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Revisiting German labour market reform effects

A panel data analysis for occupational labour markets

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Contents

Abstract

There is an ongoing discussion that centres on the German labour market reforms (2003-2005) and the role of these reforms in boosting the German economy. Considering that one of the main objectives of the reforms was to improve the matching process on the labour market, I use rich, high-frequency, and recent administrative panel data to present new details regarding the development of job-matching performance before and after the reform years. The results show that matching productivity increased during all reform stages and slightly deteriorated in 2009 (the year of the financial crisis), even after controlling for the recession. Furthermore, increases in matching productivity have become smaller in recent years. Beyond these findings, the results show detailed differences in the changes in matching productivity on occupational labour markets.

Zusammenfassung

Über einen etwaigen Beitrag der deutschen Arbeitsmarktreformen (2003-2005) zur Stabilisierung der deutschen Wirtschaft wird sowohl in Wissenschaft als auch Politik nach wie vor debattiert. Dabei war die Verbesserung der Effizienz des Arbeitsmarktausgleichs eines der erklärten Hauptziele der Reformen. Zur Frage, ob dieses Ziel erreicht wurde, stelle ich präzise und neue detaillierte Befunde auf der Basis von umfangreichen administrativen Daten vor, die auch die Zeit der Wirtschafts- und Finanzkrise (2008/2009) einschließen. Die Effizienz des Arbeitsmarktausgleichs erhöhte sich während und nach den Reformjahren deutlich. Dies lässt sich nun auch für die Einführung der letzten Reformstufe im Jahr 2005 belegen. Jedoch waren die Arbeitsmarktausgleichsprozesse nicht vollständig immun gegen die Wirtschafts- und Finanzkrise; die positive Entwicklung wurde hier unterbrochen und setzte sich danach nicht in dem gleichen Maße fort. Darüber hinaus zeigen die Analysen eine unterschiedliche Entwicklung der Matchingeffizienz in beruflichen Teilarbeitsmärkten auf.

JEL classification: C23, J44, J64

Keywords: Labour market reforms; Unemployment; Vacancies; Matching model; Panel data; Occupational labour markets

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1 Introduction

The tenth anniversary of the German labour market reforms has been accompanied by a lively discussion regarding the contributions of these reforms to the development of the German labour market and the German economy as a whole (Dustmann et al., 2014; Gartner/Fujita, 2014; Krebs/Scheffel, 2013; Rinne/Zimmermann, 2013, 2012; Hertweck/Sigrist, 2012; Burda/Hunt, 2011; Möller, 2010; Fitzenberger, 2009). Whether the results of various studies imply that German labour market policy in the last decade can thus be regarded as a role model for other countries seems to depend on policy makers' expectations for these reforms. In particular, it is debatable whether the reforms were expected to boost the entire German economy and raise its competitiveness. However, it is clear that one of the main objectives of the reforms was explicit in its mandate to improve matching processes on the German labour market (Hartz et al., 2002) because Germany suffered from a high degree of structural unemployment in the early 2000s.

In this paper, I present comprehensive details regarding the development of the job-matching function and its performance before and after the reforms took effect. The German labour market reforms were implemented in four stages and spanned the period from 2003 to 2005. The laws that were implemented are referred to as Hartz I to Hartz IV and were named after the head of the expert commission that worked out the substantial propositions for the German labour market reforms (Hartz et al., 2002). In January 2003, the first two reform stages were implemented (Hartz I and II). The third stage, Hartz III, followed in January 2004 and the last stage, Hartz IV, was implemented in January 2005. Few studies have shed light on the direction and structure of the reform's effects on job matching productivity. Fahr/Sunde (2009) reported better matching for the aggregated German labour market after the first three reform stages (Hartz I/II and Hartz III) had been implemented. Klinger/Rothe (2012) used newer and richer data, which enabled these authors to analyse the last reform stage (Hartz IV in 2005) and to distinguish between long- and short-term unemployed. Overall, these authors also found that the reforms had positive effects on matching efficiency, particularly after Hartz I/II (2003) and III (2004) were introduced. In addition, they found stronger reform effects for the long-term unemployed. However, the last reform stage (Hartz IV) – consisting of a fundamental change in the tax-financed and means-tested unemployment benefit scheme – did not lead to further positive effects. The same authors explain this finding using statistical effects because the number of unemployed increased sharply in 2005 due to the changes under Hartz IV. Hillmann (2009), who also used newer data, found that Hartz IV had positive effects; her analysis constructed the reform dummy differently for Hartz IV.[1] Finally, Klinger/Weber (2014) used data from 1979 to 2009 to analyse the inward shift of the Beveridge curve after the reform years and were able to generally confirm the positive effects of the reforms on matching efficiency, although these authors also found that the positive trend of matching efficiency came to an end in 2009. Clearly, these studies have shed light on the temporal and structural properties of the effects of these reforms.

However, until now, it has not been known whether the positive changes in matching effi-

[1] Klinger/Rothe (2012) generated a dummy variable that was valued at zero before 2005 and unity after 2005. Hillmann (2009) assumed an exponentially growing reform effect during the first 12 months after Hartz IV was implemented.

ciency can be observed for all jobs or how the matching efficiencies changed in the relevant partial labour markets and particularly in occupational labour markets. Another relevant question is whether the effects changed temporarily or permanently during (extreme) economic situations, such as the 2008/2009 financial crisis.

This paper complements previous research by estimating the parameters of a macroeconomic matching function on the basis of detailed, high-frequency, and more recent administrative data for the 2000-2011 period; thus, it includes the span of the 2008/2009 financial crisis. As this study's first step, I deliver a highly exact and detailed analysis of the evolution of the matching productivity. In the second step, I present an analyses of occupational labour markets because it is known that matching efficiency varies in different occupational labour markets, as shown in Stops/Mazzoni (2010) and Fahr/Sunde (2006). To distinguish occupational labour markets, I use the German occupational classification scheme according to Blossfeld (1983). It is possible to identify the temporal evolution of matching productivity by estimating yearly time fixed effects that can be interpreted as year-specific deviations from average matching productivity during the observation period. To identify the temporal evolution of matching productivity in occupational labour markets, I complement the model with interaction dummy variables that combine yearly and occupational labour market effects.

My analysis corroborates the previous findings of positive changes in matching productivity during and after all the reform stages and clarifies that there are also positive changes after Hartz IV. Furthermore, these findings can be corroborated in all the occupational labour markets. However, there are some differences in later years. A (temporary and small) decrease in matching productivity is observable during the recession in 2009 ("crisis dip") in some occupational labour markets, even after controlling for the recession; in addition, there are differences in more recent changes of matching productivity.

The remainder of this paper is organised as follows. In section 2, I describe some relevant facts regarding the German labour market reforms and their (theoretical) implications for matching productivity. Then, I present 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. Section 3 presents details about the data used for the analysis and certain descriptive key statistics. Section 4 explains the empirical strategy and reports and discusses estimation results. Robustness checks that generally confirm these results and that are based on both another theoretical perspective of job matching and higher aggregated data are reported in section 5. Section 6 contains the main conclusions.

2 Labour market reforms and job matching

2.1 *Hartz* reforms, organisational changes, and organisational outcomes

Empirical findings for the early 2000s in Germany reveal high and persistent unemployment that was independent of the business cycle (Klinger/Rothe, 2012). Furthermore, there were discussions regarding opportunities to measure the efforts of public job placement services and to make the job placement organisation more efficient. Therefore, the government stipulated four laws that were implemented in three waves. In particular, the government

considered the working results of an expert commission, the so-called *Hartz* commission. Each of the *Hartz* I to IV reform laws consisted of various components that refer to the organisation and rules of the labour market. The reform laws consist of three elements that should influence the job-finding rate of unemployed workers (see, for instance, Ochel, 2005; Bieber et al., 2005; Jacobi/Kluve, 2007; Klinger/Rothe, 2012).

- Raising the effectiveness and efficiency of the Federal Employment Agency: Re-Organising 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. The Federal Employment Agency consists of three levels – the head office, regional directorates (Regionaldirektionen), and employment agencies (Agenturen für Arbeit) and job centres. Before the reform, the head office was primarily responsible for the operational business of the regional units. The reform clarified that the head office is in charge of targeting and strategy development and that the regional directorates are responsible for steering the employment agencies. The latter are in charge of operational business. The employment agencies are supposed to operate as branch offices and are responsible for their own work results. Labour market instruments, such as training and/or financial support for applications, are provided that are consistent with clear customer group definitions that distinguish customers who are near the labour market from customers with a need for counselling and from customers with one or more issues regarding labour market integration. In particular, the type of counselling and the usage of labour market instruments varies with different customer groups. Generally, the Federal Employment Service should invest in an unemployed person only when the investment is economically useful, which implies that the customer group that is near the market and the group with one or more issues regarding labour market integration are hardly provided with instruments.

- More activation and higher self-responsibility of the unemployed (principle of "Promoting and demanding"[2]): new start-up subsidies, targets on re-integration efforts, reconfiguring the unemployment benefit and social assistance system towards lower or shorter benefit entitlement and higher claims of search effort.

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

2.2 Random matching

It generally remains an empirical question whether and to what extent all the reform efforts affect labour market outcomes, such as the efficiency of matching. It is not possible to identify the total extent and variation in the described efforts within the different reform stages. Nevertheless, it is possible to evaluate changes in matching productivity before, during and after the reform years with a macroeconomic matching function framework.
The macroeconomic matching function and the matching process behind it were conceived

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

by Pissarides (1979, 1985); Diamond (1982b,a); Mortensen, Dale T. (1982). The matching process begins with the decisions of firms to create a new job or to fill a vacancy (job creation decisions), and decisions of (unemployed) persons regarding how intensely to search for a new job (job search decisions) (Pissarides, 2000: p. xi). Firms spend time, financial, and personnel resources for job advertisements, screening, training, and vocational adjustments. Job seekers spend resources for job search and application procedures. Unemployed persons and firms are randomly matched and begin to bargain regarding wages. The basic model assumes homogeneous unemployed persons and homogeneous jobs. The activities of both market sides are matching technologies. The processes behind these activities are not explicitly modelled, so the matching process can be compared with a black box (Petrongolo/Pissarides, 2001). The variables U, V and M represent the stock of unemployed, the stock of vacancies and the flows of new hires, respectively. The resulting matching function $f(U,V)$ is specified in a Cobb-Douglas form:

$$M_t = A_t U_t^{\beta_{Us}} V_t^{\beta_{Vs}}, \tag{1}$$

where A describes the "augmented" matching productivity. Constant returns to scale imply $\beta_{Us} + \beta_{Vs} = 1$ with $\beta_{Us}, \beta_{Vs} > 0$. Another important assumption lies behind the approach – workers and firms are randomly matched and originate from the pool of existing unemployed workers and job vacancies.

My analysis refers to changes in the parameter A of the matching function that result of changes in the institutional framework of the labour market resulting from the reforms. The central question is whether this parameter changed after implementing the reforms. 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 entire observation period.

This model differs from Klinger/Rothe (2012) and Fahr/Sunde (2009), who both assumed that there is a constant augmented productivity for the observation period before the reforms were implemented and a (possibly) different augmented productivity after the reform was introduced[3]. In the model described above, this term differs from observation period to observation period. Therefore, it is possible to compare the temporal evolution of augmented productivity, which is similar to Klinger/Weber (2014), who estimates an "extended matching function" that contains a time-varying matching efficiency parameter that is decomposed in a cyclical and a trend component. However, their identification strategy differs from the strategy utilised herein because it is based on a multivariate time series and correlated unobserved components model, whereas the identification made in this paper is based on variations in repeated observations in regional and occupational labour markets. To analyse the reforms' effects on occupational labour markets, I use the occupational classification scheme derived by Blossfeld (1983), who divides the labour market into 12 broader occupational categories and a category "[0] Not assignable" (Table 1). These categories can be roughly assigned to qualification levels and sectors. Thus, this classification can be understood as an approximation of occupational labour markets that are assumed to be separate from one another and as a good (exogenous) base for the analy-

[3] Thus, they estimated an averaged augmented productivity term before and after the reforms' implementation.

sis of changes in the matching efficiency of occupational labour markets.

Table 1: Occupational categories.

[1]	AGR agrarian occupations
[2]	EMB simple manual occupations
[3]	QMB qualified manual occupations
[4]	TEC technicians
[5]	ING engineers
[6]	EDI simple service occupations
[7]	QDI qualified service occupations
[8]	SEMI semi-professions
[9]	PROF professions
[10]	EVB simple business and administrative occupations
[11]	QVB qualified business and administrative occupations
[12]	MAN manager
[0]	*Not assignable*

Source: Occupational categories are taken from Blossfeld (1983).

Again, I assume constant matching elasticities of unemployed and vacancies (stocks and flows) in the economy, but the augmented productivity term A_{tb} now varies with the occupational categories b and observation periods t:

$$M_{tb} = A_{tb} U_{tb}^{\beta_{Us}} V_{tb}^{\beta_{Vs}} \tag{2}$$

3 Data

I use a unique administrative panel data set of 329 occupational orders in 402 NUTS3 regions with 138 observation periods from January 2000 to June 2011. The occupational orders are coded according to the German occupational classification scheme (three digits, Kldb88[4]). All the data stem from the Federal Employment Agency. The groups are assigned to the 13 occupational labour markets described in the previous section.[5]
I use monthly data regarding flows from unemployment to employment and stocks of unemployed and registered vacancies. Table 2 shows some descriptive statistics.

Table 2: Descriptive statistics.

Measure	Monthly averages 2000-2011 (in 1,000)			
	Mean	Minimum	Maximum	Standard deviation
Employment inflows *M*	259	144	412	51
Unemployment stock *U*	3,750	2,761	4,950	570
Registered vacancies stock *V*	332	173	460	79

Source: Own calculation based on the administrative data from the statistics department of the Federal Employment Agency 2000-2011.

To get unbiased matching parameter estimations, I adjust the data set by observations

[4] *Klassifizierung der Berufe 1988.*
[5] Further information can also be found in the Appendix A.1.

for occupations and NUTS3 regions, respectively, in which vacancies, unemployed or flows into employment are zero, which leads to an unbalanced panel data structure with 2,394,250 observations.

Figure 1 shows the time series of unemployment stocks, unemployment inflows, vacancy stocks, vacancy inflows and flows from unemployment into employment and their trends. The trends are computed using the Hodrick Prescott filter (Hodrick/Prescott, 1997). It is clear that there is a change in the trends from 2003 to 2005, i.e., the reform years. Whereas the trends of the unemployment outflows and inflows and stock of registered vacancies decreased before and increased after the reform years, the stock and inflows of the unemployed increased before and decreased after the reform years. However, the strongest changes are shown in the unemployment and the vacancy stocks, whereas the outflows reveal only slight changes in the trend.

4 Empirical strategy and results

4.1 Aggregated estimations

At first, I estimate regression equations that are based on the logarithm version of equation (1) and complemented by further variables that are included stepwise:

$$\log M_{ijt} = a + \beta_{Us} \log U_{ijt} + \beta_{Vs} \log V_{ijt} + \mu_{ij} + \gamma GDP_{cyc,FS(i),year(t)} + d_t + \epsilon_{ijt} \qquad (3)$$

Here, the term $\log M_{ijt}$ denotes the logarithm of the flows from unemployment to employment for region i, occupational order j and observation period t. The parameter a is a constant and thus a component of the logarithm of the average augmented matching productivity. The variables $\log U$ and $\log V$ are the logarithms of the unemployed and vacancy stocks, whereas β_{Us} and β_{Vs} denote the matching elasticities of the unemployed and vacancies, respectively. Furthermore, the regression 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. Finally, this basic specification includes also an i.i.d. error term, ϵ_{ijt}, for each observation.

In the next step, I include the cyclical component of real gross domestic product, $GDP_{cyc,FS(i),year(t)}$, for the federal state, FS, that region i belongs to and the year that the observation period, t, belongs to. The coefficient for this variable is γ. Then, I include monthly time fixed effects, d_t, that are – for the moment – the coefficients of interest. These variables are effect coded, and their coefficients can thus be directly interpreted as the monthly deviations from the average augmented matching productivity for the 2000 to 2011 observation period.[6] The reference period is January 2000.

Finally, I modify the regression above by including dummy variables $d_q(t)$ for the 1st, 2nd, or 3rd quarter of the year. Furthermore, I substitute the monthly observation period time fixed effects with year fixed effects $d_{year(t)}$. This variable is also effect coded[7], and the reference year is 2000. Thus, the latter variable can be interpreted as the yearly seasonal

[6] Compare details about effect coding in Appendix A.2.
[7] See Appendix A.2.

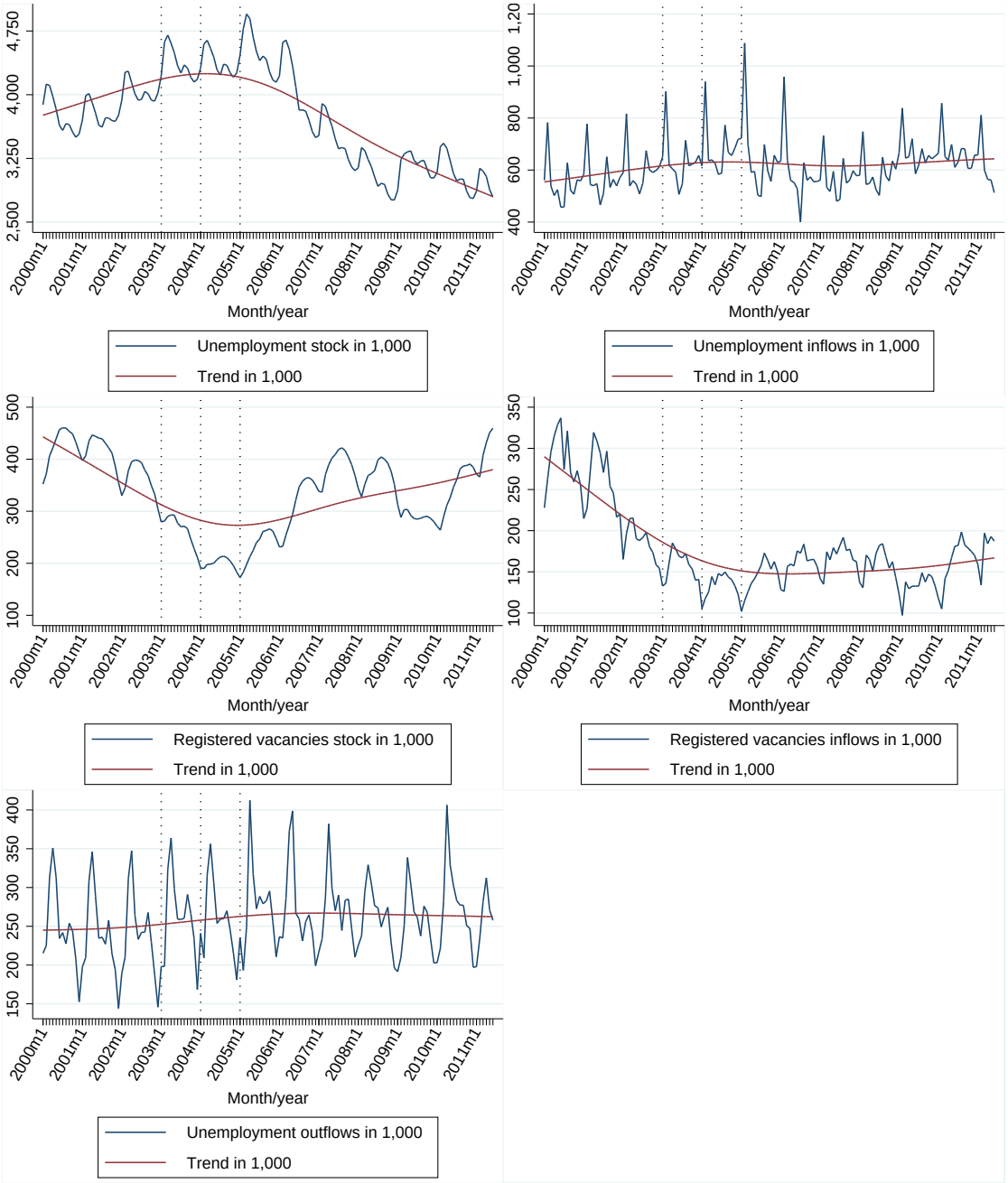

Figure 1: Time series of the key figures for the 2000-2011 analysis

Source: Statistics of the Federal Employment Agency, own computations. Trends are computed with the Hodrick Prescott filter (Hodrick/Prescott, 1997: smoothing parameter $\alpha = 1,600$).

adjusted deviation from the average of augmented matching productivity during the 2001 to 2011 observation period. The regression equation is then as follows:

$$\log M_{ijt} = a + \beta_{Us} \log U_{ijt} + \beta_{Vs} \log V_{ijt} + \gamma GDP_{cyc,FS(i),year(t)} + d_{q(t)} + d_{year(t)} + \mu_{ij} + \epsilon_{ijt} \quad (4)$$

The results of the estimations can be found in Table 3. Column FE 1 of Table 3 refers to the basic specification. As expected from the theoretical model, the matching elasticities of the unemployed and vacancy stocks are both significantly positive. Furthermore, the matching elasticity of the unemployed is higher than the matching elasticity of the vacancies. This result corroborates previous studies for Germany (Burda/Wyplosz, 1994; Entorf, 1998; Fahr/Sunde, 2004; Stops/Mazzoni, 2010; Klinger/Rothe, 2012).

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

	Dependent variable: $\log M$			
	FE 1	FE 2	FE 3	FE 4
β_{Us}	0.514***	0.519***	0.625***	0.626***
	(0.003)	(0.003)	(0.003)	(0.003)
β_{Vs}	0.060***	0.056***	0.039***	0.044***
	(0.001)	(0.001)	(0.001)	(0.001)
Year dummies, effect coded (reference: 2000):				
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)
γ		0.985***	1.336***	1.352***
		(0.021)	(0.047)	(0.047)
a	-0.428***	-0.443***	-0.990***	-0.919***
	(0.013)	(0.013)	(0.014)	(0.012)
Monthly time dummies	no	no	yes	no
Quarter dummies	no	no	no	yes
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 groups	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 2, left panel.

The results in the second column, FE 2, belong to the same specification augmented

with the cyclical component of the yearly gross domestic product for the 16 federal states ($GDP_{cyc,FS(i),year(t)}$). These results do not differ much from the results in the first column, FE 1.

The third column, FE 3, contains the results for the regression equation (3), including monthly time fixed effects. Compared with previous specifications, the matching elasticities of the unemployed are somewhat higher and the matching elasticities of the vacancies are lower. The monthly fixed effects are not presented in Table 3; however, their graphical representation can be found in the left panel of Figure 2. The right panel of this figure shows the evolution of the year fixed effects of column 4 in Table 3.

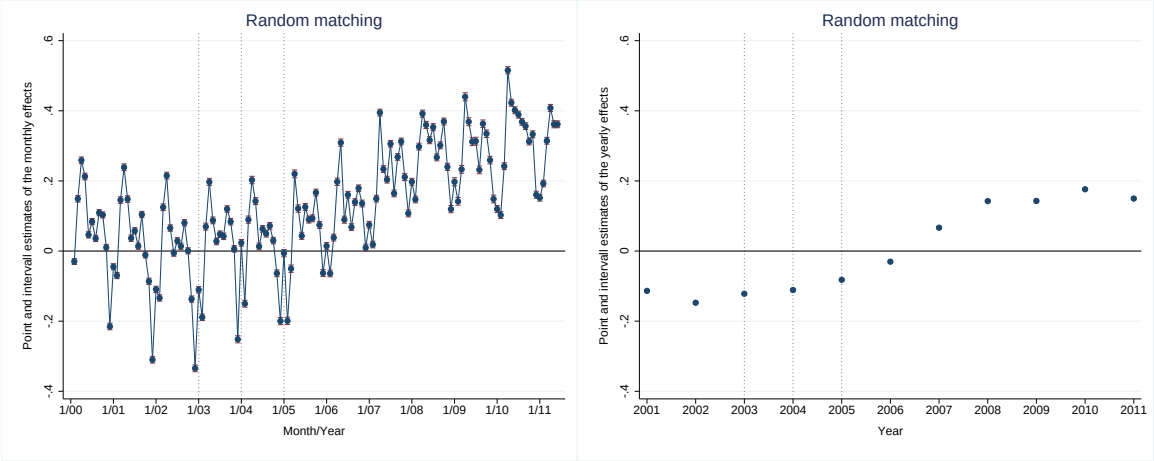

Figure 2: Month and year time fixed effects and 95 per cent confidence band.

Source:Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 3, left side, are FE 3; those from the right side are FE 4 – based on a data set disaggregated by occupations and NUTS3 regions. The blue dots and the vertical red lines mark the point and 95% interval estimates, and the interval is very small in most cases. In the left panel, the dots are linked with a line to illustrate temporal development. Time fixed effects with effect coding (the reference period is January 2000 for month fixed effects or 2000 for year fixed effects, respectively).

As explained above, these variables can be interpreted as time specific deviations from the average augmented matching productivity, where the average is normalised to zero. Accordingly, from the beginning of the observation period until 2006, the monthly deviations might be negative or positive with a seasonal pattern. In addition, beginning with the reform years, 2003-2005, and continuing forward, the monthly deviations began to increase from year to year; from 2007 onwards, the deviations are all significantly positive. These results provide the first impression of how augmented matching productivity developed after the labour market reforms were implemented in 2003 to 2005. All in all, the volatile seasonal pattern gives only a rough first impression regarding the evolution of matching productivity. In equation (4), the year dummies can be interpreted as yearly deviations from the averaged augmented matching productivity and should thus give a clearer picture. Furthermore, seasonality patterns are adjusted by quarter dummies. The results of the estimations, including the yearly deviations, are reported in column 4 of Table 3. The graphical representation of the year effects for the random matching model can be found in the right panel of Figure 2. 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; they become significantly

positive from 2007 onwards. This increase is interrupted in 2009 the year of the financial crisis (although I control for the business cycle), and after a small increase in 2010, the deviation slightly decreases in 2011.[8] In general, this result leads me to conclude that there are positive changes in matching productivity during and after implementation of the reform; in recent years, there are only small changes.

4.2 Occupational labour markets

Figure 3 describes the development of the trends of our key figures – flows from unemployment to employment, unemployment stocks, and the registered vacancy stocks – as normalised measures with index 1 first in January 2000 (left panels) and second for January 2005 (right panels).

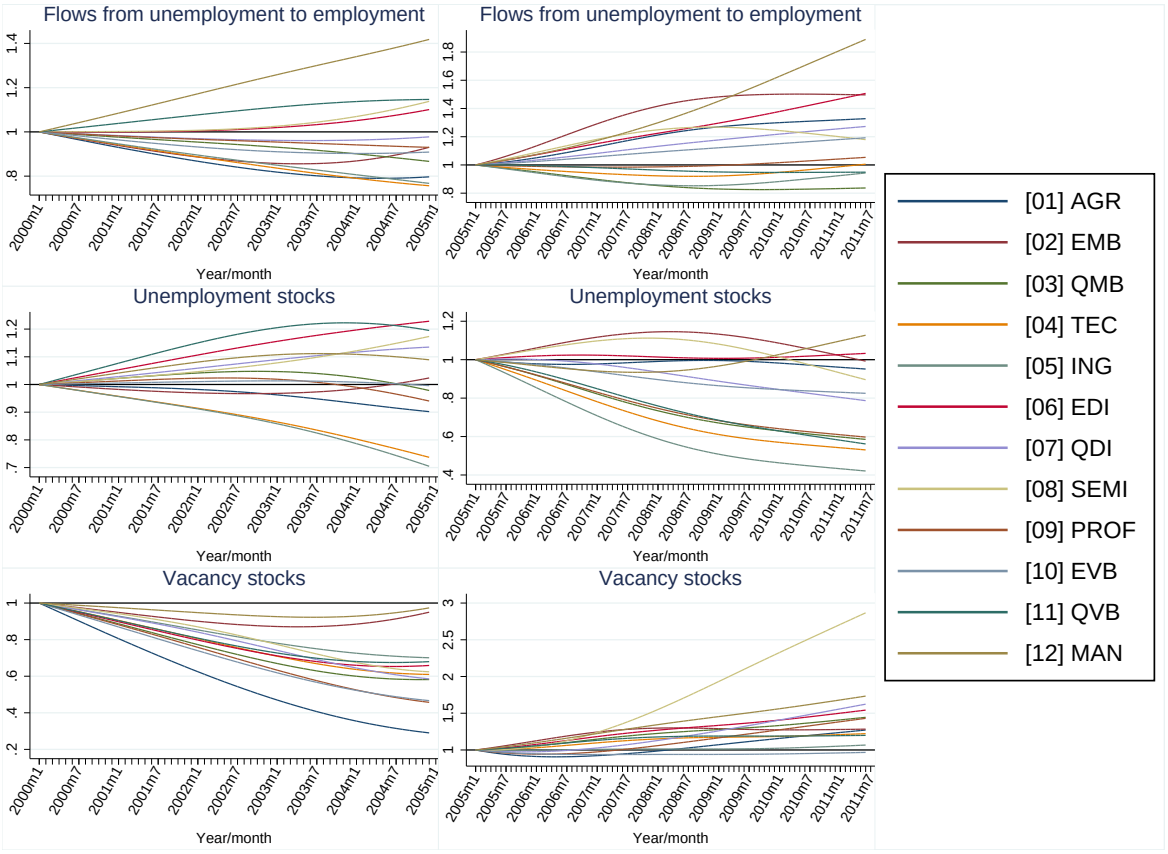

Figure 3: Key figures by occupational groups, normalised trends, 2000-2004 (January 2000 = 1, left panel) and 2005-2011 (January 2005 =1, right panel)

Source: Statistics of the Federal Employment Agency. Trends are computed with the Hodrick Prescott filter (Hodrick/Prescott, 1997: smoothing parameter $\alpha = 1,600$).
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.

[8] The changes are small, but I can observe a significant "crisis dip" in 2009 and larger elasticity and productivity coefficients based on regression equations without the recession variable as a control variable; compare with columns 1 to 3 of Table 9 and the left panels of Figures 9 and 10 in the Appendix A.3.

Generally, these figures show that there is a certain heterogeneity in the development of the key figures in different occupational labour markets, which leads me to conclude that I can expect different results regarding the analysis of the changes of the matching elasticity in these markets. Thus, I separately estimate the deviations of the averaged augmented productivity for the occupational labour markets, $b(j)$, that the occupational order j is assigned to. The regression is equivalent to the logarithm version of equation (2). Again, this specification is stepwise complemented by additional variables:

$$\log M_{ijt} = a+\beta_{Us} \log U_{ijt}+\beta_{Vs} \log V_{ijt}+GDP_{cyc,FS(i),year(t)}+d_i+d_{q(t)}+d_{year(t)}+d_{b(j)}+d_{b(j),year(t)}+\epsilon_{ijt} \quad (5)$$

Here, it is not possible to separate the occupational and regional fixed effects and the occupational labour market effects, $b(j)$, related to occupation j. Therefore, I exclude the fixed effects μ_{ij} and I estimate an ordinary least squares (OLS) model. The model is augmented by local area effects d_i, quarter dummy variables ($d_{q(t)}$), and year dummies (yearly observation period fixed effects, $d_{year(t)}$) with reference to year 2000 and thus the yearly specific deviations from the average augmented productivity. Furthermore, it contains dummy variables for 11 occupational categories with reference to the "agrarian and not assignable occupations" ($d_{b(j)}$) categories. The coefficients of these variables are equivalent to the occupational labour market's specific deviations from average matching productivity. Finally, the model contains interaction dummies for the yearly and occupational labour market–specific deviations $d_{b(j),year(t)}$. 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 the exception of the quarter dummy (the 4th quarter is the reference period).

The results can be found in Table 4. Column OLS 1 contains the OLS estimation of a pure matching model without the recession variable or further dummy variables. As expected, the coefficients for the matching elasticities are again significantly positive. After including the recession variable (OLS 2), the coefficients hardly change. Column OLS 3 of Table 4 shows the results for the specifications, including dummy variables for year effects, quarters and occupational labour markets. In particular, the year fixed effects coefficients have a similar pattern as the results of 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 year- and occupational-specific interaction effects. Due to space constraints, I do not report the latter coefficients, but I show the point and interval estimations graphically in Figures 4 and 5.

Columns OLS 3 and OLS 4 reveal another finding: the occupational labour market specific deviations from the augmented productivity for the observation period are significantly negative for occupations that are assignable to a lower skill level (EMB, EDI, EVB), and for technicians (TEC), engineers (ING), and qualified business and administrative occupations (QVB). The deviations for the remaining occupational labour markets are significantly positive.

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

	Dependent variable: $\log M$			
	OLS 1	OLS 2	OLS 3	OLS 4
β_{Us}	0.577***	0.579***	0.634***	0.633***
	(0.000)	(0.000)	(0.000)	(0.000)
β_{Vs}	0.141***	0.139***	0.117***	0.118***
	(0.000)	(0.000)	(0.000)	(0.000)
Year dummies, effect coded (reference: 2000):				
d_{2001}			-0.129***	-0.142***
			(0.001)	(0.001)
d_{2002}			-0.155***	-0.164***
			(0.001)	(0.001)
d_{2003}			-0.111***	-0.124***
			(0.001)	(0.001)
d_{2004}			-0.079***	-0.079***
			(0.001)	(0.002)
d_{2005}			-0.059***	-0.051***
			(0.001)	(0.002)
d_{2006}			-0.023***	-0.027***
			(0.001)	(0.001)
d_{2007}			0.057***	0.070***
			(0.001)	(0.002)
d_{2008}			0.132***	0.148***
			(0.001)	(0.002)
d_{2009}			0.150***	0.168***
			(0.002)	(0.002)
d_{2010}			0.170***	0.172***
			(0.001)	(0.001)
d_{2011}			0.132***	0.139***
			(0.001)	(0.002)
Dummies for occupational categories, effect coded (reference: [0]/[1] AGR):				
[02] EMB			-0.038***	-0.040***
			(0.001)	(0.001)
[03] QMB			0.153***	0.152***
			(0.001)	(0.001)
[04] TEC			-0.038***	-0.036***
			(0.002)	(0.002)
[05] ING			-0.033***	-0.024***
			(0.002)	(0.002)
[06] EDI			-0.178***	-0.178***
			(0.001)	(0.001)
[07] QDI			0.007***	0.005***
			(0.001)	(0.001)
[08] SEMI			0.037***	0.034***
			(0.001)	(0.001)
[09] PROF			0.252***	0.257***
			(0.002)	(0.002)
[10] EVB			-0.233***	-0.231***
			(0.001)	(0.001)
[11] QVB			-0.012***	-0.012***
			(0.001)	(0.001)
[12] MAN			0.046***	0.043***
			(0.002)	(0.002)
γ		0.667***	1.378***	1.345***
		(0.018)	(0.041)	(0.041)
a	-0.923***	-0.925***	-1.161***	-1.162***
	(0.007)	(0.007)	(0.007)	(0.007)
Local area effects	yes	yes	yes	yes
Occupational yearly interaction dummies	no	no	no	yes
Quarter dummies	no	no	yes	yes
Observations	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.684	0.684	0.718	0.720

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

Columns OLS 4 includes yearly time and occupational category interaction effects (reference year is 2000, reference category is "[01] AGR Agrarian and not assignable occupations"), and all dummy variables are effect coded; compare Appendix A.2.
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; and [12] MAN manager.

In the following, I discuss the results for the year- and occupational-specific interaction effects. Figures 4 and 5 show 95 per cent interval estimate sums of the yearly dummy and the yearly interaction effects dummy variables in 11 panels for each occupational labour market ($d_{year(t)} + d_{b(j),year(t)}$), with the exception of the reference category "[AGR] agrarian and not assignable occupations"). These sums represent the yearly deviations from average occupational labour market–specific augmented productivity ($d_{b(j)}$); thus, they show how the augmented productivity in a certain occupational labour market is changed based on a "pure" time effect.

The common finding is that there is a positive change in the deviation from occupational labour market–specific augmented productivity after the reform years, which can be understood as an indicator that the reform had effects on the entire labour market. However, there are certain differences regarding the timing of the change and the further development of matching efficiency. In addition, differences arise during the years of the financial crisis in 2008/2009.

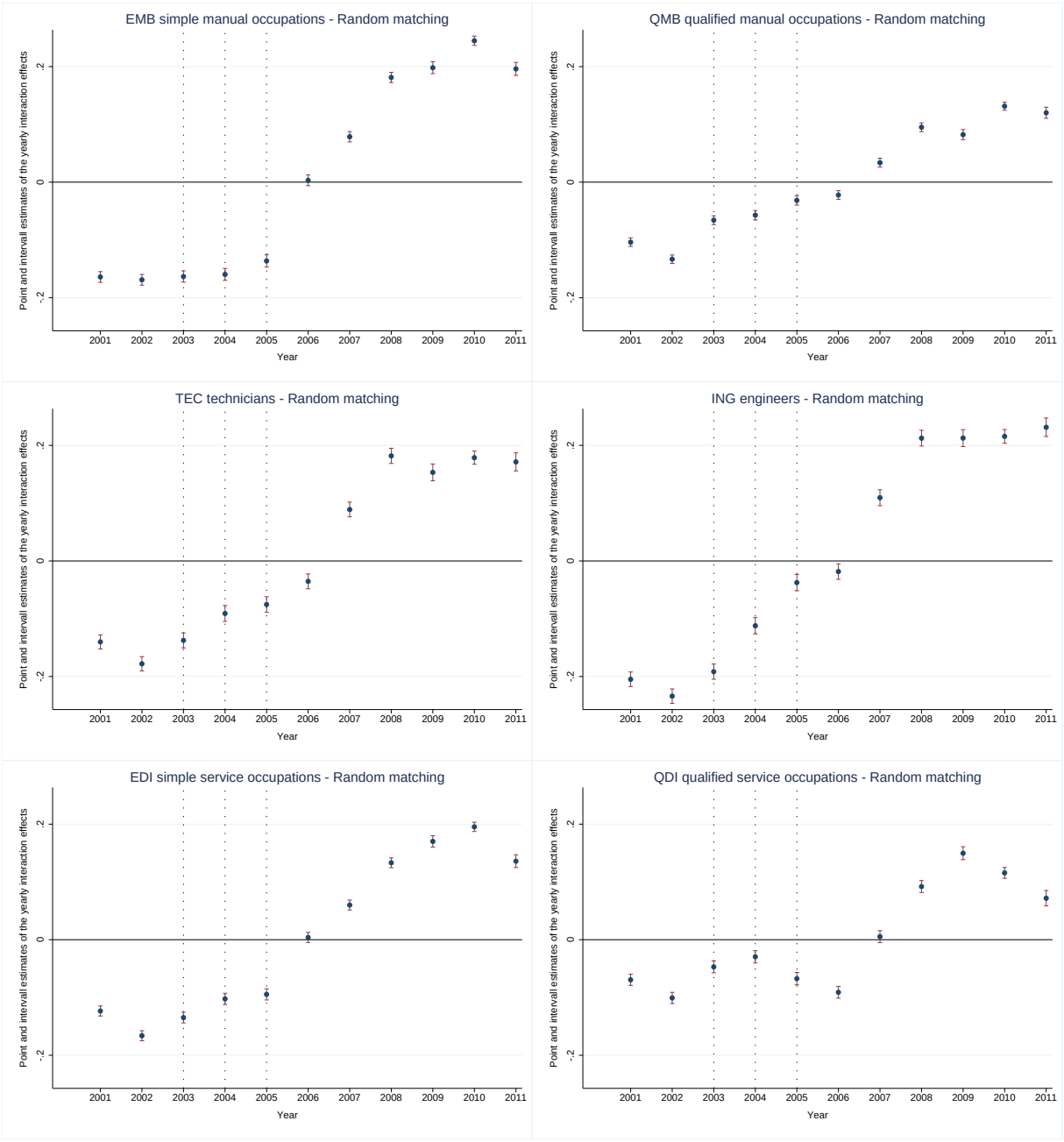

Figure 4: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 1/2).

Source:Statistics of the Federal Employment Agency, own computations.
Notes: The graphs refer to the results in column OLS 4 in Table 4, based on a data set disaggregated by occupations and NUTS3 regions. The blue dots and the vertical red lines mark the point and 95% interval estimates.

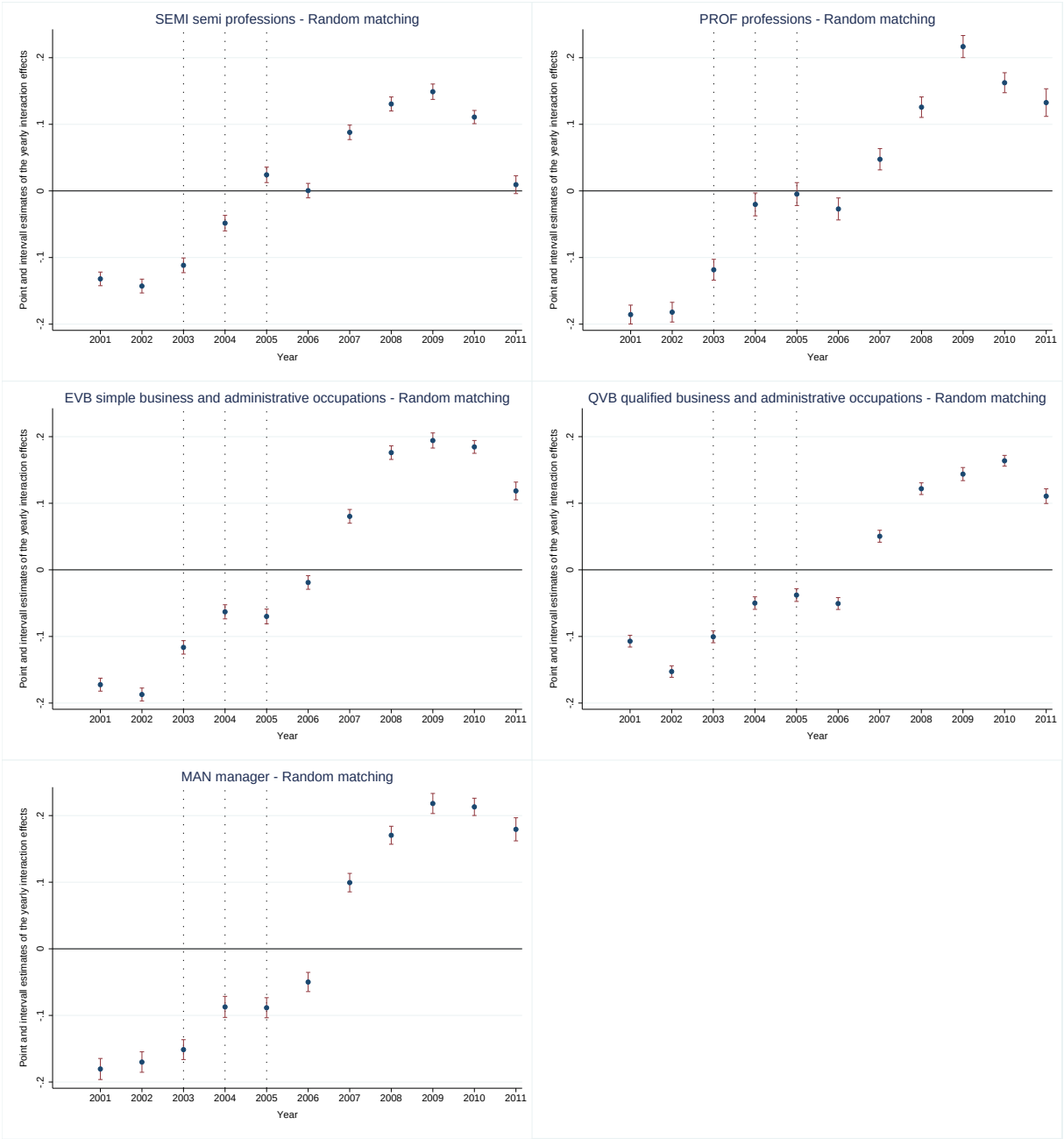

Figure 5: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 2/2).

Source:Statistics of the Federal Employment Agency, own computations.
Notes: Graphs refer to results in column OLS 4 in Table 4, based on the data set disaggregated by occupations and NUTS3 regions. The blue dots and the vertical red lines mark the point and 95% interval estimates.

Regarding the structure of the time effects after the crisis, there are significantly positive effects observable from 2007 onwards, at the latest. Information regarding the timing of the effects complements previous studies that only compared matching productivity before or during the reform years and after the reform years (part., Fahr/Sunde, 2009; Klinger/Rothe, 2012) and also illustrates that it is hardly possible to distinguish between the effects of the different reform stages because it would imply that the consequences of each reform stage

came into effect within one year.[9] This result can hardly be corroborated based on the results in this study.[10] Overall, the view on the year effects in the different occupational labour markets corroborate that the development of the matching efficiency is rather different in different labour markets; thus, the timing of the effects is also different.

Regarding the further evolution of the time fixed effects, the results reveal that the effects differ between the occupational labour markets in recent years, e.g., in the qualified service occupations (QDI), the semi-professions (SEMI), and the professions (PROF), the positive deviations decreased in at least the last years, i.e., 2009 to 2011. For the other occupational labour market the development moves more "sideward". Generally, the results suggest that there were further positive changes with respect to the augmented (occupational specific) matching productivities one or two years after the last reform stage. In the years following, smaller positive or even negative changes were observed.

Finally, the results in Figures 4 and 5 suggest that there is a "crisis dip" in 2009 but only in the occupational labour markets of qualified manual occupations (QMB) and technicians (TEC), which illustrates that the German labour market was not generally invulnerable during the crisis, at least regarding matching productivity, even after considering the recession variable.

5 Validity and robustness checks

5.1 Another theoretical perspective: selective search

Gregg/Petrongolo (2005) state that the unstable results of papers that study the parameters of matching functions result in a certain misspecification of the matching function due to the assumption of (completely) random search. These authors propose to utilise a stock-flow matching model framework, originally derived by Coles (1994) and Coles/Smith (1998). This approach considers job searching that is not completely random. However, for this, it must state an assumption that might be understood as a further restriction of the random matching approach: the assumption is made that the agents on both sides of the market are able to sample the entire relevant part of the stocks of the other side with no friction due to the availability of quite efficient information channels. Following that, the agents who

[9] In addition, the identification might also be difficult due to possible anticipation effects, which would be the case when firms or the unemployed changed their search decisions after the reform plans were published but before these plans were realised.

[10] If I base this analysis on the assumption that the estimated average matching productivity (the constant in all models) for the 2000-2011 observation period is equivalent to long-term augmented productivity and should not change after varying the observation periods in the estimation, I might even conclude that the reform effects arise with a certain delay. However, this assumption can hardly be tested because it must be expected that a sample with fewer observation periods would reveal another value for the long-term augmented productivity and that massive short-term shocks on the labour market based on the Hartz reforms or the financial crisis would explain that more than "invalid" data. This analysis implies that when there are substantial concerns about the value of the estimated augmented productivity, the observed positive or negative deviations from that productivity might be different based on the true value. However, the relative size of those time effects and a comparison of their year-to-year differences reveal that in seven of 11 occupational categories, the highest positive change was from 2006 to 2007 (in addition to the Figures 4 and 5, which is shown in Table 12 in Appendix A.3). For the simple manual occupations (EMB) and the simple service occupations (EDI), this is one year earlier (2005/2006); for the professions, this is from 2003 to 2004; and for the qualified manual occupations, this is from 2002 to 2003. The results are also different for the professions (PROF); here, the largest change was 2008/2009.

didn't found adequate offers and, therefore, remain in the unemployed or vacancy stocks, respectively, only select further offers on the other market side from those that have just arrived. However, Gregg/Petrongolo (2005) concluded that the true (single) matching process is equivalent to one that is somewhere between the random matching approach and the stock-flow matching approach. Whereas random matching assumes a search process that consumes time to sample and assess all available and relevant (stocks of) offers from the other market side, the stock-flow matching approach is assumed to minimise the required time to check the stocks of the other market side to zero. These concepts offer me a good opportunity to discuss the robustness of the focussed efficiency parameter estimates on the basis of two different matching functions.

Therefore, the matches are determined, on the one hand, by the stocks of the unemployed and the inflows of vacancies and, on the other hand, by the stocks of vacancies and the inflows of the unemployed. Technically, the matching function in equation (1) is complemented by the inflows of the unemployed u and vacancies v with their matching elasticities β_{Uf} and β_{Vf}:

$$M_t = A_t U_t^{\beta_{Us}} u_t^{\beta_{Uf}} V_t^{\beta_{Vs}} v_t^{\beta_{Vf}} \tag{6}$$

The model that considers the variation of the augmented productivity term with occupational labour markets b, compared with equation (2), is then modified to:

$$M_{tb} = A_{tb} U_{tb}^{\beta_{Us}} u_{tb}^{\beta_{Uf}} V_t^{\beta_{Vs}} v_{tb}^{\beta_{Vf}} \tag{7}$$

Table 5 shows some descriptive statistics for the aggregated flows from the data set.

Table 5: Descriptive statistics.

Measure	Monthly averages 2000-2011 (in 1,000)			
	Mean	Minimum	Maximum	Standard deviation
Unemployment inflows *u*	616	400	1,088	101
Registered vacancies inflows *v*	177	97	337	52

Source: Own calculation based on the administrative data from the statistics department of the Federal Employment Agency 2000-2011.

The logarithm versions of the stock-flow models are equivalent to the regression equations (3) and (4) for the random matching model complemented by parameters and variables of the logarithm of the flow measures:

$$\log M_{ijt} = \quad [\textit{Right side of equation (3) or (4)}] + \beta_{Uf} \log u_{ijt} + \beta_{Vf} \log v_{ijt} \tag{8}$$

Thus, the variables $\log u$ and $\log v$ are the logarithms of the unemployed and vacancy inflows whereas β_{Uf} and β_{Vf} denote the matching elasticities of the inflows of the unemployed and vacancies, respectively.

The results of the estimations of the stock-flow matching parameters can be found in Table 6. Compared with Table 3, the columns contain the results of the same specifications augmented with the inflow measures for registered vacancies and the unemployed. The graphic representation for the month fixed effects (FE 3) and year fixed effects (FE 4) can be found in Figure 6. Overall, the results do not reveal fundamental differences with those

that are based on the random matching approach.

The foregoing is also true for the regressions' estimates without the recession variable, compared with columns 4 to 6 of Table 9 and the right panels of Figures 9 and 10 in the Appendix A.3. Again, the "crisis dip" becomes larger after excluding the recession variable.

Table 6: Robustness check: Fixed effects estimation results based on the stock-flow matching model and data set disaggregated by occupations and NUTS3 regions

	Dependent variable: $\log M$			
	FE 1	FE 2	FE 3	FE 4
β_{Us}	0.453***	0.457***	0.565***	0.584***
	(0.003)	(0.003)	(0.003)	(0.003)
β_{Uf}	0.085***	0.087***	0.071***	0.049***
	(0.002)	(0.002)	(0.001)	(0.001)
β_{Vs}	0.041***	0.037***	0.020***	0.022***
	(0.001)	(0.001)	(0.001)	(0.001)
β_{Vf}	0.029***	0.029***	0.031***	0.035***
	(0.001)	(0.001)	(0.001)	(0.001)
Year dummies, effect coded (reference: 2000):				
d_{2001}				-0.115***
				(0.001)
d_{2002}				-0.140***
				(0.001)
d_{2003}				-0.115***
				(0.001)
d_{2004}				-0.109***
				(0.001)
d_{2005}				-0.074***
				(0.002)
d_{2006}				-0.023***
				(0.001)
d_{2007}				0.068***
				(0.002)
d_{2008}				0.136***
				(0.002)
d_{2009}				0.139***
				(0.002)
d_{2010}				0.167***
				(0.001)
d_{2011}				0.142***
				(0.002)
γ		1.094***	1.375***	1.413***
		(0.021)	(0.045)	(0.045)
a	-0.381***	-0.395***	-0.909***	-0.867***
	(0.012)	(0.012)	(0.014)	(0.012)
Monthly time dummies	no	no	yes	no
Quarter dummies	no	no	no	yes
Observations	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.213	0.215	0.309	0.278
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), compared with Figure 6, left panel.

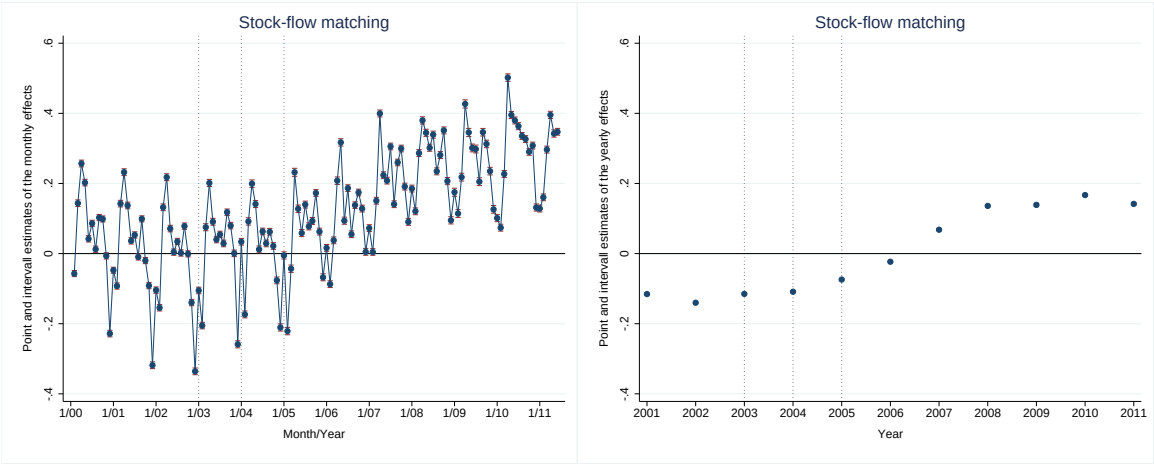

Figure 6: Monthly and yearly time fixed effects and 95 per cent confidence band.

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 6, left side: FE 3; right side: FE 4, based on the data set disaggregated by occupations and NUTS3 regions. The blue dots and the vertical red lines mark the point and 95% interval estimates; in most cases, the interval is very small. In the left panel, the dots are linked with a line to illustrate temporal development. Time fixed effects with effect coding (reference period is January 2000 for month or year 2000 for year fixed effects).

The results of the analysis for the occupational labour markets can be found in Table 7. The columns contain the results of specifications analogous to Table 4, augmented with the flow measures. Again, the results are quite similar to those based on the random matching approach.

Only the yearly deviations from average augmented productivity are mainly less volatile in the stock-flow matching approach than in the random matching model. Thus, the main conclusions of the previous section are unaffected. Finally, column OLS 4 reports the results of the full specification, including the year- and occupational-specific interaction effects. Again, I do not report the results for the specification, including year- and occupational-specific interaction effects (OLS 4), but I graphically show the point and interval estimations in Figures 7 and 8.

There is one difference between the results based on the stock-flow matching model compared with the random matching model for the the occupational labour market–specific deviations of the qualified service occupations (QDI) and the engineers (ING): the signs of the deviations differ between the stock-flow matching and the random matching model. However, the magnitude of these deviations are quite small in both models.

Table 7: Robustness check: OLS estimation results based on stock-flow matching model and data set disaggregated by occupations and NUTS3 regions

	Dependent variable: $\log M$			
	OLS 1	OLS 2	OLS 3	OLS 4
β_{Us}	0.347***	0.348***	0.440***	0.441***
	(0.001)	(0.001)	(0.001)	(0.001)
β_{Uf}	0.247***	0.249***	0.196***	0.193***
	(0.001)	(0.001)	(0.001)	(0.001)
β_{Vs}	0.063***	0.060***	0.049***	0.049***
	(0.001)	(0.001)	(0.001)	(0.001)
β_{Vf}	0.075***	0.074***	0.076***	0.078***
	(0.001)	(0.001)	(0.000)	(0.000)
Year dummies, effect coded (reference: 2000):				
d_{2001}			-0.117***	-0.127***
			(0.001)	(0.001)
d_{2002}			-0.123***	-0.133***
			(0.001)	(0.001)
d_{2003}			-0.082***	-0.096***
			(0.001)	(0.001)
d_{2004}			-0.070***	-0.072***
			(0.001)	(0.002)
d_{2005}			-0.028***	-0.025***
			(0.001)	(0.002)
d_{2006}			0.005***	-0.003*
			(0.001)	(0.001)
d_{2007}			0.061***	0.072***
			(0.001)	(0.002)
d_{2008}			0.099***	0.114***
			(0.001)	(0.002)
d_{2009}			0.110***	0.126***
			(0.002)	(0.002)
d_{2010}			0.124***	0.130***
			(0.001)	(0.001)
d_{2011}			0.093***	0.103***
			(0.001)	(0.002)
Dummies for occupational categories, effect coded (reference: [0]/[1] AGR):				
[02] EMB			-0.045***	-0.047***
			(0.001)	(0.001)
[03] QMB			0.113***	0.112***
			(0.001)	(0.001)
[04] TEC			-0.019***	-0.018***
			(0.002)	(0.002)
[05] ING			0.006***	0.013***
			(0.002)	(0.002)
[06] EDI			-0.176***	-0.177***
			(0.001)	(0.001)
[07] QDI			-0.022***	-0.024***
			(0.001)	(0.001)
[08] SEMI			0.017***	0.013***
			(0.001)	(0.001)
[09] PROF			0.245***	0.250***
			(0.002)	(0.002)
[10] EVB			-0.210***	-0.208***
			(0.001)	(0.001)
[11] QVB			-0.008***	-0.009***
			(0.001)	(0.001)
[12] MAN			0.062***	0.059***
			(0.002)	(0.002)
γ		0.985***	1.400***	1.368***
		(0.017)	(0.040)	(0.040)
a	-0.498***	-0.499***	-0.790***	-0.791***
	(0.007)	(0.007)	(0.007)	(0.007)
Local area effects	yes	yes	yes	yes
Occupational yearly interaction dummies	no	no	no	yes
Quarter dummies	no	no	no	yes
Observations	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.704	0.705	0.731	0.732

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.2.
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.

Considering the results for the year- and occupational-specific interaction effects, there are only minor differences regarding the timing of the change and the further development of the matching efficiency. Furthermore, there are differences during the years of the financial crisis in 2008/2009.

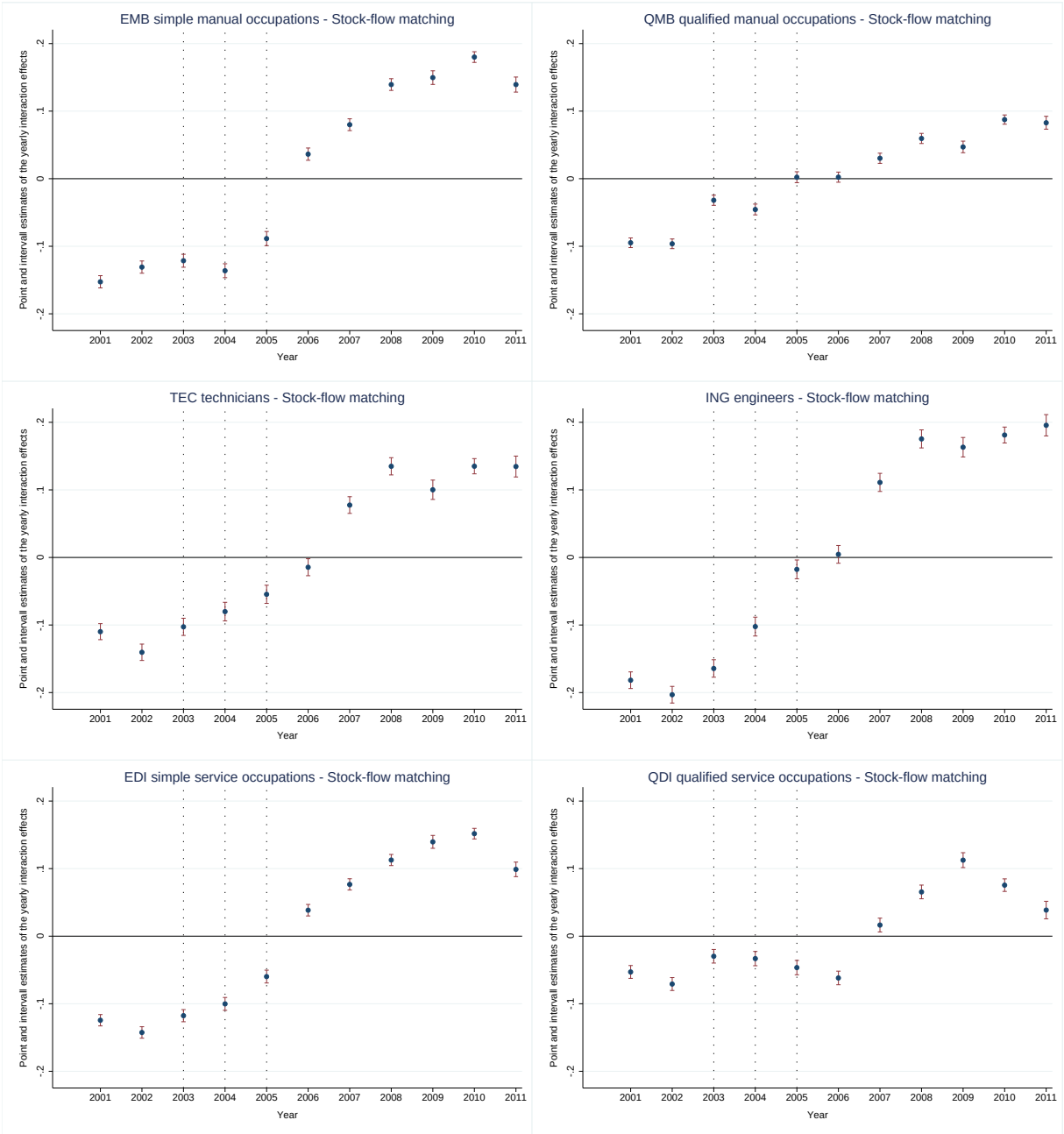

Figure 7: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 1/2).

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Graphs refer to column OLS 4 in Table 7, based on a data set disaggregated by occupations and NUTS3 regions.
The blue dots and the vertical red lines mark the point and 95% interval estimates.

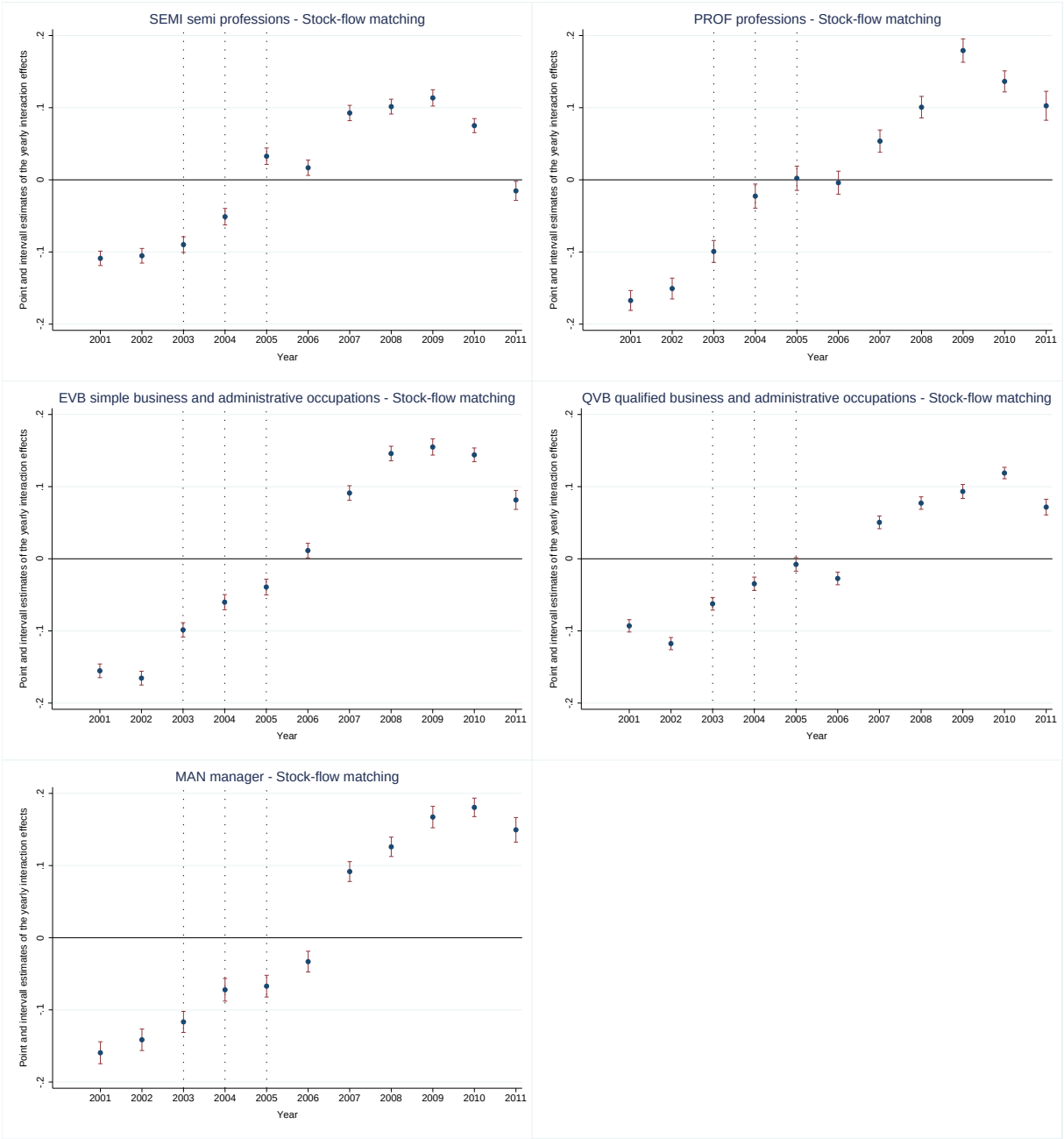

Figure 8: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 2/2).

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Graphs refer to column OLS 4 in Table 7, based on data set disaggregated by occupations and NUTS3 regions. The blue dots and the vertical red lines mark the point and 95% interval estimates.

Regarding the largest absolute changes of the yearly time fixed effects from year to year, Table 13 in the Appendix A.3 shows hardly any differences compared with the results based on the random matching model (Table 12) with the exception of the semi-professions and professions. For these occupational categories, the largest absolute changes in the yearly time fixed effects based on the stock-flow matching model was measured from 2004 to 2005 for the semi professions and from 2008 to 2009 for the professions.

5.2 Aggregated data

Most of the estimates presented are highly significant with very small standard errors and are also significantly different from one another. The reason for this result is the enormous variation of the data set the study is based on. From my knowledge, this study is the first to deliver such exact evidence. However, one shortcoming of such a detailed data set is that the probability of measurement errors at the small local area level or occupational level increases. In aggregated data sets, those measurement errors could be "compensated" for, and the prize are higher standard errors. Because I am interested in the effects on partial labour markets, it is important to see whether the results would change after aggregating the data set. Therefore, I aggregated the data sets by NUTS3 regions over occupations and vice versa. As expected, the results show less precision, but the main conclusions remain stable. Compare further results in the Appendix A.3, Table 10 with Figures 11 and 12 for the data set with NUTS3 regions as well as Table 11 with Figures 13 and 14 for the data set with occupations.

6 Conclusions

In this paper, I present analyses of changes in the job matching productivity before, during, and after the German labour market reforms of 2003 to 2005, which are also known as the Hartz reforms. Although one of the main objectives of the German labour market reforms was to improve the matching processes on the labour market, there are only a few studies that elucidate the direction and structure of the reform effects on job matching. Previous studies confirm positive effects, but there are different conclusions regarding the effects of the different reform stages. Furthermore, it was not known whether the reform effects covered the entire labour market or only parts of it. Another question is how the effects change during extreme economic situations like the financial crisis of 2008/2009.

The paper closes some of these gaps by estimating (unrestricted) macroeconomic matching function parameters on the basis of detailed, high-frequency, and recent administrative panel data for the 2000-2011 period. To identify effects for occupational labour markets, I utilise an occupational category scheme that distinguishes between simple manual occupations, qualified manual occupations, technicians, engineers, simple service occupations, qualified service occupations, semi-professions, professions, simple business and administrative occupations, qualified business and administrative occupations, and managers.

The results complement previous findings and show significant differences in the changes of matching productivity in different occupational labour markets. In general, six important new conclusions can be derived: (1) matching productivity increased during all reform stages, including Hartz IV; (2) even after controlling for the recession, matching productivity was (slightly) deteriorated in 2009, the year of the financial crisis; (3) the positive changes become smaller in recent years; (4) the reform reached all occupational labour markets, as suggested, in particular, by the results of the analysis for occupational labour markets; (5) the result of smaller positive effects in recent years is not true for all occupational groups; and (6) a (rather small) "crisis dip" during 2009 can be observed in the occupational labour markets of technicians and qualified manual occupations.

The results complement studies that find that the German reforms had positive effects on

the labour market. It can be stated that a more efficient job matching contributes to a more successful realisation of companies' activity plans and, therefore, this higher efficiency should boost – rather than weaken – the standing of firms in their relevant markets.

A Appendix

A.1 Occupational labour markets

Table 8: Assignment of Blossfelds occupational categories to the 3-digit code of the German occupational classification scheme 1988 (*KldB 88*)

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
[01] AGR agrarian occupations	11	Farmers
	12	Winegrowers
	21	Livestock farmer
	22	Fish farmer
	41	Mixed crop and livestock farm labourers
	42	Livestock and dairy producers
	44	Pet groomers, animal care workers and related occupations
	51	Gardeners, horticultural and nursery growers
	53	Florists
	61	Forestry production managers, foresters and huntspersons
	62	Forestry labourers
[02 EMB simple manual occupations	71	Miners
	72	Mining shot firers and blasters
	81	Stone crushers
	82	Earth, gravel and sand quarry workers
	83	Gas and crude oil quarry workers
	91	Mineral and stone processing plant operators
	101	Stone splitters, cutters and carvers
	102	Precious-stone workers, jewel preparers
	111	Brickmakers and other stoneware makers
	112	Cement and concrete block makers
	121	Ceramics plant operators
	131	Frit makers, glass vitrifiers
	132	Hollow glassware makers
	133	Flat glass makers
	135	Glass cutters, grinders and refiners
	141	Chemical products, plant and machine operators
	143	Rubber products machine operators
	151	Plastic products machine operators
	161	Pulp and cellulose plant operators
	162	Packaging makers
	164	Other paper products machine operators
	176	Hecto- and mimeo-graphers
	177	Printer's hands
	181	Wood-processing plant operators

continued on the next page

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
	182	Woodworking machine setters and setter-operators, and appropriate occupations
	183	Wood products, brush- and cork-maker
	184	Basketry weavers and wicker worker
	191	Ore and metal furnace operators, metal melters
	192	Rolling-mill operators
	193	Metal drawers and extruders
	203	Casters of semi-finished products and other mould casters
	211	Sheet metal pressers, drawer and puncher
	212	Wire moulder, cable splicers
	213	Other metal moulders non cutting deformation
	222	Metal milling cutters
	223	Metal planers
	224	Metal borers
	225	Metal grinders
	226	Other metal-cutting occupations
	231	Metal polishers
	232	Engravers, chasers
	233	Metal finishers
	234	Galvanisers, metal colourers
	235	Enamelers, zinc platers and other metal surface finishers
	241	Welder, oxy-acetylene cutters
	242	Solderers
	243	Riveters
	244	Metal bonders and other metal connectors
	263	Pipe and tube fitters
	301	Precious fitters otherwise undisclosed
	313	Electric motor, transformer fitters
	321	Electrical appliance and equipment assemblers
	322	Metal, rubber, plastic, paperboard, textile and related products assemblers
	323	Metal plant operators no further specification
	332	Spoolers, twisters, rope makers
	341	Weaving- and knitting-machine preparers
	342	Weavers and weaving-machine operators
	343	Tufted textile-, fur- and leather-products makers
	344	Knitters and knitting-machine operators
	345	Felt and hat body makers
	346	Textile braiders
	352	Sewers and sewing-machine operators
	353	Lingerie tailors and sewers
	354	Embroiderers
	355	Hatters and cap makers
	356	Sewer and sewing-machine operators otherwise undisclosed

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	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
	357	Other textile-products makers
	361	Textile dyer and dyeing-machine operators
	362	Textile bleaching-, cleaning-machine operators and other finishers
	371	Tanners, catgut string makers and other leather-preparing machine operators
	373	Shoemaking-machine operators
	375	Purse, hand bag and other fine-leather products makers
	376	Leather garment makers and other leather-products machine operators
	377	Leather glove makers
	402	Meat- and sausage-processing machine operators
	403	Fish-processing machine operators
	412	Ready-made meal-, fruit- and vegetable-processing machine operators
	424	Tobacco preparers, product makers
	431	Dairy-products machine operators, butter, lard and margarine makers
	432	Grain- and spice-milling machine operators
	433	Sugar-production machine operators, chocolate, sweets and ice-cream makers
	442	Steel fixers, concrete workers
	452	Roofers
	453	Scaffolders
	461	Pavers
	462	Road building experts
	463	Track building experts
	465	Land improvement, maintenance and hydraulic structure building experts
	466	Well, duct and other civil engineering building experts
	471	Earth-moving labourers
	472	Building construction labourers and other construction and maintenance labourers otherwise undisclosed
	482	Insulators and proofers
	486	Composition floor and terrazzo layers
	504	Other wood-products makers, Boat-, glider- and wooden sports-equipment building experts
	512	Goods painters and varnishers
	513	Wood surface finishers, veneers
	514	Glass, ceramics and related decorative painters, glass engravers and etchers
	521	Products testers, sorters otherwise undisclosed
	522	Product packagers, balers, wrappers, qualifiers and other loading agents
	531	Labourers not further specified
	543	Pump-, compressor-, assembly line-, boring and other machines operators
	544	Crane and hoist plant operators
	545	Earth-moving and related plant operators
	546	Construction plant operators
	547	Machine maintenance operators, machinists' assistants
	548	Boiler persons, incinerators and related plant operators

continued on the next page

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
	549	Machine-tool setters and setter-operators no further specified
[03] QMB qualified	134	Gaffer
manual occupations	142	Chemical laboratory workers
	144	Tyre vulcanisers
	163	Bookbinding workers
	171	Type setters, pre-press workers
	173	Book printers, letterpress
	174	Flat screen, gravure and intaglio printers
	175	Special, silk-screen printers
	201	Moulders and core makers
	202	Casters
	221	Metal lathe operators
	251	Steel-, black-, hammersmiths and forging press workers
	252	Tank and container builders, coppersmiths and related occupations
	261	Tinsmiths
	262	Plumbers
	270	Locksmiths and fitters, not further specified
	271	Building fitters
	272	Sheet metal worker, plastics fitters
	273	Engine fitters
	274	Plant and maintenance fitters
	275	Steel construction fitters, steel ship builders
	281	Motor vehicle repairers
	282	Agricultural machinery repairers
	283	Aircraft mechanics
	284	Precision mechanics
	285	Other mechanics
	286	Watch-, clockmakers
	291	Toolmakers, instrument mechanics
	302	Precious metal smiths
	305	Musical instrument makers
	306	Doll, model makers, taxidermists
	311	Electrical fitters, mechanics
	312	Telecommunications mechanics, craftsmen
	314	Electrical appliance fitters
	315	Radio, sound equipment mechanics
	331	Spinner, fibre-preparer
	351	Tailors and dressmakers
	372	Shoe-makers
	374	Saddlers, truss makers and other coarse-leather-products makers
	378	Pelt dressers, furriers and other fur-products makers
	391	Bakers and baked-goods, cereal- and chocolate-products machine operators

continued on the next page

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
	392	Pastry-cooks and confectionery makers
	401	Butchers and stickers
	411	Cooks
	421	Wine coopers and other wine-processing operators
	422	Brewers, maltsters and other brewer machine operators
	423	Other beverage makers, coffee-processing-machine operators, tasters and graders
	441	Bricklayers and masons
	451	Carpenters
	464	Shot firers and blasters except mining shot firers
	481	Stuccoers, plasterers
	483	Tile setters
	484	Stove setters and air heating fitters
	485	Glaziers
	491	Interior decorators, carpet and parquet layers
	492	Upholsterers, mattresses makers
	501	Cabinetmakers, carpenters and joiners
	502	Pattern and mold carpenters
	503	Cartwrights, wheelwrights, coopers and tubbers
	511	Construction painters, wallpaperers, varnishers
	541	Power production plant operators
	542	Winding-, conveyor- and ropeway-machine operators
[04] TEC technicians	32	Agricultural engineers and advisors
	52	Garden and landscape architects and administrators
	303	Dental technicians
	304	Ophthalmic opticians
	601	Mechanical and automotive engineers
	602	Electrical and electronics engineers
	603	Architects, civil and structural engineers
	604	Cartographers and survey engineers
	605	Mining, metallurgy, foundry engineers
	606	Other production engineers
	607	Industrial and other operating engineers
	611	Chemists, chemical engineers
	612	Physicists, physics engineers, mathematicians
	621	Mechanical engineering technicians
	622	Electrical, electronics and telecommunications engineering technicians
	623	Civil engineering technicians
	624	Survey engineering technicians
	625	Mining, metallurgy, foundry engineering technicians
	626	Chemical and physical engineering technicians
	627	Other production technicians
	628	Industrial and other operating technicians

continued on the next page

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
	629	Forepersons and other operations managers
	631	Agronomy, forestry and life science technicians
	632	Physical and mathematical science technicians
	633	Chemical science technicians
	634	Photo laboratory technicians
	635	Draftspersons
	721	Navigators, nautical ships' officers and pilots
	722	Technical ship's officers, engineers, technicians and machinists
	726	Aircraft pilots, flight engineers and other air traffic occupations
	733	Radio operators
	857	Medical technical, laboratory, radiological assistants
	883	Biologists, geographers, meteorologists and other natural scientists, otherwise undisclosed
[06] EDI simple service occupations	685	Chemist's assistants in pharmacies
	686	Filling station attendants
	706	Cashiers, ticket agents, Debt- and vending-machine money collectors and ticket inspectors
	713	Other brake, signal and switch operators, transport guides and conductors, fleet managers
	714	Car, taxi, bus, (heavy) truck and other motor vehicle drivers
	715	Cabby
	716	Construction and maintenance labourers: roads, dams, bridges and similar constructions
	723	Seagoing ships' deck crews
	724	Inland boatmen and related ships' decks crews
	725	Ferrymen, lockmasters, coastguards and other water traffic occupations
	741	Stocks administrators and clerks
	742	Lift, lifting-trucks and other materials handling equipment operators
	743	Longshoremen, furniture removers
	744	Stock, loading and other transport workers
	791	Factories security offices, store, hotel and other detectives
	792	Watchpersons, custodians, attendants and related workers
	793	Door-, gatekeepers and caretakers
	794	Menials, bellmen, ushers and groundkeepers
	805	Disinfectors, morticians, meat and and other health inspectors
	838	Clowns, magicians, acrobats, professional sportspersons, mountain guides and models
	911	Hoteliers, innkeepers, restaurateurs and management assistants in hotels and restaurants
	912	Waiters, waitresses, stewards, stewardesses and buspersons
	913	Porters, bartenders and other hotel and restaurant attendants
	923	Valets, chambermaids and other housekeeping attendants

continued on the next page

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
	931	Launderers and ironers
	932	Textile cleaner, dyers, chemical purifiers
	933	Dishwashers, room and domestic cleaners
	934	Windows, frontages and buildings cleaners
	935	Sweepers, streets and sewerages cleaners, dustmen and other waste disposal workers
	936	Car washers, vehicle cleaners, car and vehicle carers
	937	Machinery, plant, tube and container cleaners
[07] QDI qualified service occupations	172	Stereotypers and electrotypers
	684	Chemists in drugstores
	704	Finance, stock, trade, ship, real estate, insurance brokers
	705	Landlords, hirers, agents, bookers, auctioneers
	711	Locomotive engine, tram and subway drivers
	712	Railway brake, signal and switch operators, shunters and railway guards and conductors
	801	Soldiers, border guards, police officers
	802	Firefighters
	803	Safety inspectors, trade controllers, gauging, and environmental protection officers
	804	Chimney sweepers
	812	Law officers
	814	Executory officers, prison guards
	831	Composers, music directors and musicians
	832	Film, stage and related directors, actors, singers and dancers
	833	Sculptors, painters, graphic and related artists
	834	Decorators, sign painters
	835	Set designer, light board, image and sound recording engineers, technicians and operators
	836	Interior architects, visual merchandiser
	837	Photographers, camera and retouching operators
	851	Non-medical practitioners, psychotherapists
	852	Masseurs, physiotherapists and health care professionals
	854	Paramedics and nursing auxiliary workers
	855	Dieticians, nutritionists and pharmacy technicians
	856	Doctor's receptionists and assistants
	892	Nuns, friars and other religious associate professionals
	893	Sextons, cantors and other religious assistants
	901	Hairdressers, barbers, wigmakers and related workers
	902	Beauticians, manicurists, pedicurists and related workers
	921	Housekeepers and related workers
	922	Energy and other consumer advisors
[08] SEMI semi	821	Authors, journalists, editors and announcers

continued on the next page

	KldB 88 - occupational orders	
Occupational category	**Code**	**Title**
professions	822	Interpreters, translators
	823	Librarians, archivists, documentalists, curators, library and filing clerks
	853	Nurses, midwifes, nursing and midwifery associate professionals
	861	Social work, welfare, health care professionals and workers; geriatric nurses
	862	Housemasters, social pedagogue, deacons
	863	Employment, vocational training, study, careers advisors
	864	Kindergarten teachers, child care workers and paediatric nurses
	873	Primary, secondary school, special education teachers and related teaching professionals
	874	Vocational, professional college teachers and related teaching professionals
	875	Art, music and voice teachers and related teaching professionals, otherwise undisclosed
	876	PE teachers, related teaching professionals, skiing and other sports instructors
	877	Driving, flying, hygienic and other instructors, otherwise undisclosed
[09] PROF professions	811	Judges and prosecutors
	813	Lawyers, notaries, legal representatives, advisors and other legal professionals
	841	Medical doctors
	842	Dentists
	843	Veterinaries
	844	Pharmacists
	871	University, college professors and related teaching professionals
	872	Grammar school teacher and related teaching professionals
	881	Economists, psychologists, sociologists, political scientists, statisticians
	882	Philologists, historians, philosophers and other humanities scientists, otherwise undisclosed
	891	Bishops, pastors, chaplains and other religious professionals
[10] EVB simple business and administrative occupations	682	Shop, stall and market salespersons and demonstrators
	687	Commercial sales representatives and sales agents
	732	Mail carriers, sorting clerks, porters and deliverers
	734	Telephone switchboard operators
	773	Cashiers and ticket clerks
	782	Secretaries, stenographers and typists
	783	Data entry operators
	784	Scribes and other office hands
[11] QVB qualified business and administrative occupations	31	Agricultural production manager
	681	Wholesaler, retail salespersons and buying agents
	683	Publishers, management assistants in publishing and booksellers
	691	Banking experts including tellers, finance clerks as well as finance dealers and brokers
	692	Building society experts including representatives as well as clerks
	693	Health insurance experts including representatives as well as clerks, not social security
	694	Life, property insurance experts including representative as well as clerks
	701	Logistics managers and transport clerks

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Occupational category	KldB 88 - occupational orders Code	Title
	702	Travel agency clerks, attendants, stewards, consultants, organisers and guides
	703	Advertising and public relations experts
	771	Calculators, calculating and counting clerks
	772	Bookkeepers
	774	Computer scientists, equipment operators, computing and data processing professionals
	781	Office clerks, otherwise undisclosed
[12] MAN manager	751	Entrepreneurs, managing directors and division managers
	752	Management personnel and other business consultants
	753	Financial, tax accountants and accounting clerks
	762	Senior and administrative state officials
	763	Senior and administrative officials of humanitarian and other special-interest organisations
[00] not assignable	982	Interns, volunteer with occupation remaining to be specified
	983	Job-seekers with occupation remaining to be specified
	991	Labourers not further specified

A.2 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 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_b with $b = [2, ..., 12]$ with reference category "Agrarian and not assignable occupations" (occupational category=1) are coded as follows:

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

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 $d_{b,y}$ with $y =$

$[2001, ..., 2011]$ and $b = [2, ..., 12]$ is coded as follows:

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

A.3 Further empirical results

Table 9: Fixed effects estimation results based on data set disaggregated by occupations and NUTS3 regions, all regressions without recession variable.

	Dependent variable: $\log M$					
	FE 1	FE 2	FE 3	FE 4	FE 5	FE 6
β_{Us}	0.514***	0.623***	0.624***	0.453***	0.563***	0.582***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
β_{Uf}				0.085***	0.071***	0.049***
				(0.002)	(0.001)	(0.001)
β_{Vs}	0.060***	0.040***	0.044***	0.041***	0.021***	0.023***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
β_{Vf}				0.029***	0.030***	0.034***
				(0.001)	(0.001)	(0.001)
Year dummies, effect coded (reference: 2000):						
d_{2001}			-0.100***			-0.101***
			(0.001)			(0.001)
d_{2002}			-0.146***			-0.139***
			(0.001)			(0.001)
d_{2003}			-0.135***			-0.129***
			(0.001)			(0.001)
d_{2004}			-0.123***			-0.121***
			(0.001)			(0.001)
d_{2005}			-0.103***			-0.096***
			(0.002)			(0.002)
d_{2006}			-0.023***			-0.016***
			(0.001)			(0.001)
d_{2007}			0.099***			0.102***
			(0.001)			(0.001)
d_{2008}			0.174***			0.169***
			(0.002)			(0.002)
d_{2009}			0.089***			0.083***
			(0.001)			(0.001)
d_{2010}			0.165***			0.155***
			(0.001)			(0.001)
d_{2011}			0.162***			0.155***
			(0.002)			(0.002)
a	-0.428***	-0.970***	-0.912***	-0.381***	-0.888***	-0.861***
	(0.013)	(0.014)	(0.012)	(0.012)	(0.014)	(0.012)
Monthly time dummies	no	yes	no	no	yes	no
Quarter dummies	no	no	yes	no	no	yes
Observations	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.206	0.304	0.274	0.213	0.309	0.278
Number of groups	55,422	55,422	55,422	55,422	55,422	55,422

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

Columns FE 2 and FE 5 include monthly time fixed effects with effect coding (reference period is January 2000), compare with Figure 9.

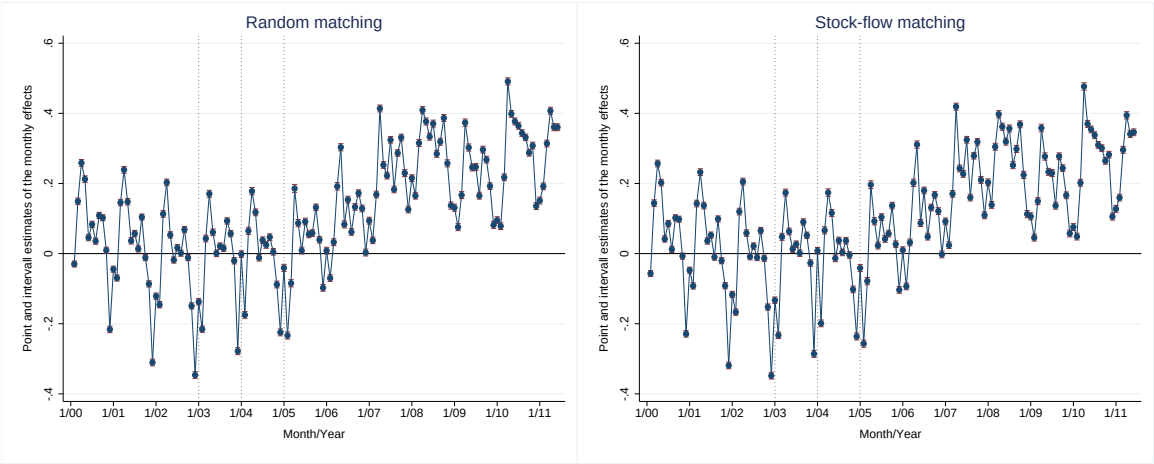

Figure 9: Monthly time fixed effects and 95 per cent confidence band.

Source:Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 9, left side: FE 2, right side: FE 5, based on data set disaggregated by occupations and NUTS3 regions, all regressions without recession variable. The blue dots and the vertical red lines mark the point and 95% interval estimates; in 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).

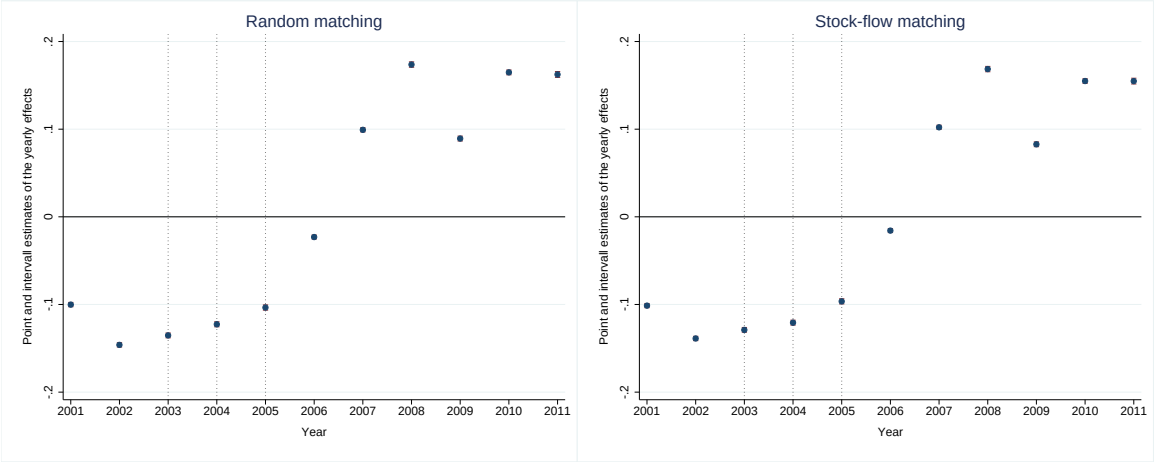

Figure 10: Yearly time fixed effects and 95 per cent confidence band.

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 9, left side: FE 3, right side: FE 6, based on a data set disaggregated by occupations and NUTS3 regions, all regressions without recession variable. The blue dots and the vertical red lines mark the point and 95% interval estimates; in most cases, the interval is very small. Yearly time fixed effects with effect coding (reference period is 2000).

Table 10: Fixed effects estimation results based on data set disaggregated by NUTS3 regions.

	Dependent variable: $\log M$							
	FE 1	FE 2	FE 3	FE 4	FE 5	FE 6	FE 7	FE 8
β_{Us}	0.469***	0.469***	0.618***	0.690***	0.476***	0.476***	0.527***	0.745***
	(0.016)	(0.016)	(0.021)	(0.024)	(0.019)	(0.019)	(0.024)	(0.029)
β_{Vs}	0.123***	0.123***	0.061***	0.110***	0.074***	0.076***	0.026***	0.031***
	(0.009)	(0.009)	(0.007)	(0.008)	(0.012)	(0.012)	(0.008)	(0.009)
β_{Uf}					-0.056***	-0.058***	0.151***	-0.109***
					(0.015)	(0.016)	(0.016)	(0.014)
β_{Vf}					0.062***	0.063***	0.075***	0.141***
					(0.009)	(0.009)	(0.006)	(0.007)
Year dummies, effect coded (reference: 2000):								
d_{2001}				-0.143***				-0.195***
				(0.005)				(0.005)
d_{2002}				-0.165***				-0.171***
				(0.005)				(0.005)
d_{2003}				-0.099***				-0.096***
				(0.006)				(0.006)
d_{2004}				-0.066***				-0.057***
				(0.006)				(0.006)
d_{2005}				-0.025***				-0.021***
				(0.007)				(0.007)
d_{2006}				-0.003				-0.007
				(0.005)				(0.006)
d_{2007}				0.066***				0.065***
				(0.005)				(0.005)
d_{2008}				0.133***				0.149***
				(0.007)				(0.007)
d_{2009}				0.122***				0.177***
				(0.009)				(0.010)
d_{2010}				0.172***				0.201***
				(0.006)				(0.007)
d_{2011}				0.097***				0.114***
				(0.008)				(0.009)
γ		0.014	0.895***	0.921***		-0.203***	1.121***	1.266***
		(0.066)	(0.156)	(0.162)		(0.077)	(0.139)	(0.162)
a	1.285***	1.285***	0.181	-0.685***	1.568***	1.568***	-0.302	-0.701***
	(0.182)	(0.183)	(0.207)	(0.228)	(0.169)	(0.169)	(0.196)	(0.220)
Monthly time dummies	no	no	yes	no	no	no	yes	no
Quarter dummies	no	no	no	yes	no	no	no	yes
Observations	55,371	55,371	55,371	55,371	55,371	55,371	55,371	55,371
R-squared	0.144	0.144	0.666	0.426	0.151	0.151	0.675	0.446
Number of groups	402	402	402	402	402	402	402	402

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

Columns FE 3 and FE 7 include monthly time fixed effects with effect coding (reference period is January 2000), compare with Figure 11.

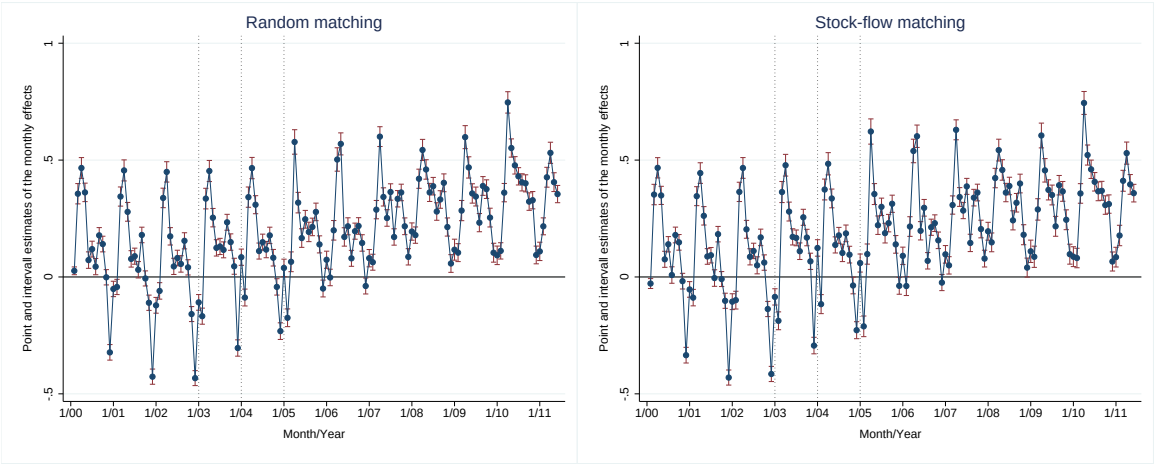

Figure 11: Monthly time fixed effects and 95 per cent confidence band.

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 10, left side: FE 3, right side: FE 7, based on data set disaggregated by NUTS3 regions.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 temporal development. Monthly time fixed effects with effect coding (reference period is January 2000).

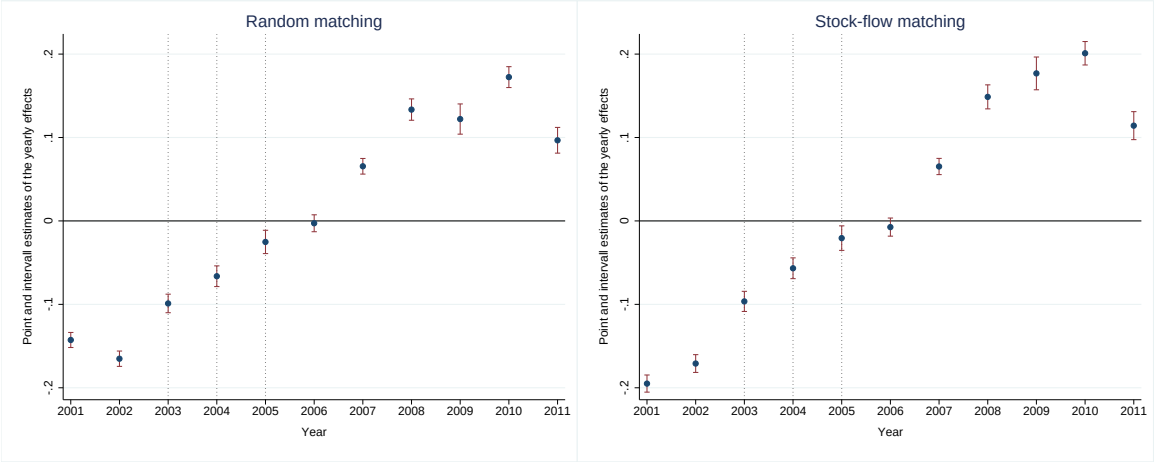

Figure 12: Yearly time fixed effects and and 95 per cent confidence band.

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 10, left side: FE 4, right side: FE 8, based on data set disaggregated by NUTS3 regions. The blue dots and the vertical red lines mark the point and 95% interval estimates. Yearly time fixed effects with effect coding (reference period is 2000).

Table 11: Fixed effects estimation results based on data set disaggregated by occupations.

	Dependent variable: $\log M$							
VARIABLES	FE 1	FE 2	FE 3	FE 4	FE 5	FE 6	FE 7	FE 8
β_{Us}	0.640***	0.645***	0.927***	0.928***	0.507***	0.505***	0.832***	0.940***
	(0.017)	(0.017)	(0.018)	(0.018)	(0.028)	(0.028)	(0.043)	(0.039)
β_{Uf}					0.174***	0.188***	0.091**	-0.029
					(0.038)	(0.039)	(0.042)	(0.037)
β_{Vs}	0.138***	0.132***	0.087***	0.098***	0.092***	0.085***	0.031***	0.035***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.013)	(0.013)	(0.010)	(0.010)
β_{Vf}					0.052***	0.048***	0.071***	0.083***
					(0.013)	(0.013)	(0.010)	(0.010)
Year dummies, effect coded (reference: 2000):								
d_{2001}				-0.260***				-0.281***
				(0.009)				(0.012)
d_{2002}				-0.282***				-0.282***
				(0.008)				(0.010)
d_{2003}				-0.209***				-0.214***
				(0.009)				(0.011)
d_{2004}				-0.141***				-0.149***
				(0.009)				(0.009)
d_{2005}				-0.075***				-0.084***
				(0.009)				(0.011)
d_{2006}				-0.043***				-0.042***
				(0.006)				(0.007)
d_{2007}				0.113***				0.126***
				(0.008)				(0.009)
d_{2008}				0.237***				0.254***
				(0.010)				(0.014)
d_{2009}				0.279***				0.292***
				(0.011)				(0.015)
d_{2010}				0.320***				0.330***
				(0.010)				(0.014)
d_{2011}				0.248***				0.265***
				(0.014)				(0.017)
d_{q1}				0.361***				0.352***
				(0.028)				(0.024)
d_{q2}				0.224***				0.215***
				(0.016)				(0.012)
d_{q3}				0.114***				0.113***
				(0.007)				(0.007)
γ		0.717***		1.800***		1.042***		1.624***
		(0.146)		(0.180)		(0.175)		(0.177)
a	-0.596***	-0.595***	-2.874***	-2.723***	-0.590***	-0.603***	-2.696***	-2.684***
	(0.158)	(0.159)	(0.148)	(0.139)	(0.145)	(0.145)	(0.162)	(0.152)
Monthly time dummies	no	no	yes	no	no	no	yes	no
Quarter dummies	no	no	no	yes	no	no	no	yes
Observations	42,053	42,053	42,053	42,053	42,053	42,053	42,053	42,053
R-squared	0.453	0.454	0.675	0.610	0.464	0.466	0.681	0.616
Number of bo_nr	327	327	327	327	327	327	327	327

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

Columns FE 3 and FE 7 include monthly time fixed effects with effect coding (reference period is January 2000), compare with Figure 13. Specifications FE 3 and FE 7 without $GDP_{cyc,quarter(t)}$ due to collinearity.

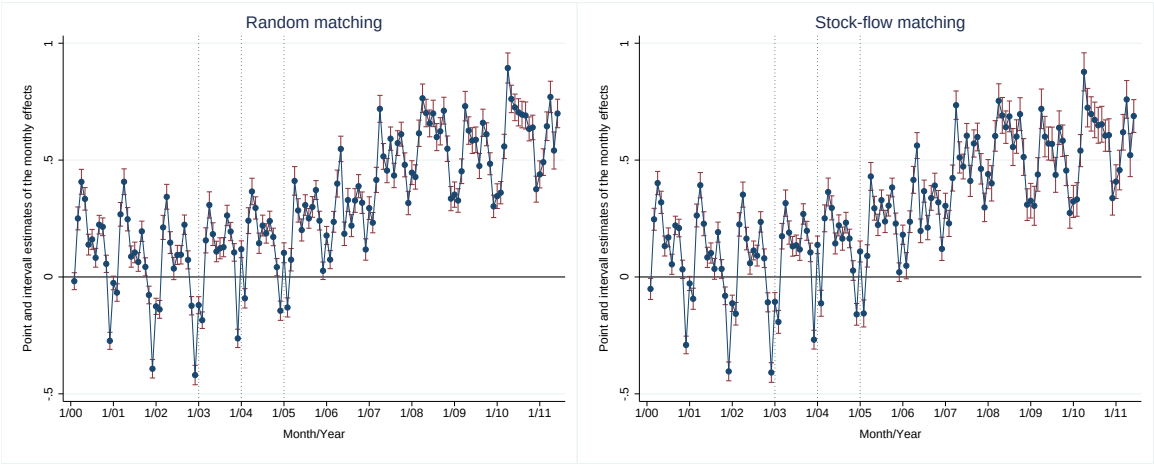

Figure 13: Monthly time fixed effects and 95 per cent confidence band.

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 11, left side: FE 3, right side: FE 7, based on data set disaggregated by occupations. 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).

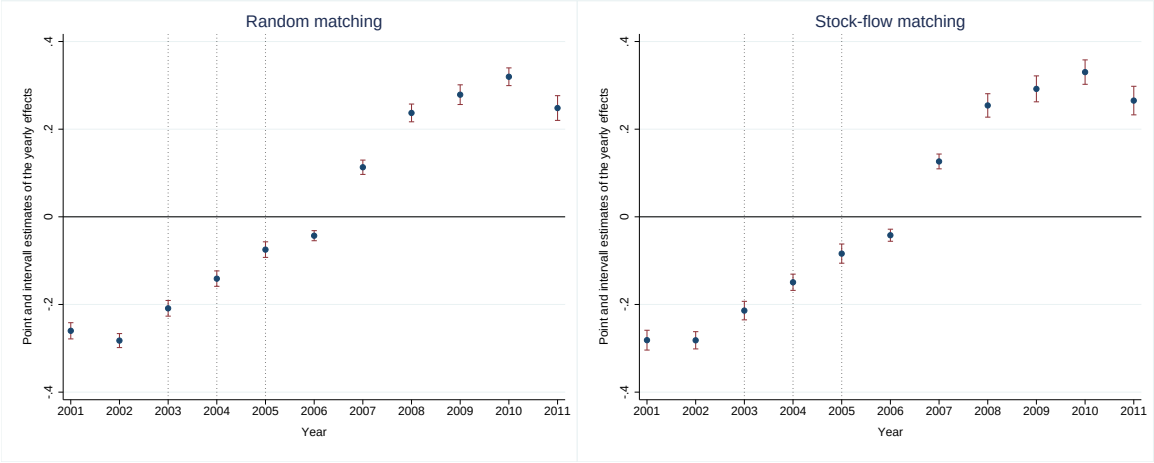

Figure 14: Yearly time fixed effects and 95 per cent confidence band.

Source: Statistics of the Federal Employment Agency, own computations.
Notes: Specifications from Table 11, left side: FE 4, right side: FE 8, based on data set disaggregated by occupations.The blue dots and the vertical red lines mark the point and 95% interval estimates; in 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).

Occupational category	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
[2]EMB	-0.005	0.006	0.004	0.023	**0.140**	0.075	0.103	0.017	0.047	-0.049
[3] QMB	-0.029	**0.067**	0.009	0.026	0.009	0.056	0.061	-0.013	0.049	-0.011
[4] TEC	-0.038	0.040	0.047	0.015	0.040	**0.124**	0.093	-0.029	0.025	-0.007
[5] ING	-0.029	0.042	0.079	0.075	0.019	**0.128**	0.103	0.000	0.003	0.016
[6] EDI	-0.043	0.031	0.032	0.008	**0.099**	0.056	0.073	0.037	0.025	-0.059
[7] QDI	-0.031	0.054	0.017	-0.038	-0.024	**0.096**	0.087	0.058	-0.034	-0.044
[8] SEMI	-0.011	0.031	0.063	0.073	-0.024	**0.087**	0.043	0.018	-0.038	-0.101
[9] PROF	0.004	0.064	**0.098**	0.016	-0.022	0.075	0.078	0.091	-0.054	-0.030
[10] EVB	-0.015	0.071	0.053	-0.007	0.051	**0.099**	0.096	0.018	-0.010	-0.066
[11] QVB	-0.046	0.052	0.051	0.012	-0.013	**0.101**	0.071	0.022	0.020	-0.053
[12] MAN	0.010	0.019	0.064	-0.001	0.039	**0.149**	0.071	0.048	-0.005	-0.034

Table 12: Absolute year-to-year differences between the yearly time fixed effects sums from Figures 4 and 5, based on the random matching model.

Source: Statistics of the Federal Employment Agency, own computations. Bold printed values denote the maximal positive absolute changes of the time fixed effects.
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.

Occupational category	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
[2] EMB	0.022	0.009	-0.015	0.048	**0.125**	0.044	0.059	0.010	0.030	-0.041
[3] QMB	-0.002	**0.064**	-0.014	0.048	0.000	0.028	0.029	-0.013	0.040	-0.005
[4] TEC	-0.031	0.038	0.023	0.026	0.040	**0.092**	0.057	-0.035	0.035	0.000
[5] ING	-0.021	0.039	0.062	0.085	0.022	**0.107**	0.064	-0.012	0.018	0.014
[6] EDI	-0.018	0.025	0.017	0.040	**0.098**	0.038	0.036	0.027	0.012	-0.053
[7] QDI	-0.018	0.041	-0.003	-0.013	-0.015	**0.078**	0.049	0.047	-0.037	-0.037
[8] SEMI	0.004	0.015	0.039	**0.084**	-0.016	0.076	0.009	0.012	-0.038	-0.090
[9] PROF	0.017	0.051	0.077	0.025	-0.006	0.058	0.047	**0.079**	-0.043	-0.034
[10] EVB	-0.010	0.067	0.038	0.021	0.051	**0.080**	0.055	0.009	-0.011	-0.063
[11] QVB	-0.025	0.055	0.028	0.027	-0.019	**0.078**	0.027	0.016	0.026	-0.047
[12] MAN	0.018	0.025	0.045	0.005	0.034	**0.125**	0.034	0.041	0.013	-0.031

Table 13: Absolute year-to-year differences between the yearly time fixed effects sums from Figures 7 and 8, based on the stock-flow matching model.

Source:Statistics of the Federal Employment Agency, own computations. Bold printed values denote the maximal positive absolute changes of the time fixed effects.
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.

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