibility of the unemployed (principle of "Promoting and demanding"[1]: new start-up subsidies, targets on re-integration efforts, reconfiguring the unemployment benefit and social assistance system towards less or shorter benefit entitlement and higher claims of search effort.

- easing of Labour market policy: relaxing of regulations for temporary agency work, fixed term contracts, and employment protection.

Generally, it's an empirical question if and to which extent all those affords have effects on labour market outcomes like the matching of job searching persons and firms. Surely, it is not possible to observe the extent and the variation in the described affords to conduct a straightforward causal analysis on the micro level. Nevertheless, with a macroeconomic matching function framework it is possible to evaluate changes of the matching productivity before, during and after the reform years. This framework and the matching process behind will be explained in the next subsection.

2.2 Matching function

2.2.1 Basic model

The starting point of the matching process are the decisions of firms to create a new job or to fill a vacancy (job creation decision) and the decision of (unemployed) persons about their intensity to search for a new job (job search decision)(Pissarides, 2000, p. xi). Firms spend time, financial, and personal resources for job advertisements, screening, training, and vocational adjustments. Job seekers spend resources for job search and application procedures. Unemployed and firms are randomly matched and start to bargain about the wage.
The basic model assumes homogeneous unemployed and homogeneous jobs and the activities of both market sides can be described as matching technology. The processes behind are not explicitly modelled, so the matching process can be compared with a black box (Petrongolo and Pissarides, 2001). The variables U, V and M stand each for the number of unemployed, vacancies and new hires. The matching functon $f(U, V)$ is often specified by a Cobb-Douglas form:

$$M = AU^{\beta_U} V^{\beta_V}, \tag{1}$$

[1]German expression *"Fördern und Fordern"*.

whereas A describes the "augmented" matching productivity. Constant returns of scale imply $\beta_U + \beta_V = 1$ with $\beta_U, \beta_V > 0$.
In technical terms my analysis refers to changes of the parameter A of the matching function due to changes in the institutional framework of the labour market by the labour market reforms. The central question is if this parameter changed after implementing the reform; therefore I assume that this parameter varies over time, thus A_t is different for different observation periods whereas the elasticities remain constant during the whole observation period. The model equation is then:

$$M_t = A_t U_t^{\beta_U} V_t^{\beta_V} \tag{2}$$

This model differs to Klinger and Rothe (2012) and Fahr and Sunde (2009) who both assumed that there is a constant augmented productivity for the observation period before the reform came in effect and a (possibly) different augmented productivity after the reform was introduced[2]. In the model above this term differs from observation period to observation period; therefore, it will be possible to compare the temporal evolution of the augmented productivity.

2.2.2 Occupational labour markets

For analysing the reform effects on occupational labour markets I use the occupational classification scheme derived by Blossfeld (1983). He divides the labour market in 12 broader occupational labour markets and a category "[0] Not assignable". Table 1 shows how the 12 partial labour markets can be assigned to qualification levels and to economic sectors.

Table 1: Occupational categories by sectors and qualification levels.

Occupational category in …	low qualification level	high qualification level
… primary sector	[1] AGR agrarian occupations	
… secondary sector	[2] EMB simple manual occupations	[3] QMB qualified manual occupations
… tertiary sector	[6] EDI simple service occupations	[7] QDI qualified service occupations
… all sectors	[10] EVB simple business and administrative occupations	[8] SEMI semi professions [9] PROF professions [4] TEC technicians [5] ING engineers [11] QVB qualified business and administrative occupations [12] MAN manager

Source: Occupational categories are derived by Blossfeld (1983). Sorting by qualification level and sectors by the author.

Based on those occupational categories, an econometric analysis could shed light on the question if the reform effects cover all qualification levels and sectors in the economy.
Again, I assume constant matching elasticities of unemployed and vacancies in the economy but the augmented productivity term $A_{t,bk}$ now varies with the occupational labour markets bk and observation period t:

$$M_{t,bk} = A_{t,bk} U_{t,bk}^{\beta_U} V_{t,bk}^{\beta_V}. \tag{3}$$

[2] In technical terms they decided to estimate an averaged augmented productivity term before and after the introduction of the reform.

3 Data

I use an unique administrative panel data set for 309 occupational groups in 402 NUTS3 regions with 138 observation periods for January 2000 to June 2011. The occupational groups are coded according to the German occupational classification scheme (Kldb88[3]). All the data stem from the Federal Employment Agency. The groups are assigned to 13 occupational labour markets described in section 2.2.2[4].
I use monthly data about stocks, inflows, and outflows of unemployed and registered vacancies. To get unbiased matching parameter estimations, I adjust the data set by observations for occupations and NUTS3 regions, respectively, where vacancies, unemployed or flows into employment are zero. This leads to an unbalanced panel data structure with 2,394,250 observations. Table 2 shows some descriptive statistics for the aggregated stocks and flows from the data set.

Table 2: Descriptive statistics (monthly averages 2000-2011)

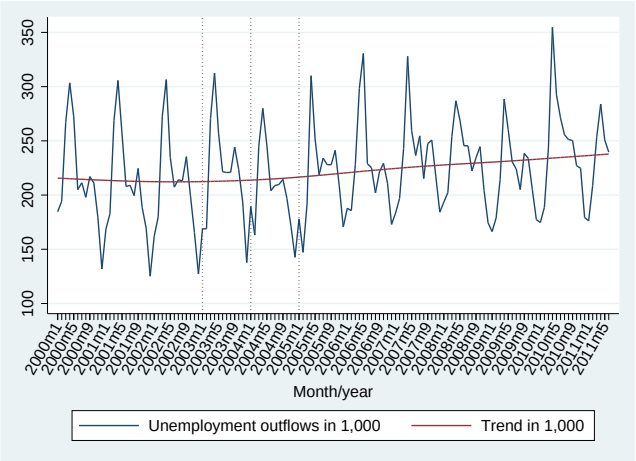
Measure	Averages 2000-2011 (in 1,000)
Unemployment outflows	259
Unemployment stock	3,750
Registered vacancies stock	332

Note: Own calculation of averaged stocks and flows.
Source: administrative data of the centre of the statistics department of the Federal Employment Agency 2000-2011.

Figures 1, 2, and 3 show the time series of the flows from unemployment into employment, unemployed stocks, and vacancy stocks. Here we can already see that there is a change of the trends in the reform years 2003 to 2005. Hereby, the trends are computed using the Hodrick Prescott filter. Whereas the trends of the unemployment outflows and the stock of registered vacancies decreased before and increased after the reform years the stock of unemployed increased before and decreased after the reform years. However, the strongest changes can be observed for the unemployment and the vacancy stocks whereas the ouflows reveal only slightly changes in the trend.

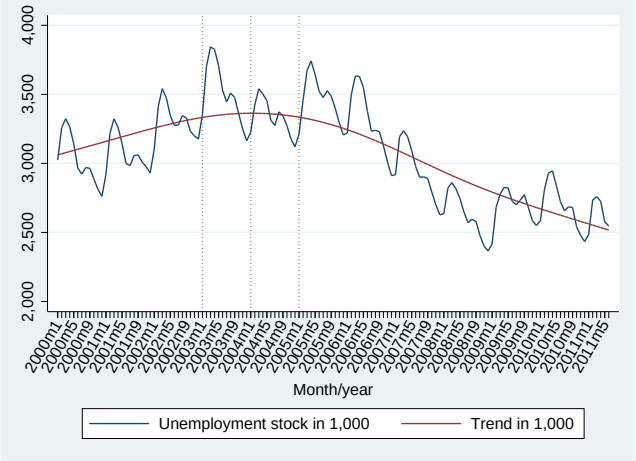
[3] *Klassifizierung der Berufe 1988*
[4] Further information about that will be given in a complemented version of that paper.

Figure 1: Flows from unemployment to employment 2000-2011



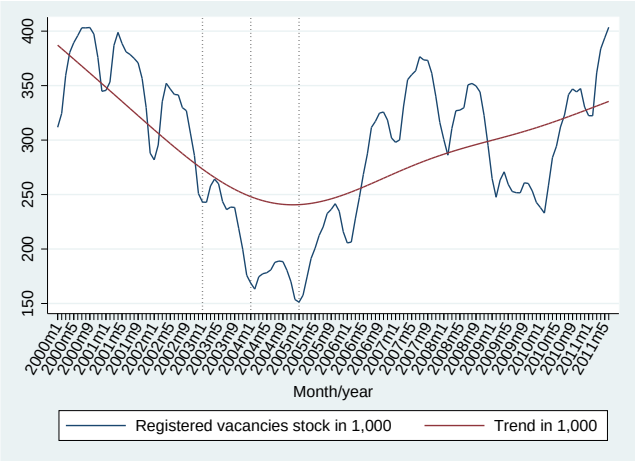
Source: Statistics of the Federal Employment Agency, own computations. Trends are computed with the Hodrick Prescott filter.

Figure 2: Unemployment stock 2000-2011



Source: Statistics of the Federal Employment Agency, own computations. Trends are computed with the Hodrick Prescott filter.

Figure 3: Registered vacancies stock 2000-2011



Source: Statistics of the Federal Employment Agency, own computations. Trends are computed with the Hodrick Prescott filter.

4 Empirical strategy and results

4.1 Aggregated results

At first, I estimate the following regression, related to equation (2):

$$m_{ijt} = a + \beta_u u_{ijt} + \beta_v v_{ijt} + GDP_{cyc,FS(i),year(t)} + \mu_{ij} + d_t + \epsilon_{ijt} \tag{4}$$

Hereby, m_{ijt} denotes the logarithm of the flows from unemployment to employment for region i, occupation j and observation period t. The variable a is the constant, thus the average augmented matching productivity. The variables u / v are the logarithms of the unemployed and vacancy stocks whereas β_u and β_v denote the matching elasticities of unemployed and vacancies respectively. The term $GDP_{cyc,FS(i),year(t)}$ denotes the cyclical component of the real gross domestic product for federal state FS region i belongs to and the year observation period t belongs to. Furthermore, the regressions equation contains a fixed effect μ_{ij} for each regional occupational labour market ij that can be interpreted as the occupational and local area specific augmented productivity. The variable d_t is the (monthly) time fixed effect and - for the moment - the coefficient of interest. It can be interpreted as the monthly deviation from the average of the augmented matching productivity in the observation period 2000 to 2011. This variable is effect coded, thus it's coefficient can directly be interpreted.[5] The reference period is January 2005. Finally, the term ϵ_{ijt} denotes the i.i.d. error term for each observation. Secondly, to adjust for seasonal patterns, I modify the regression equation by including dummy variables $d_q(t)$ for the 1st, 2nd, or 3rd quarter of the year where the month in t belongs to. Furthermore, I substitute the monthly observation period time fixed effects by yearly fixed effects $d_{year(t)}$. This variable is also effect coded[6]; the reference year is

[5] Compare details in Appendix A.1.
[6] See Appendix A.1.

2000. Thus, the latter variable can be interpreted as the yearly seasonal adjusted deviation from the average of the augmented matching productivity during the observation period 2001 to 2011. The regression equation is then:

$$m_{ijt} = a + \beta_u u_{ijt} + \beta_v v_{ijt} + GDP_{cyc,FS(i),year(t)} + d_{q(t)} + d_{year(t)} + \mu_{ij} + \epsilon_{ijt} \qquad (5)$$

The results for those estimations can be found in Table 3. The first column of Table 3 contains the results of basic specification of the matching function. This means that the regression equation consists of new hires m_{ijt} as dependent, registered vacancies v_{ijt} and unemployed u_{ijt} stocks as independent variables and a regional and a occupational specific augmented matching productivity μ_{ij}. As expected from the theoretical model the matching elasticities of the unemployed and vacancies are both significantly positive. For Germany most studies either found that the matching elasticity of the unemployed is higher than the matching elasticity of the vacancies (Burda and Wyplosz, 1994; Entorf, 1998; Fahr and Sunde, 2004; Stops and Mazzoni, 2010; Klinger and Rothe, 2012).

Table 3: Fixed effects estimation results based on data set disaggregated by occupations and NUTS3 regions

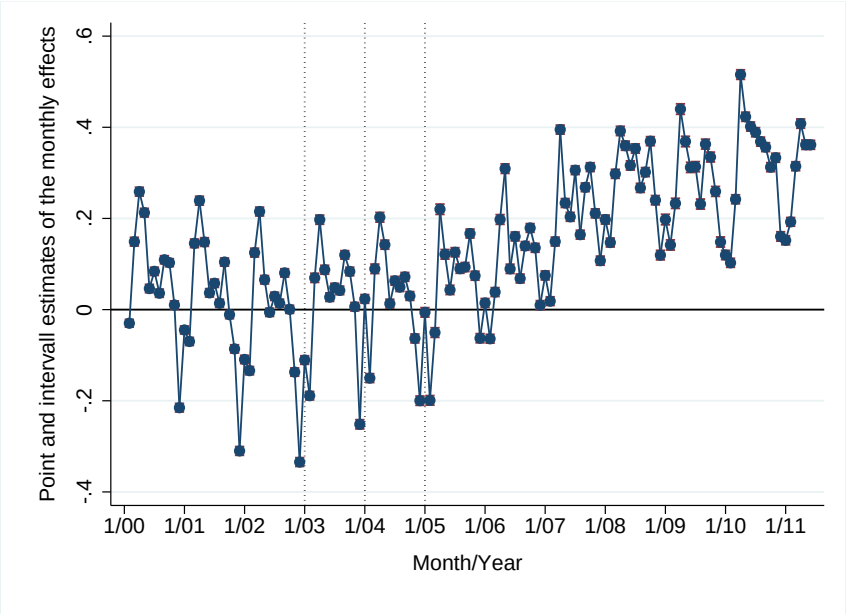
VARIABLES	(1) FE 1	(2) FE 2	(3) FE 3	(4) FE 4
β_u	0.514***	0.519***	0.625***	0.626***
	(0.003)	(0.003)	(0.003)	(0.003)
β_v	0.060***	0.056***	0.039***	0.044***
	(0.001)	(0.001)	(0.001)	(0.001)
d_{2001}				-0.114***
				(0.001)
d_{2002}				-0.147***
				(0.001)
d_{2003}				-0.122***
				(0.001)
d_{2004}				-0.111***
				(0.001)
d_{2005}				-0.082***
				(0.002)
d_{2006}				-0.030***
				(0.001)
d_{2007}				0.067***
				(0.002)
d_{2008}				0.143***
				(0.002)
d_{2009}				0.143***
				(0.002)
d_{2010}				0.176***
				(0.001)
d_{2011}				0.150***
				(0.002)
d_{q1}				0.216***
				(0.003)
d_{q2}				0.149***
				(0.002)
d_{q3}				0.089***
				(0.001)
$GDP_{cyc,FS(i),year(t)}$		0.985***	1.336***	1.352***
		(0.021)	(0.047)	(0.047)
Constant	-0.428***	-0.443***	-0.990***	-0.919***
	(0.013)	(0.013)	(0.014)	(0.012)
Observations	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.206	0.207	0.304	0.275
Number of id	55,422	55,422	55,422	55,422

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column FE 3 includes monthly time fixed effects with effect coding (reference period is January 2000), compare with Figure 4.

The results in the second column belong to the same specification augmented with the cyclical component of the yearly gross domestic product for the 16 federal states $GDP_{cyc,FS(i),year(t)}$. They don't differ very much to the results in the first column.
In the third column there are the results for regression equation (4). After including the monthly time fixed effects the matching elasticities of the unemployed increase whereas the matching elasticities of the vacancies decrease. The monthly fixed effects are not presented in Table 3, but they can be found in Figure 4.

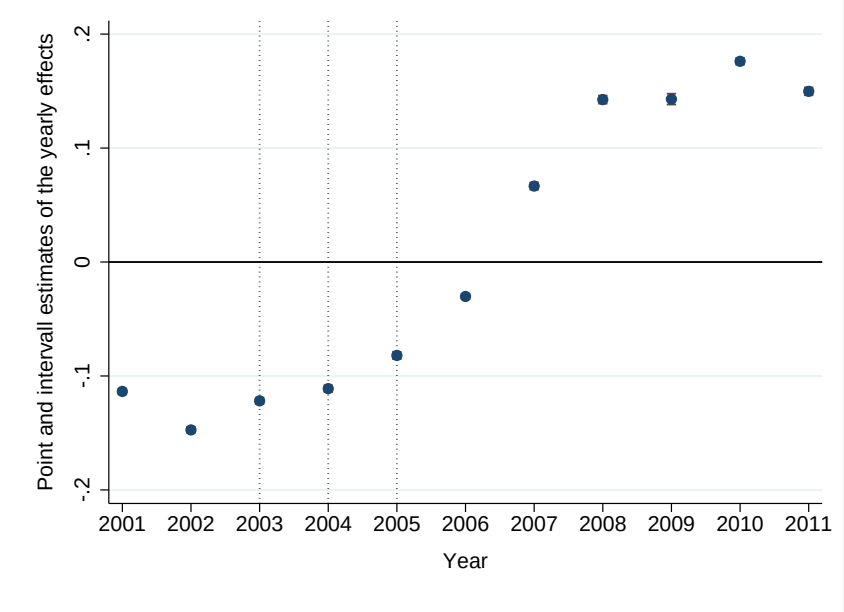
Figure 4: Time fixed effects point and 5-per-cent-interval estimates (FE 3 in Table 3, based on data set disaggregated by occupations and NUTS3 regions)



Source:Statistics of the Federal Employment Agency, own computations.
Notes: The blue dots and the vertical red lines mark the point and 95% interval estimates; in the most cases the interval is very small. The dots are linked with a line to illustrate the temporal development. Monthly time fixed effects with effect coding (reference period is January 2000).

As mentioned those variables can be interpreted as time specific deviations from the average augmented matching productivity, whereas this average is normalized to Zero in that figures. According to that interpretation one can see that from the beginning of the observation period until the year 2006 the monthly deviations could be negative or positive with a seasonal pattern that is quite similar in each year. One can see that from the reform years 2003-2005 on the monthly deviations started to increase from year to year and from 2007 the deviations are all significantly positive. Those results give a first impression how the augmented matching productivity developed after implementing the labour market reforms in 2003 to 2005. However, the volatile seasonal pattern doesn't give a good impression about the development of the productivity deviations.
In equation (5) the year dummies can be interpreted as yearly deviations from the averaged augmented matching productivity and, thus, should give a clearer picture. Furthermore seasonality patterns are adjusted by quarter dummies. The results of the estimations can be found in column (4) of Table 3 including the yearly deviations. A graphic representation of the year effects can be found in Figure 5.

Figure 5: Year effects point and 5-per-cent-interval estimates (FE 4 in Table 3, based on data set disaggregated by occupations and NUTS3 regions)



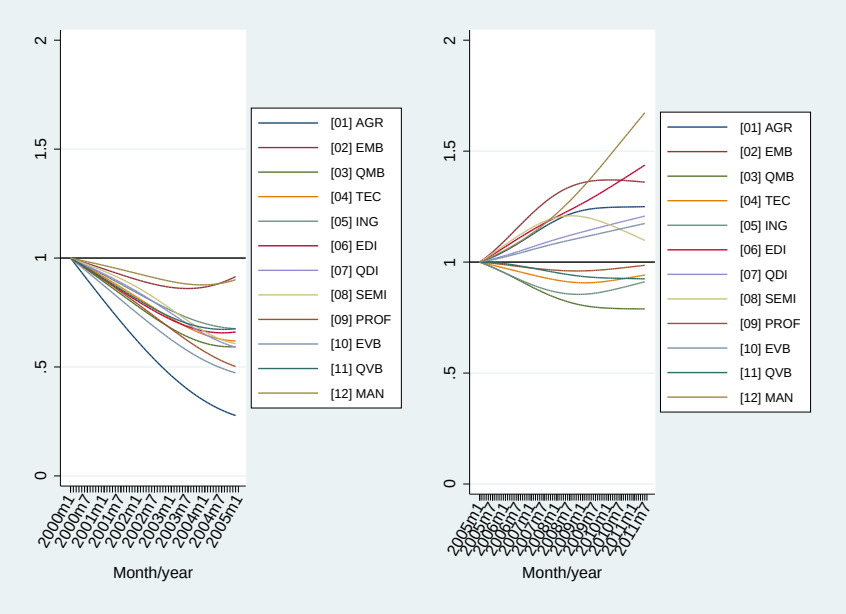
Source:Statistics of the Federal Employment Agency, own computations.
Notes: The blue dots and the vertical red lines mark the point and 95% interval estimates; in the most cases the interval is very small. Yearly time fixed effects with effect coding (reference year is 2000).

The yearly deviations are negative at the beginning of the observation period and begin to increase from 2002 with a sharper increase from 2005 onwards and they get significantly positive from 2007. This increase is - though I control for the business cycle - interrupted in 2009, the year of the financial crisis, and after a small increase in 2010 the deviation decreases in 2011 again. All in all, this let me conclude that there are positive effects on the matching productivity after implementing the reform; but those effects became smaller in the last years.
All effects are highly significant with very small standard errors and differ from each other. The reason for this is the enormous variation of the data set the study is based on. From my knowledge this is the first study that delivers such exact evidence. However, one shortcoming of such detailed data set is that the probability of measurement errors on the small local area level or occupational level increases. In aggregated data sets those measurement errors could be "compensated"; the prize are higher standard errors and less precision.
Since in the next step of this study I am interested in the effects on partial labour markets it is important to see if the results would change after aggregating the data set. Therefore, I aggregated the data sets by NUTS3 regions over occupations and vice versa. However, the results show less precision as expected but the main conclusions remain stable (compare further results in Appendix A.2 on page 22, Table 5 with Figures 10 and 11 for the data set with NUTS3 regions as well as Table **??** with Figures **??** and **??** for the data set with occupations).

4.2 Occupational labour markets

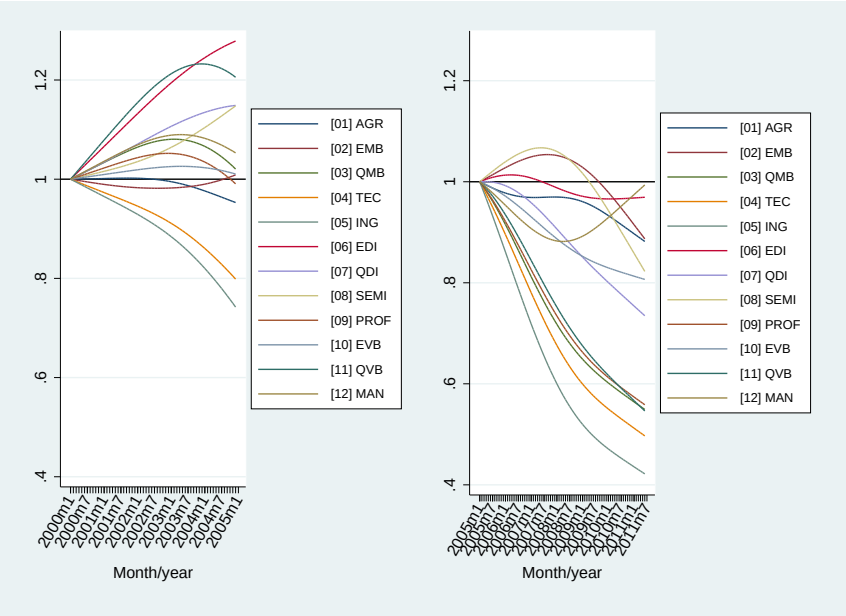
Figures 6 to 8 describe the development of the trends of our key figures, flows from unemployment to employment, unemployment, and the registered vacancy stocks, as indized measures with index 1 firstly for January 2000 (left figure) and secondly for January 2005 (right figure).

Figure 6: Flows from unemployment to employment by occupational labour markets, 2000-2004 with normalized trends (January 2000 = 1, left graph) and 2005-2011 (January 2005 =1, right graph)



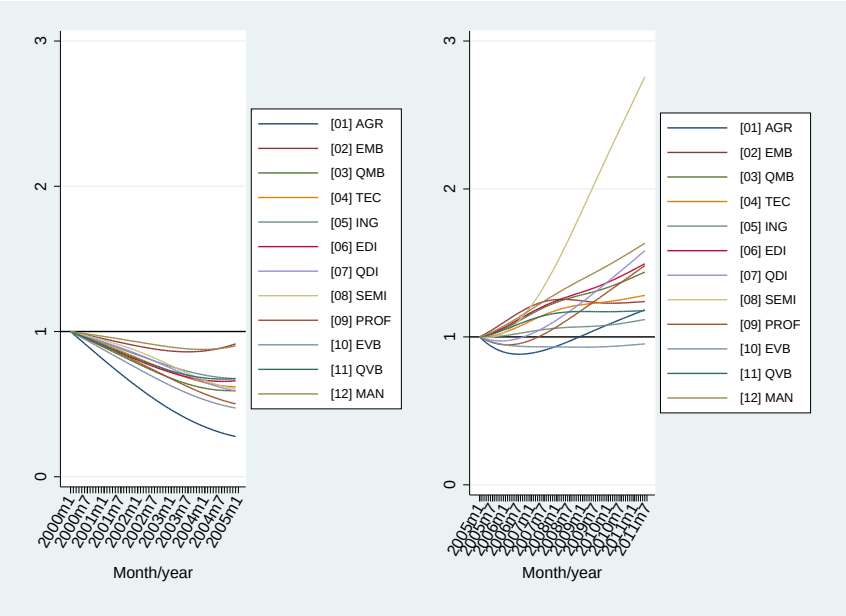
Source:Statistics of the Federal Employment Agency, own computations.
Abbreviations: [01] AGR agrarian occupations; [02] EMB simple manual occupations; [03] QMB qualified manual occupations; [04] TEC technicians; [05] ING engineers; [06] EDI simple service occupations; [07] QDI qualified service occupations; [08] SEMI semi professions; [09] PROF professions; [10] EVB simple business and administrative occupations; [11] QVB qualified business and administrative occupations; [12] MAN manager.

Figure 7: Unemployment stocks by occupational labour markets, 2000-2004 with normalized trends (January 2000 = 1, left graph) and 2005-2011 (January 2005 = 1, right graph)



Source:Statistics of the Federal Employment Agency, own computations.
Abbreviations: [01] AGR agrarian occupations; [02] EMB simple manual occupations; [03] QMB qualified manual occupations; [04] TEC technicians; [05] ING engineers; [06] EDI simple service occupations; [07] QDI qualified service occupations; [08] SEMI semi professions; [09] PROF professions; [10] EVB simple business and administrative occupations; [11] QVB qualified business and administrative occupations; [12] MAN manager.

Figure 8: Registered vacancy stocks by occupational labour markets, 2000-2004 with normalized trends (January 2000 = 1, left graph) and 2005-2011 (January 2005 = 1, right graph)



Source:Statistics of the Federal Employment Agency, own computations.
Abbreviations: [01] AGR agrarian occupations; [02] EMB simple manual occupations; [03] QMB qualified manual occupations; [04] TEC technicians; [05] ING engineers; [06] EDI simple service occupations; [07] QDI qualified service occupations; [08] SEMI semi professions; [09] PROF professions; [10] EVB simple business and administrative occupations; [11] QVB qualified business and administrative occupations; [12] MAN manager.

Generally, these figures shows that there is a certain heterogeneity in the development of the key figures in different occupational labour markets. This let me conclude that I can expect different results regarding the analysis of the changes of the matching elasticity in those markets. To do this, I change the regressions equation. Now, I separately estimate the deviations of the averaged augmented productivity for the occupational labour markets $bk(j)$ occupation j is assigned to:

$$m_{ijt} = a+\beta_u u_{ijt}+\beta_v v_{ijt}+GDP_{cyc,FS(i),year(t)}+d_{q(t)}+d_{year(t)}+d_{bk(j)}+d_{bk(j),year(t)}+\epsilon_{ijt}. \quad (6)$$

It is not possible to separate the occupational and regional fixed effects and the occupational labour market effects, $bk(j)$, related to the occupation j. That's why I excluded the fixed effects μ_{ij} and I estimate an ordinary least squares model. The model is augmented by quarter dummy variables ($d_{q(t)}$), year dummies (yearly observation period fixed effects, $d_{year(t)}$) with reference year 2000, thus the yearly specific deviations from the average augmented productivity; furthermore; it contains dummy variables for 11 occupational labour markets with reference categories "agrarian and not assignable occupations" ($d_{bk(j)}$). The coefficients of those variables are equivalent to the occupational labour market specific deviations from the average matching productivity. Finally, the model contains interaction dummies for the yearly and occupational labour market specific deviations $d_{bk(j),year(t)}$. Formally, the latter variable is the interaction term of the year dummies and the occupational labour market dummy variables. Again, dummy variables are effect coded with exception of the quarter dummy; and

the agrarian and not assignable occupations are the reference period.
The results can be found in Table 4. Hereby, the first column OLS 1 contains the OLS estimation of a pure matching model, thus without the recession variable and further dummy variables. As expected, the coefficients for the matching elasticities are again significantly positive. After including the recession variable in column OLS 2 the coefficients hardly change. Generally, compared to the fixed effects estimations, columns FE 1 and FE 2 in Table 3, the coefficients for the matching elasticities are larger whereas the coefficient for the recession variable is smaller. After including the dummy variables for year effects, quarters and occupational labour markets (column OLS 3 in Table 4) all coefficients get more similar, respectively, to the fixed effect specifications (FE 4 in Table 3). This is especially true for the yearly fixed effects coefficients that have a similar pattern to the fixed effects estimations, thus the main conclusions of the previous section are unaffected.
Finally, column OLS 4 reports the results of the full specification including the yearly and occupational specific interaction effects. Due to space constraints I do not report the latter coefficients but I graphically show the point and interval estimations in Figure 9 and discuss them later.
Columns OLS 3 and OLS 4 reveal another important result: the occupational labour market specific deviations from the augmented productivity for the observation period are significantly negative for occupations assigned to lower qualification level (EMB, EDI, EVB), the technicians (TEC) and engineers (ING). The deviations for the remaining occupational labour markets are significantly positive. This result could be an indication for qualification specific deviations from the matching productivity. However, its validation is a purpose for further analysis based on qualification levels and would be beyond the scope of this study.

Table 4: OLS estimation results based on data set disaggregated by occupations and NUTS3 regions

VARIABLES	(1) OLS 1	(2) OLS 2	(3) OLS 3	(4) OLS 4
β_u	0.573***	0.574***	0.615***	0.614***
	(0.000)	(0.000)	(0.000)	(0.000)
β_v	0.115***	0.114***	0.095***	0.095***
	(0.000)	(0.000)	(0.000)	(0.000)
d_{2001}			-0.117***	-0.127***
			(0.001)	(0.001)
d_{2002}			-0.147***	-0.153***
			(0.001)	(0.001)
d_{2003}			-0.113***	-0.124***
			(0.001)	(0.002)
d_{2004}			-0.089***	-0.089***
			(0.001)	(0.002)
d_{2005}			-0.072***	-0.064***
			(0.001)	(0.002)
d_{2006}			-0.020***	-0.027***
			(0.001)	(0.002)
d_{2007}			0.070***	0.081***
			(0.001)	(0.002)
d_{2008}			0.142***	0.156***
			(0.001)	(0.002)
d_{2009}			0.123***	0.140***
			(0.002)	(0.002)
d_{2010}			0.165***	0.167***
			(0.001)	(0.001)
d_{2011}			0.139***	0.146***
			(0.002)	(0.002)
[02] EMB			-0.026***	-0.027***
			(0.001)	(0.001)
[03] QMB			0.177***	0.176***
			(0.001)	(0.001)
[04] TEC			-0.076***	-0.073***
			(0.002)	(0.002)
[05] ING			-0.081***	-0.072***
			(0.002)	(0.002)
[06] EDI			-0.145***	-0.145***
			(0.001)	(0.001)
[07] QDI			0.007***	0.005***
			(0.001)	(0.001)
[08] SEMI			0.050***	0.048***
			(0.001)	(0.001)
[09] PROF			0.192***	0.197***
			(0.002)	(0.002)
[10] EVB			-0.202***	-0.200***
			(0.001)	(0.001)
[11] QVB			0.016***	0.016***
			(0.001)	(0.001)
[12] MAN			0.017***	0.014***
			(0.002)	(0.002)
d_{q1}			0.244***	0.246***
			(0.002)	(0.002)
d_{q2}			0.162***	0.163***
			(0.001)	(0.001)
d_{q3}			0.089***	0.089***
			(0.001)	(0.001)
$GDP_{cyc,FS(i),year(t)}$		0.621***	0.782***	0.746***
		(0.018)	(0.042)	(0.042)
Constant	-0.784***	-0.786***	-0.993***	-0.994***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.657	0.657	0.691	0.693

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column OLS 4 includes yearly time and occupational category interaction effects (reference year is 2000, reference category is "[01] AGR Agrarian and not assignable occupations), all dummy variables are effect coded, compare Appendix A.1. See also the discussion of the interaction effects in the following subsections.
Abbreviations: [01] AGR agrarian and not assignable occupations; [02] EMB simple manual occupations; [03] QMB qualified manual occupations; [04] TEC technicians; [05] ING engineers; [06] EDI simple service occupations; [07] QDI qualified service occupations; [08] SEMI semi professions; [09] PROF professions; [10] EVB simple business and administrative occupations; [11] QVB qualified business and administrative occupations; [12] MAN manager.

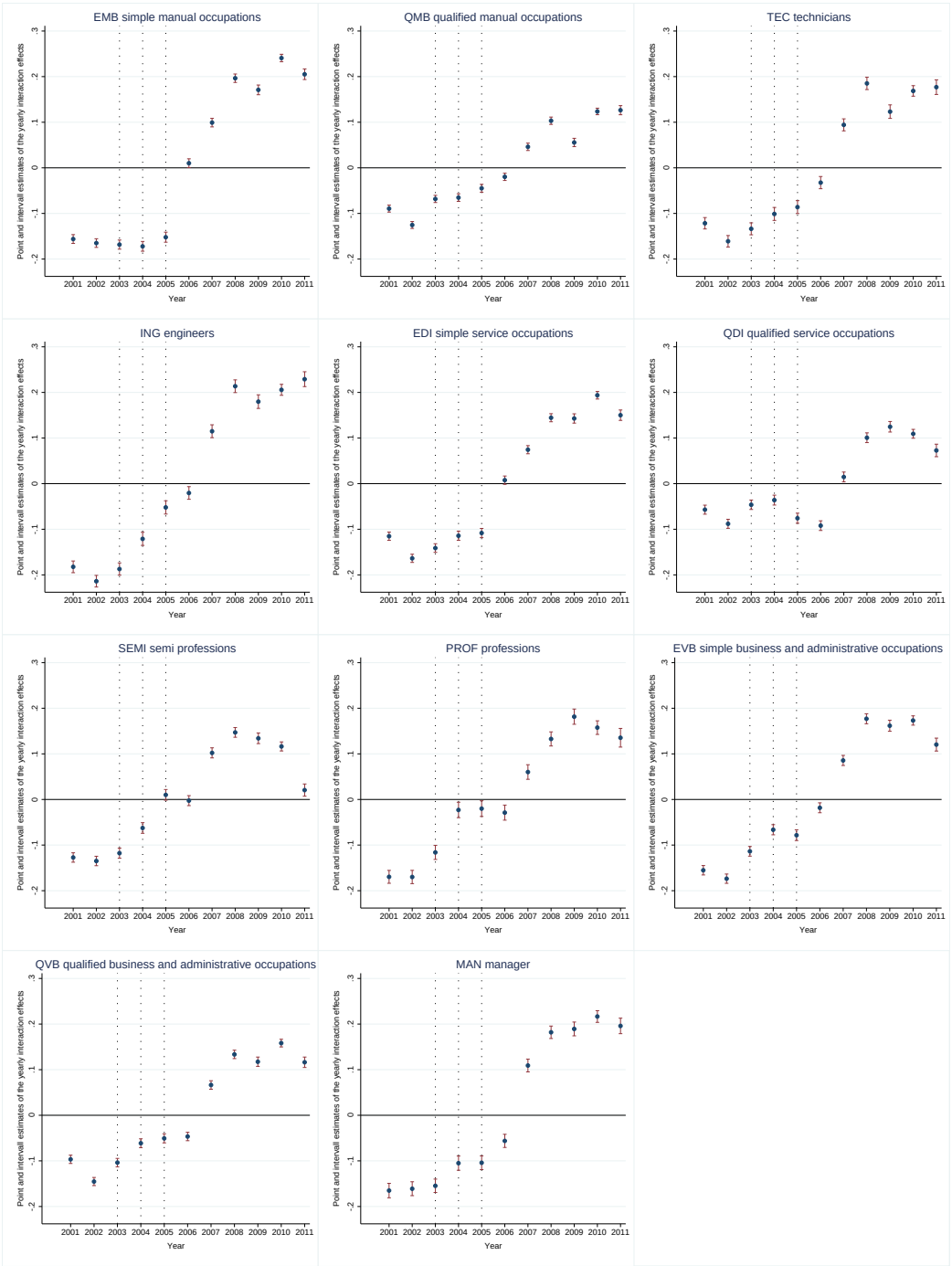
In the following, I discuss the results for the yearly and occupational specific interaction effects. Figure 9 shows point and 5-per-cent-interval estimate sums of the yearly dummy and the yearly interaction effects dummy variables in 11 panels for each occupational labour market (with exception of the agrarian and not assignable occupations). These sums represent the yearly deviations from the average occupational labour market specific augmented productivity, thus it shows how the augmented productivity in a certain occupational labour market is changed due to the "pure" time effect. The common finding is that there is a sharply positive change of the deviation from the occupational labour market specific augmented productivity after the reform years, thus this is an indicator that the reform had effects on the whole labour market. But there are some differences regarding the timing of the change and the sustainability of the effects. Furthermore differences arise during the years of the financial crisis in 2008/2009.

Regarding the timing of the crisis, the fastest effects are observable for the simple manual occupations (EMB), simple service occupations (EDI), and semi professions (SEMI). In those labour markets there are first significantly positive or zero deviations (with significantly negative deviations before) in 2006 and for the semi professions even in 2005. In all other occupational labour markets positive effects are not observable before 2007. This result implies that the reform effects potentially arise with a certain delay that is different between different occupational labour markets and this information about the timing of the effects complements previous studies that only compared the matching productivity before or during the reform years and after the reform years (part. Fahr and Sunde, 2009; Klinger and Rothe, 2012).

According to the results time effects differ between the occupational labour markets in recent years. E.g., in the qualified service occupations (QDI), the semi profession (SEMI), and the professions (PROF) the positive deviations decreased in at least the last years 2010 and 2011. For the other occupational labour market the development seems to move more "sideward". Generally, the results suggest that there was a sharply positive change of the augmented (occupational specific) matching productivities one or two years after the reform came in effect, but the changes were quite smaller in the following years or even negative.

Finally, the results in Figure 9 suggest that for 7 of 11 occupational labour markets there is a "crisis dip" in 2009. Only the qualified service occupations (QDI), semi professions (SEMI), professions (PROF) and managers (MAN) are not or hardly affected in 2009. This illustrates that the German labour market was not generally invulnerable during the crisis.

Figure 9: Point and 5-per-cent-interval estimate sums of the yearly dummy and the yearly interaction effects by occupational labour markets (OLS 4 in Table 4, based on data set disaggregated by occupations and NUTS3 regions)



Source:Statistics of the Federal Employment Agency, own computations.

5 Conclusions

In the paper I present analyses of changes in the job matching productivity before, during, and after the of the German labour market reforms from 2003 to 2005. Though one of the main objectives of the German labour market reforms was to improve the matching process on the labour market, there are only a few studies that shed light on the direction and the structure of the reform effects on job matching. Previous studies confirm positive effects, but there are different results regarding the effects of the different reform steps. All in all, only a few political implications could be derived since up to now it is not well known if the reform effects covered the whole labour market or if the effects changed during extreme economic situations like the financial crisis 2008/2009.

The paper closes some of those gaps by estimation of (unrestricted) macroeconomic matching function parameters on the base of detailed, high frequency, and quite recent administrative panel data for 2000 to 2011. To identify effects for occupational labour markets, I utilize an occupational classification scheme that assigns single occupations to economic sectors and qualification levels, thus two relevant dimensions for labour market research and policy.

The results generally confirm previous results. Beyond that, the results show significant differences in the reform effects on occupational labour markets. All in all, seven important and – from my knowledge – new conclusions can be derived: (1) Generally, the German labour market reform effects on the matching productivity arised with a certain delay; (2) even after controlling for the recession, the matching productivity was detoriated in the year 2009, the year of the financial crisis; (3) the positive effects get smaller in recent years. Particularly, the results of the analysis for occupational labour markets suggest (4) that the reform reached all occupational labour markets; (5) the effects arise earlier in the lower qualified occupations; (6) the result of smaller positive effects in recent years is not true for all occupational groups; and (7) the "crisis dip" is not observable in qualified occupations in the service sector, and in some qualified occupations like professions and manager occupations.

In the further course of this study I plan further analyses regarding the effects in different qualification levels and local areas. Furthermore, though the results are based on quite exact and detailed data, the robustness of the results have to be validated by considering panel data properties like cross-sectional dependence, unit roots, and other dynamic aspects.

A Appendix

A.1 Effect coding

The time dummy variables, the occupational labour market dummy variables, and the interaction variables that are used in the regression equation to analyse occupational and time specific changes in the matching productivity are effect coded. The advantage of effect coding is that the coefficients can be directly interpreted as deviations from the general, the time or the occupational specific intercept in the model. This intercept can be interpreted as the average overall, time specific or occupational matching productivity.
Formally, the time dummy variable d_y with $y = [2001, ..., 2011]$ with reference year 2000 is coded as follows:

$$d_y = \begin{cases} -1 & year(t) = 2000 \\ 0 & year(t) \neq y \\ 1 & year(t) = y \end{cases}$$

The occupational labour market dummy variables d_{bk} with $bk = [2, ..., 12]$ with reference category "Agrarian and not assignable occupations" (occupational category=1) are coded as follows:

$$d_{bk} = \begin{cases} -1 & \text{occupational category}(j) = 1 \\ 0 & \text{occupational category}(j) \neq bk \\ 1 & \text{occupational category}(j) = bk \end{cases}$$

To measure the occupational category specific reform effects I use effect coded interaction dummy variables with the occupational reference category "Agrarian and not assignable occupations" and the reference year 2000. This interaction effect variable $d_{bk,y}$ with $y = [2001, ..., 2011]$ and $bk = [2, ..., 12]$ is coded as follows:

$$d_{bk,y} = \begin{cases} -1 & year(t) = 2000 \text{ and occupational category}(j) = 1 \\ 0 & year(t) \neq y \text{ and} \\ & \text{occupational category}(j) \neq bk \\ 1 & year(t) = y \text{ and occupational category}(j) = bk \end{cases}$$

A.2 Further empirical results

Table 5: Fixed effects estimation results based on data set disaggregated by NUTS3 regions

VARIABLES	(1) FE 1	(2) FE 2	(3) FE 3	(4) FE 4
β_u	0.461***	0.461***	0.618***	0.686***
	(0.016)	(0.016)	(0.021)	(0.024)
β_v	0.108***	0.107***	0.061***	0.090***
	(0.007)	(0.008)	(0.005)	(0.006)
d_{2001}				-0.138***
				(0.004)
d_{2002}				-0.162***
				(0.005)
d_{2003}				-0.101***
				(0.006)
d_{2004}				-0.075***
				(0.006)
d_{2005}				-0.032***
				(0.007)
d_{2006}				-0.005
				(0.005)
d_{2007}				0.066***
				(0.005)
d_{2008}				0.133***
				(0.006)
d_{2009}				0.121***
				(0.009)
d_{2010}				0.174***
				(0.006)
d_{2011}				0.102***
				(0.008)
d_{q1}				0.496***
				(0.014)
d_{q2}				0.298***
				(0.008)
d_{q3}				0.151***
				(0.003)
$GDP_{cyc,FS(i),year(t)}$		0.115*	0.893***	0.976***
		(0.062)	(0.157)	(0.163)
Constant	1.451***	1.451***	0.145	
	(0.167)	(0.167)	(0.198)	
Observations	55,476	55,476	55,476	55,476
R-squared	0.144	0.144	0.659	0.422
Number of kreis_id	402	402	402	402

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column FE 3 includes monthly time fixed effects with effect coding (reference period is January 2000), compare with Figure 10.

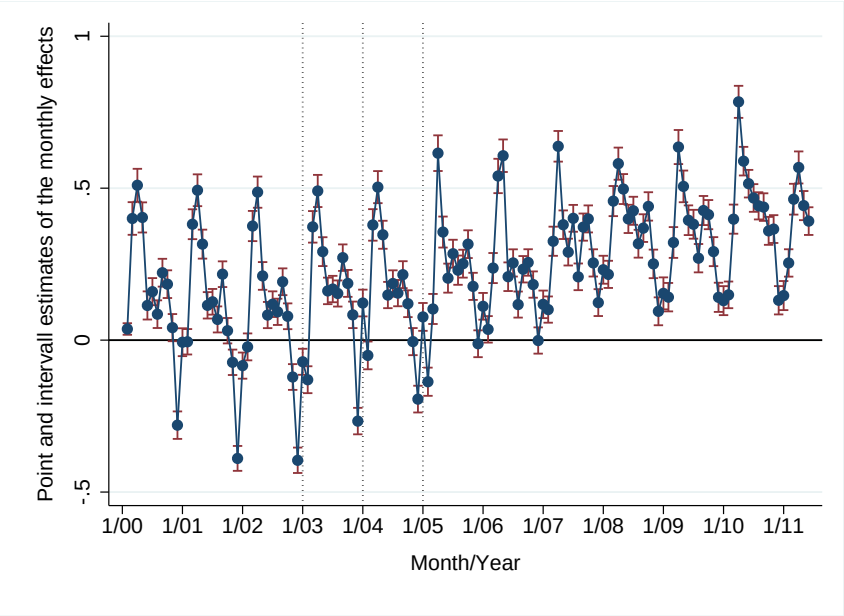


Figure 10: Time fixed effects point and 5-per-cent-interval estimates (FE 3 in Table 5, based on data set disaggregated by NUTS3 regions)

Source:Statistics of the Federal Employment Agency, own computations.
Notes: The blue dots and the vertical red lines mark the point and 95% interval estimates; in the most cases the interval is very small. Yearly time fixed effects with effect coding (reference year is 2000).

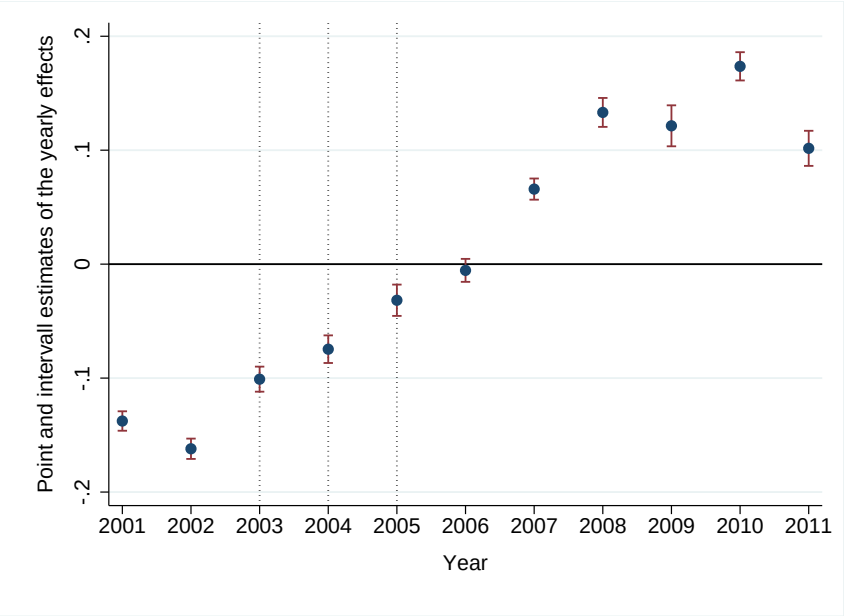


Figure 11: Year effects point and 5-per-cent-interval estimates (FE 4 in Table 5, based on data set disaggregated by NUTS3 regions)

Source:Statistics of the Federal Employment Agency, own computations.
Notes: The blue dots and the vertical red lines mark the point and 95% interval estimates; in the most cases the interval is very small. Yearly time fixed effects with effect coding (reference year is 2000).

Table 6: Fixed effects estimation results based on data set disaggregated by occupations

VARIABLES	(1) FE 1	(2) FE 2	(3) FE 3	(4) FE 4
β_u	0.640***	0.645***	0.927***	0.928***
	(0.017)	(0.017)	(0.018)	(0.018)
β_v	0.138***	0.132***	0.087***	0.098***
	(0.011)	(0.011)	(0.008)	(0.008)
d_{2001}				-0.260***
				(0.009)
d_{2002}				-0.282***
				(0.008)
d_{2003}				-0.209***
				(0.009)
d_{2004}				-0.141***
				(0.009)
d_{2005}				-0.075***
				(0.009)
d_{2006}				-0.043***
				(0.006)
d_{2007}				0.113***
				(0.008)
d_{2008}				0.237***
				(0.010)
d_{2009}				0.279***
				(0.011)
d_{2010}				0.320***
				(0.010)
d_{2011}				0.248***
				(0.014)
d_{q1}				0.361***
				(0.028)
d_{q2}				0.224***
				(0.016)
d_{q3}				0.114***
				(0.007)
$GDP_{cyc,quarter(t)}$		0.717***		1.800***
		(0.146)		(0.180)
Constant	-0.596***	-0.595***	-2.874***	
	(0.158)	(0.159)	(0.148)	
Observations	42,053	42,053	42,053	42,053
R-squared	0.453	0.454	0.675	0.610
Number of bo_nr	327	327	327	327

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column FE 3 includes monthly time fixed effects with effect coding (reference period is January 2000), compare with Figure 12.

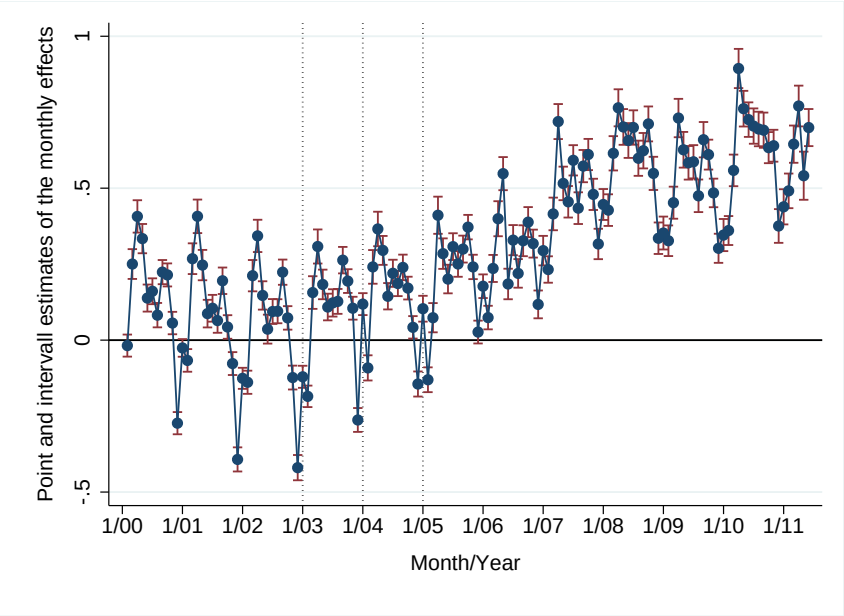


Figure 12: Time fixed effects point and 5-per-cent-interval estimates (FE 3 in Table 6, based on data set disaggregated by occupations")

Source:Statistics of the Federal Employment Agency, own computations.
Notes: The blue dots and the vertical red lines mark the point and 95% interval estimates; in the most cases the interval is very small. Yearly time fixed effects with effect coding (reference year is 2000).

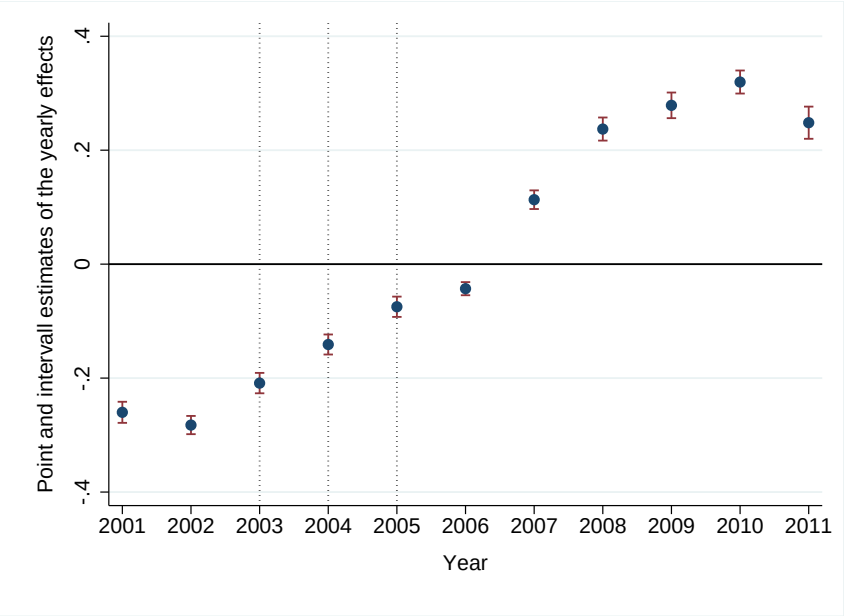


Figure 13: Year effects point and 5-per-cent-interval estimates (FE 4 in Table 6, based on data set disaggregated by occupations)

Source:Statistics of the Federal Employment Agency, own computations.
Notes: The blue dots and the vertical red lines mark the point and 95% interval estimates; in the most cases the interval is very small. Yearly time fixed effects with effect coding (reference year is 2000).

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