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## Revisiting German labour market reform effects

A panel data analysis for occupational labour markets

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# Revisiting German labour market reform effects

## A panel data analysis for occupational labour markets

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## 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.<sup>1</sup> 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-

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<sup>1</sup> 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"<sup>2</sup>): 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

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<sup>2</sup> 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:

$$M_t = A_t U_t^{\beta_{Us}} V_t^{\beta_{Vs}}, \quad (1)$$

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<sup>3</sup>. 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-

<sup>3</sup> 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  $t$ :

$$M_{tb} = A_{tb} U_{tb}^{\beta_{Us}} V_{tb}^{\beta_{Vs}} \quad (2)$$

### 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<sup>4</sup>). All the data stem from the Federal Employment Agency. The groups are assigned to the 13 occupational labour markets described in the previous section.<sup>5</sup>

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

<sup>4</sup> *Klassifizierung der Berufe 1988.*

<sup>5</sup> 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:

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

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  $\beta_{Us}$  and  $\beta_{Vs}$  denote the matching elasticities of the unemployed and vacancies, respectively. Furthermore, the regression equation contains a fixed effect,  $\mu_{ij}$ , 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,  $\epsilon_{ijt}$ , 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  $\gamma$ . 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.<sup>6</sup> 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<sup>7</sup>, and the reference year is 2000. Thus, the latter variable can be interpreted as the yearly seasonal

<sup>6</sup> Compare details about effect coding in Appendix A.2.

<sup>7</sup> See Appendix A.2.

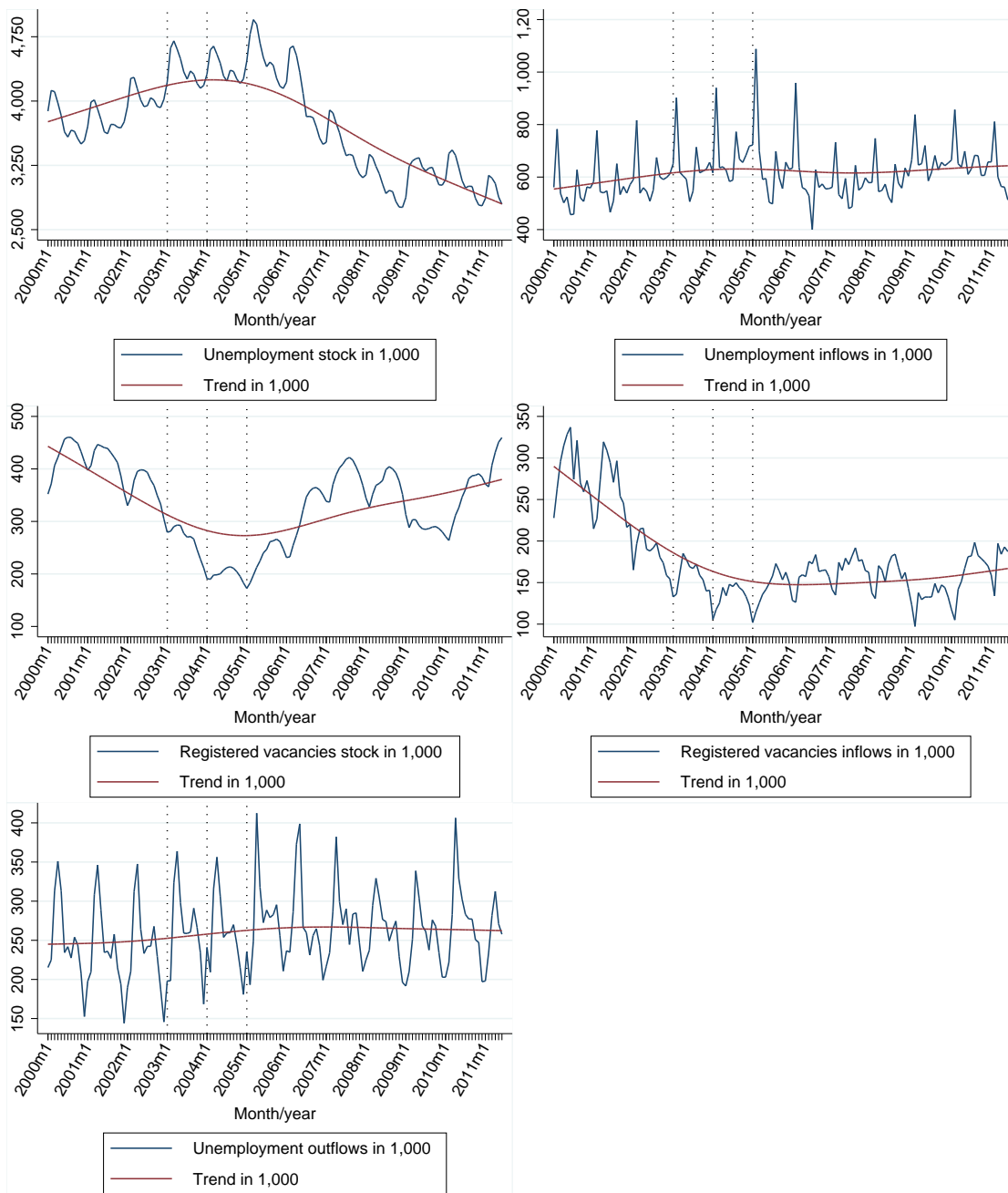


Figure 1: Time series of the key figures for the 2000-2011 analysis

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                 |
| $\beta_{Us}$   | 0.514***<br>(0.003)          | 0.519***<br>(0.003)  | 0.625***<br>(0.003)  | 0.626***<br>(0.003)  |
| $\beta_{Vs}$   | 0.060***<br>(0.001)          | 0.056***<br>(0.001)  | 0.039***<br>(0.001)  | 0.044***<br>(0.001)  |
| <i>Year dummies, effect coded (reference: 2000):</i> |                              |                      |                      |                      |
| $d_{2001}$   |                              |                      |                      | -0.114***<br>(0.001) |
| $d_{2002}$   |                              |                      |                      | -0.147***<br>(0.001) |
| $d_{2003}$   |                              |                      |                      | -0.122***<br>(0.001) |
| $d_{2004}$   |                              |                      |                      | -0.111***<br>(0.001) |
| $d_{2005}$   |                              |                      |                      | -0.082***<br>(0.002) |
| $d_{2006}$   |                              |                      |                      | -0.030***<br>(0.001) |
| $d_{2007}$   |                              |                      |                      | 0.067***<br>(0.002)  |
| $d_{2008}$   |                              |                      |                      | 0.143***<br>(0.002)  |
| $d_{2009}$   |                              |                      |                      | 0.143***<br>(0.002)  |
| $d_{2010}$   |                              |                      |                      | 0.176***<br>(0.001)  |
| $d_{2011}$   |                              |                      |                      | 0.150***<br>(0.002)  |
| $\gamma$   |                              | 0.985***<br>(0.021)  | 1.336***<br>(0.047)  | 1.352***<br>(0.047)  |
| $a$  | -0.428***<br>(0.013)         | -0.443***<br>(0.013) | -0.990***<br>(0.014) | -0.919***<br>(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.

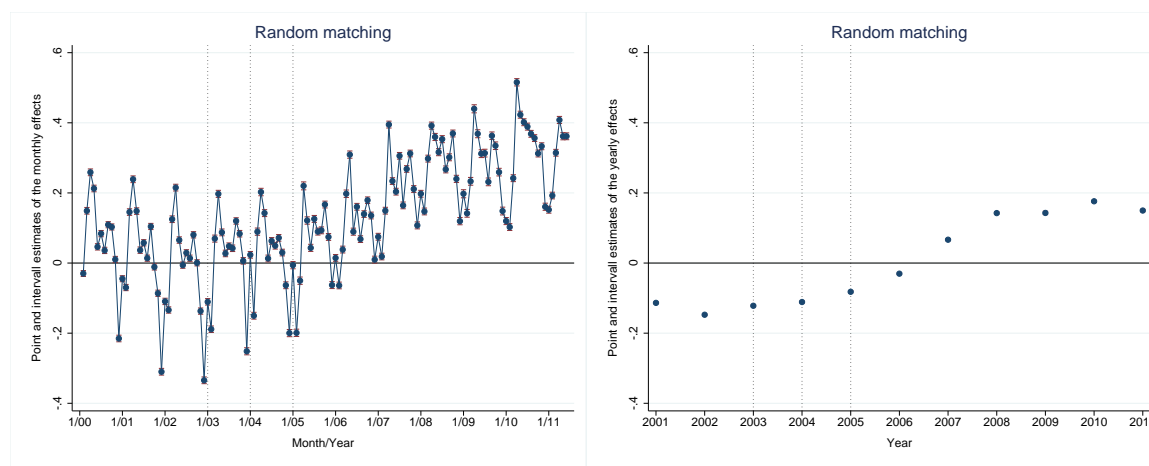


Figure 2: Month and year time fixed effects and 95 per cent confidence band.

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.<sup>8</sup> 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).

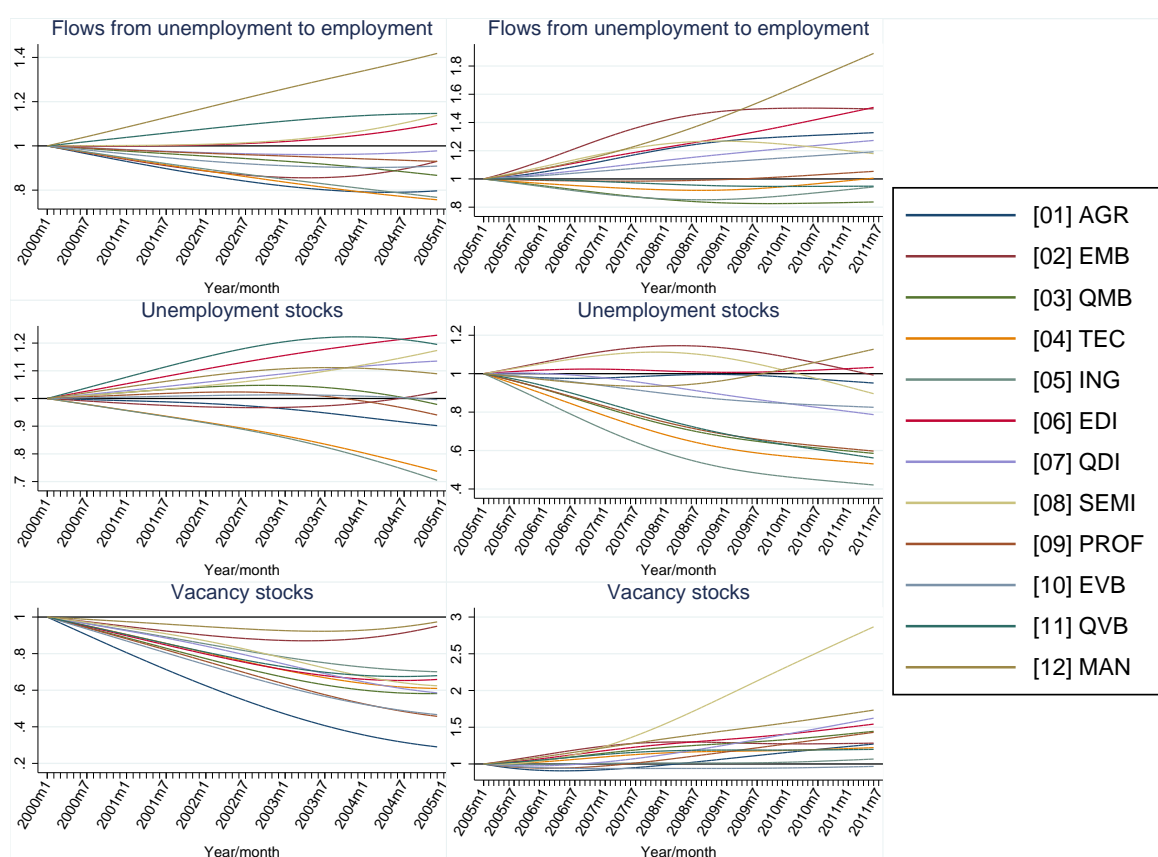


Figure 3: Key figures by occupational groups, normalised trends, 2000-2004 (January 2000 = 1, left panel) and 2005-2011 (January 2005 = 1, right panel)

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.

<sup>8</sup> 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  $\mu_{ij}$  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                |
| $\beta_{Us}$   | 0.577***<br>(0.000)          | 0.579***<br>(0.000)  | 0.634***<br>(0.000)  | 0.633***<br>(0.000)  |
| $\beta_{Vs}$   | 0.141***<br>(0.000)          | 0.139***<br>(0.000)  | 0.117***<br>(0.000)  | 0.118***<br>(0.000)  |
| <i>Year dummies, effect coded (reference: 2000):</i>                               |                              |                      |                      |                      |
| $d_{2001}$   |                              |                      | -0.129***<br>(0.001) | -0.142***<br>(0.001) |
| $d_{2002}$   |                              |                      | -0.155***<br>(0.001) | -0.164***<br>(0.001) |
| $d_{2003}$   |                              |                      | -0.111***<br>(0.001) | -0.124***<br>(0.001) |
| $d_{2004}$   |                              |                      | -0.079***<br>(0.001) | -0.079***<br>(0.002) |
| $d_{2005}$   |                              |                      | -0.059***<br>(0.001) | -0.051***<br>(0.002) |
| $d_{2006}$   |                              |                      | -0.023***<br>(0.001) | -0.027***<br>(0.001) |
| $d_{2007}$   |                              |                      | 0.057***<br>(0.001)  | 0.070***<br>(0.002)  |
| $d_{2008}$   |                              |                      | 0.132***<br>(0.001)  | 0.148***<br>(0.002)  |
| $d_{2009}$   |                              |                      | 0.150***<br>(0.002)  | 0.168***<br>(0.002)  |
| $d_{2010}$   |                              |                      | 0.170***<br>(0.001)  | 0.172***<br>(0.001)  |
| $d_{2011}$   |                              |                      | 0.132***<br>(0.001)  | 0.139***<br>(0.002)  |
| <i>Dummies for occupational categories, effect coded (reference: [0]/[1] AGR):</i> |                              |                      |                      |                      |
| [02] EMB   |                              |                      | -0.038***<br>(0.001) | -0.040***<br>(0.001) |
| [03] QMB   |                              |                      | 0.153***<br>(0.001)  | 0.152***<br>(0.001)  |
| [04] TEC   |                              |                      | -0.038***<br>(0.002) | -0.036***<br>(0.002) |
| [05] ING   |                              |                      | -0.033***<br>(0.002) | -0.024***<br>(0.002) |
| [06] EDI   |                              |                      | -0.178***<br>(0.001) | -0.178***<br>(0.001) |
| [07] QDI   |                              |                      | 0.007***<br>(0.001)  | 0.005***<br>(0.001)  |
| [08] SEMI  |                              |                      | 0.037***<br>(0.001)  | 0.034***<br>(0.001)  |
| [09] PROF  |                              |                      | 0.252***<br>(0.002)  | 0.257***<br>(0.002)  |
| [10] EVB   |                              |                      | -0.233***<br>(0.001) | -0.231***<br>(0.001) |
| [11] QVB   |                              |                      | -0.012***<br>(0.001) | -0.012***<br>(0.001) |
| [12] MAN   |                              |                      | 0.046***<br>(0.002)  | 0.043***<br>(0.002)  |
| $\gamma$   |                              | 0.667***<br>(0.018)  | 1.378***<br>(0.041)  | 1.345***<br>(0.041)  |
| $a$  | -0.923***<br>(0.007)         | -0.925***<br>(0.007) | -1.161***<br>(0.007) | -1.162***<br>(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.

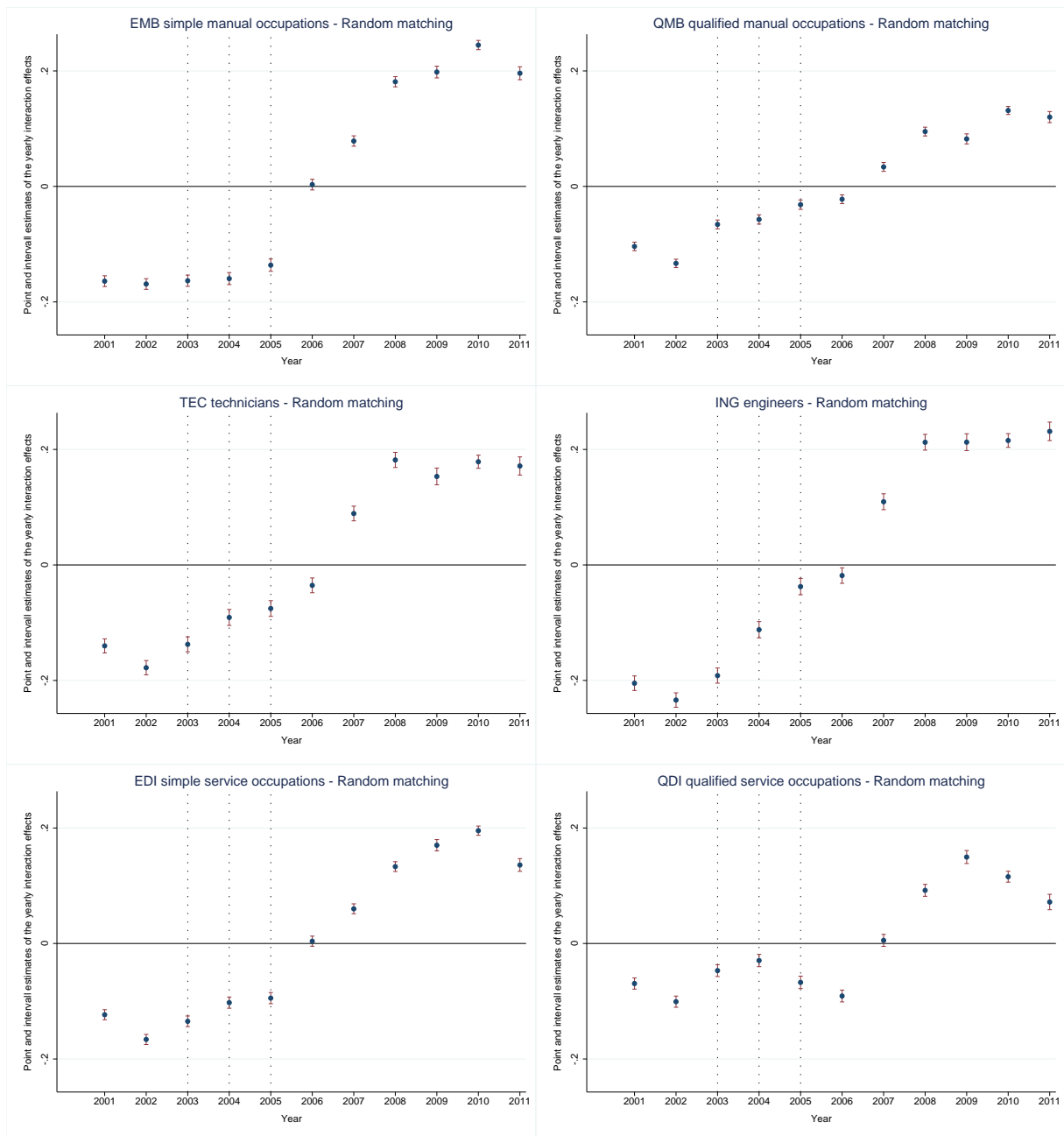


Figure 4: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 1/2).

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.

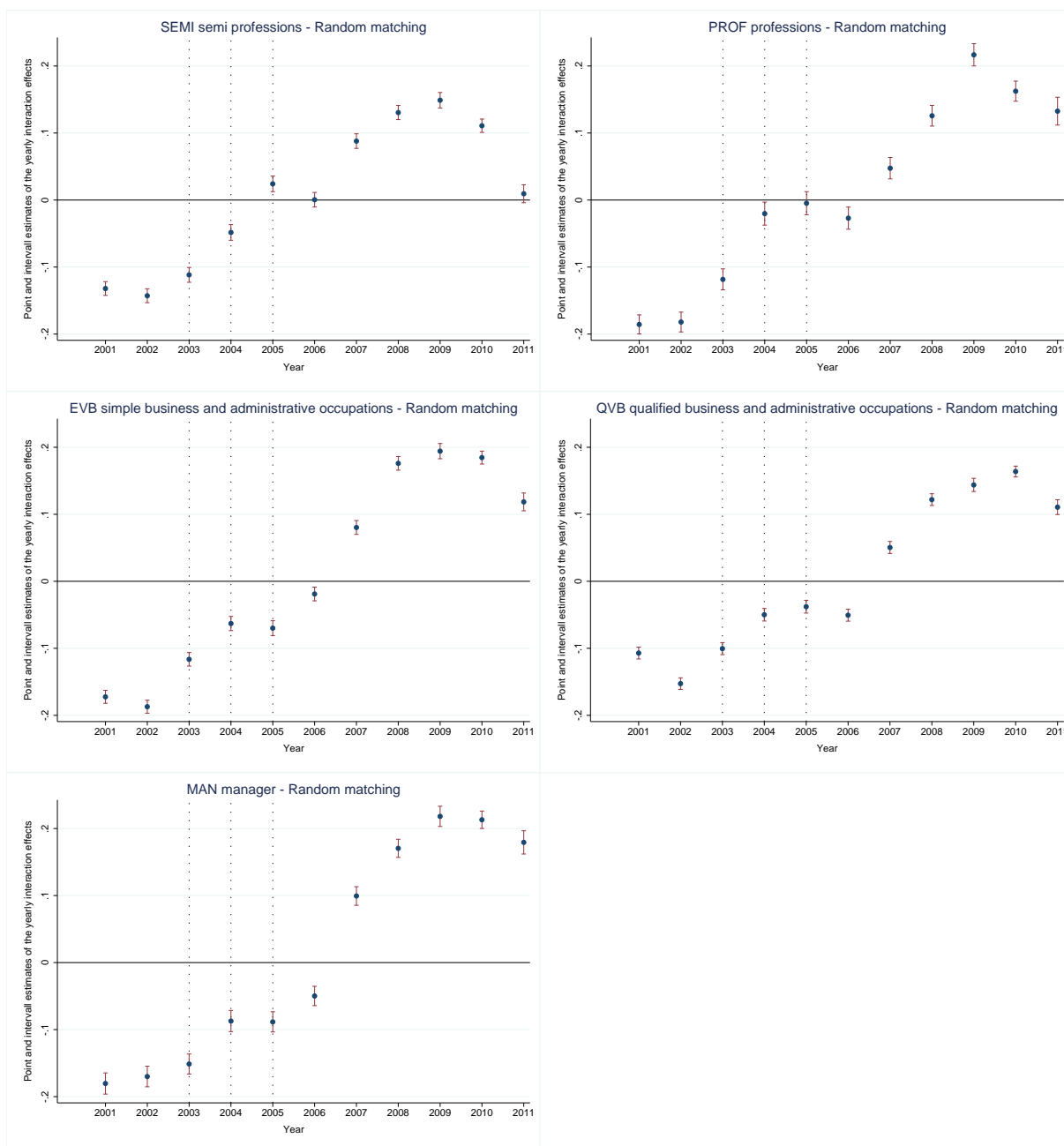


Figure 5: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 2/2).

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.<sup>9</sup> This result can hardly be corroborated based on the results in this study.<sup>10</sup> 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

<sup>9</sup> 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.

<sup>10</sup> 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 find 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  $\beta_{Uf}$  and  $\beta_{Vf}$ :

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

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

$$M_{tb} = A_{tb} U_{tb}^{\beta_{Us}} u_{tb}^{\beta_{Uf}} V_{tb}^{\beta_{Vs}} v_{tb}^{\beta_{Vf}} \quad (7)$$

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:

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

Thus, the variables  $\log u$  and  $\log v$  are the logarithms of the unemployed and vacancy inflows whereas  $\beta_{Uf}$  and  $\beta_{Vf}$  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                 |
| $\beta_{Us}$   | 0.453***<br>(0.003)          | 0.457***<br>(0.003)  | 0.565***<br>(0.003)  | 0.584***<br>(0.003)  |
| $\beta_{Uf}$   | 0.085***<br>(0.002)          | 0.087***<br>(0.002)  | 0.071***<br>(0.001)  | 0.049***<br>(0.001)  |
| $\beta_{Vs}$   | 0.041***<br>(0.001)          | 0.037***<br>(0.001)  | 0.020***<br>(0.001)  | 0.022***<br>(0.001)  |
| $\beta_{Vf}$   | 0.029***<br>(0.001)          | 0.029***<br>(0.001)  | 0.031***<br>(0.001)  | 0.035***<br>(0.001)  |
| <i>Year dummies, effect coded (reference: 2000):</i> |                              |                      |                      |                      |
| $d_{2001}$   |                              |                      |                      | -0.115***<br>(0.001) |
| $d_{2002}$   |                              |                      |                      | -0.140***<br>(0.001) |
| $d_{2003}$   |                              |                      |                      | -0.115***<br>(0.001) |
| $d_{2004}$   |                              |                      |                      | -0.109***<br>(0.001) |
| $d_{2005}$   |                              |                      |                      | -0.074***<br>(0.002) |
| $d_{2006}$   |                              |                      |                      | -0.023***<br>(0.001) |
| $d_{2007}$   |                              |                      |                      | 0.068***<br>(0.002)  |
| $d_{2008}$   |                              |                      |                      | 0.136***<br>(0.002)  |
| $d_{2009}$   |                              |                      |                      | 0.139***<br>(0.002)  |
| $d_{2010}$   |                              |                      |                      | 0.167***<br>(0.001)  |
| $d_{2011}$   |                              |                      |                      | 0.142***<br>(0.002)  |
| $\gamma$   |                              | 1.094***<br>(0.021)  | 1.375***<br>(0.045)  | 1.413***<br>(0.045)  |
| $a$  | -0.381***<br>(0.012)         | -0.395***<br>(0.012) | -0.909***<br>(0.014) | -0.867***<br>(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.

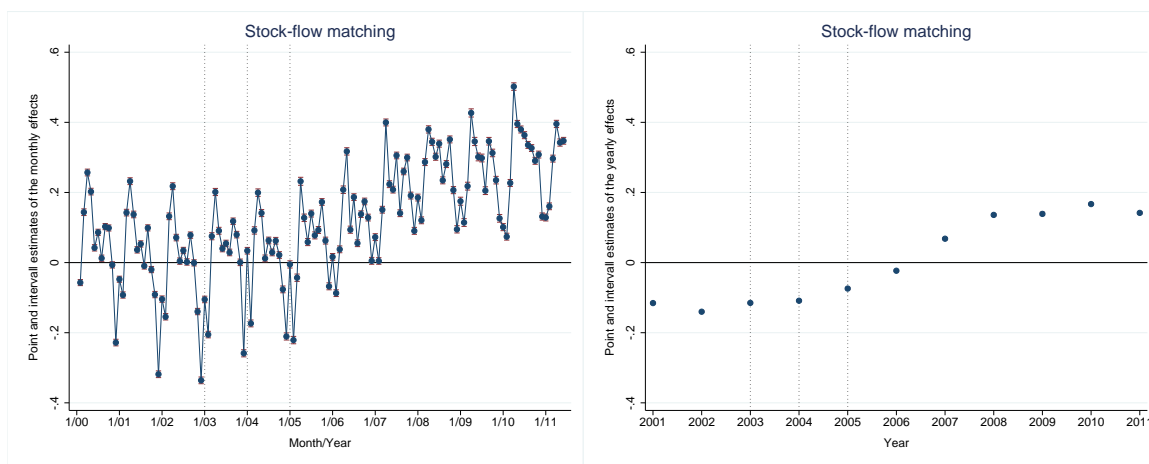


Figure 6: Monthly and yearly time fixed effects and 95 per cent confidence band.

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                |
| $\beta_{Us}$   | 0.347***<br>(0.001)          | 0.348***<br>(0.001)  | 0.440***<br>(0.001)  | 0.441***<br>(0.001)  |
| $\beta_{Uf}$   | 0.247***<br>(0.001)          | 0.249***<br>(0.001)  | 0.196***<br>(0.001)  | 0.193***<br>(0.001)  |
| $\beta_{Vs}$   | 0.063***<br>(0.001)          | 0.060***<br>(0.001)  | 0.049***<br>(0.001)  | 0.049***<br>(0.001)  |
| $\beta_{Vf}$   | 0.075***<br>(0.001)          | 0.074***<br>(0.001)  | 0.076***<br>(0.000)  | 0.078***<br>(0.000)  |
| <i>Year dummies, effect coded (reference: 2000):</i>                               |                              |                      |                      |                      |
| $d_{2001}$   |                              |                      | -0.117***<br>(0.001) | -0.127***<br>(0.001) |
| $d_{2002}$   |                              |                      | -0.123***<br>(0.001) | -0.133***<br>(0.001) |
| $d_{2003}$   |                              |                      | -0.082***<br>(0.001) | -0.096***<br>(0.001) |
| $d_{2004}$   |                              |                      | -0.070***<br>(0.001) | -0.072***<br>(0.002) |
| $d_{2005}$   |                              |                      | -0.028***<br>(0.001) | -0.025***<br>(0.002) |
| $d_{2006}$   |                              |                      | 0.005***<br>(0.001)  | -0.003*<br>(0.001)   |
| $d_{2007}$   |                              |                      | 0.061***<br>(0.001)  | 0.072***<br>(0.002)  |
| $d_{2008}$   |                              |                      | 0.099***<br>(0.001)  | 0.114***<br>(0.002)  |
| $d_{2009}$   |                              |                      | 0.110***<br>(0.002)  | 0.126***<br>(0.002)  |
| $d_{2010}$   |                              |                      | 0.124***<br>(0.001)  | 0.130***<br>(0.001)  |
| $d_{2011}$   |                              |                      | 0.093***<br>(0.001)  | 0.103***<br>(0.002)  |
| <i>Dummies for occupational categories, effect coded (reference: [0]/[1] AGR):</i> |                              |                      |                      |                      |
| [02] EMB   |                              |                      | -0.045***<br>(0.001) | -0.047***<br>(0.001) |
| [03] QMB   |                              |                      | 0.113***<br>(0.001)  | 0.112***<br>(0.001)  |
| [04] TEC   |                              |                      | -0.019***<br>(0.002) | -0.018***<br>(0.002) |
| [05] ING   |                              |                      | 0.006***<br>(0.002)  | 0.013***<br>(0.002)  |
| [06] EDI   |                              |                      | -0.176***<br>(0.001) | -0.177***<br>(0.001) |
| [07] QDI   |                              |                      | -0.022***<br>(0.001) | -0.024***<br>(0.001) |
| [08] SEMI  |                              |                      | 0.017***<br>(0.001)  | 0.013***<br>(0.001)  |
| [09] PROF  |                              |                      | 0.245***<br>(0.002)  | 0.250***<br>(0.002)  |
| [10] EVB   |                              |                      | -0.210***<br>(0.001) | -0.208***<br>(0.001) |
| [11] QVB   |                              |                      | -0.008***<br>(0.001) | -0.009***<br>(0.001) |
| [12] MAN   |                              |                      | 0.062***<br>(0.002)  | 0.059***<br>(0.002)  |
| $\gamma$   |                              | 0.985***<br>(0.017)  | 1.400***<br>(0.040)  | 1.368***<br>(0.040)  |
| $\alpha$   | -0.498***<br>(0.007)         | -0.499***<br>(0.007) | -0.790***<br>(0.007) | -0.791***<br>(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.

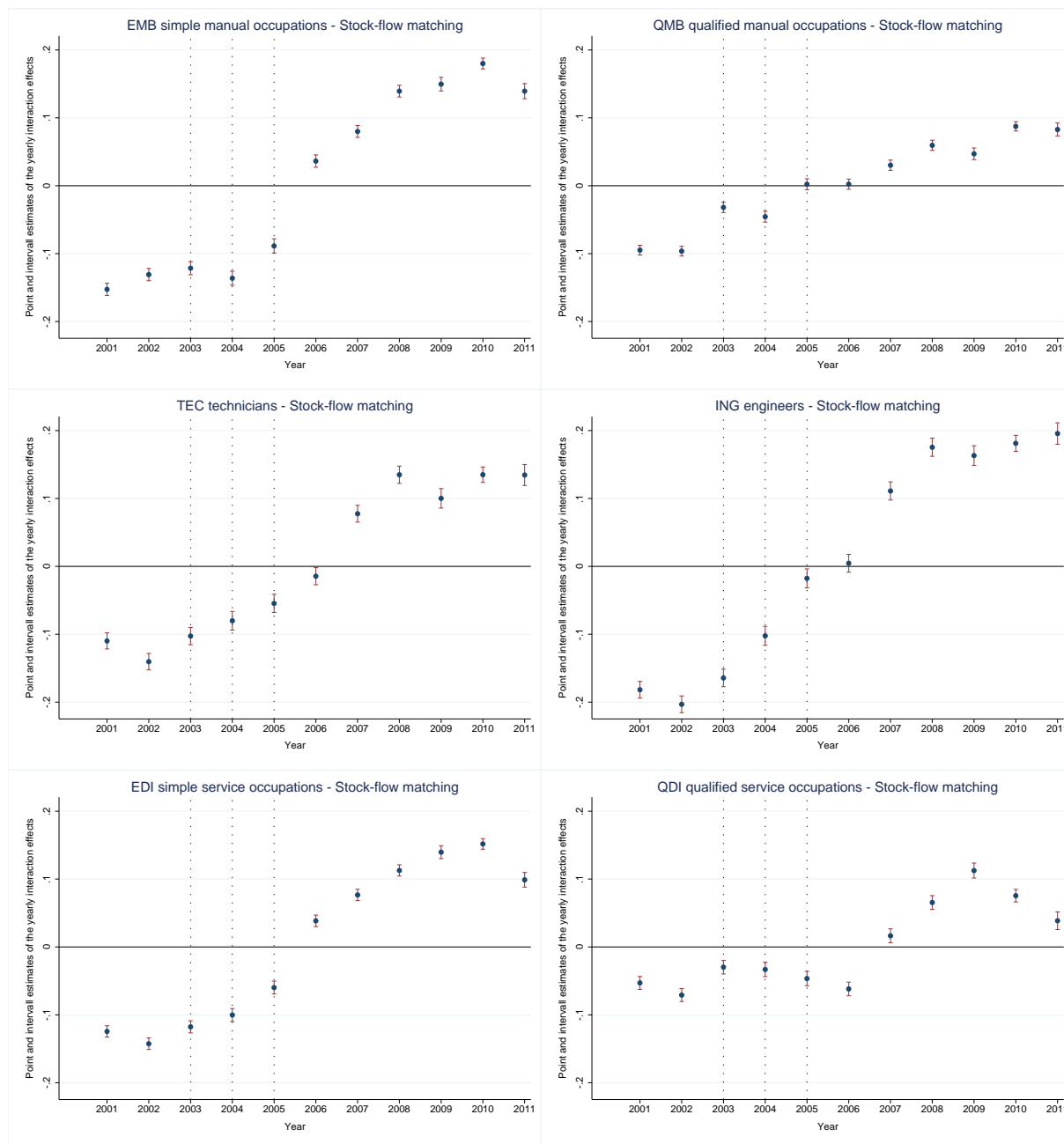


Figure 7: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 1/2).

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.

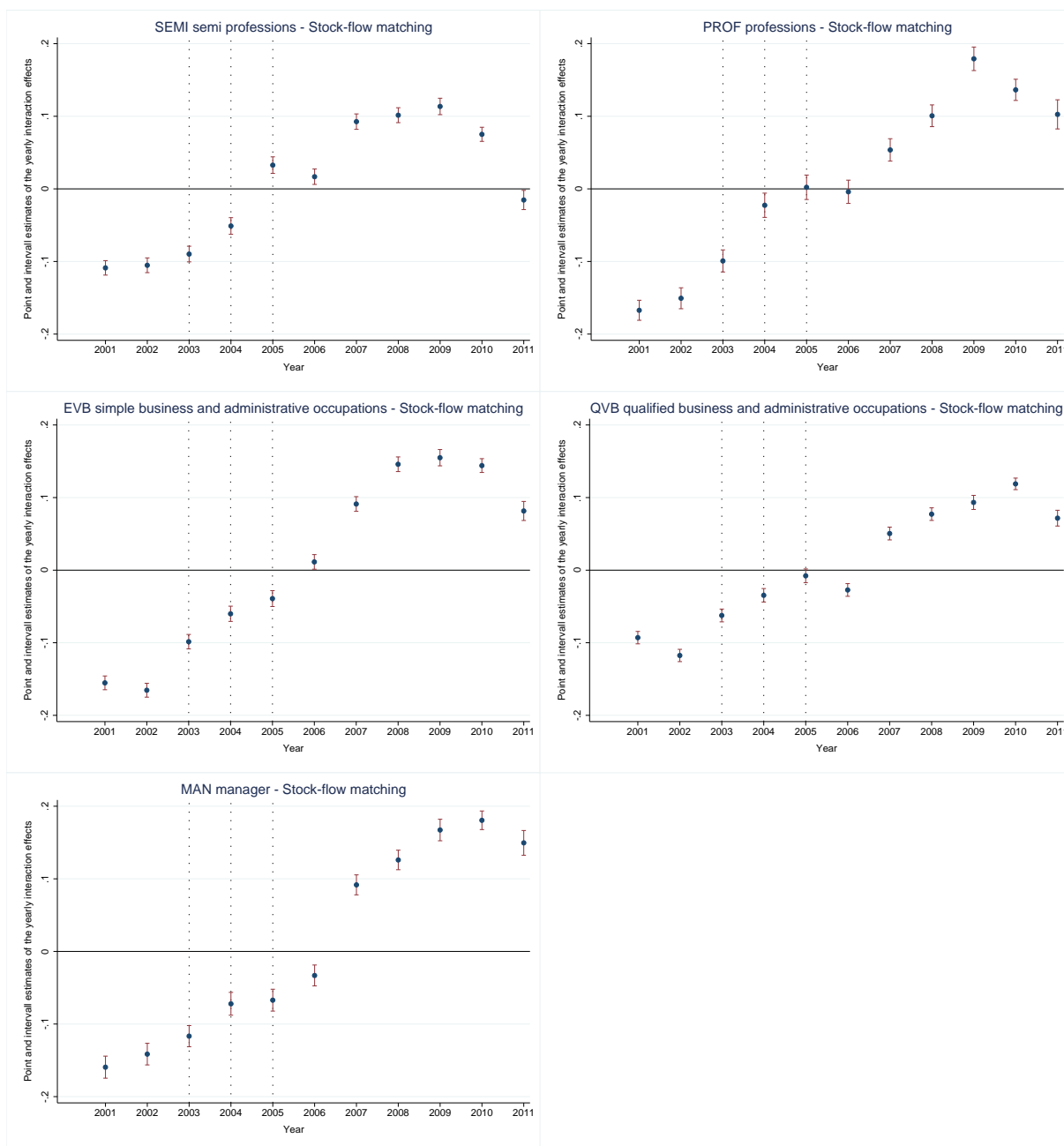


Figure 8: Estimated sums of the yearly dummy and the yearly interaction effects and 95 per cent confidence band by occupational categories (part 2/2).

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 (*KI dB 88*)

| KI dB 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

| <b>KIdB 88 - occupational orders</b> |             |   |
|--------------------------------------|-------------|---|
| <b>Occupational category</b>         | <b>Code</b> | <b>Title</b>  |
|                                      | 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         | Enamellers, 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, twistors, 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                      |

continued on the next page

| <b>KIDB 88 - occupational orders</b> |             |  |
|--------------------------------------|-------------|--|
| <b>Occupational category</b>         | <b>Code</b> | <b>Title</b>   |
|                                      | 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   |

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| <b>KIDB 88 - occupational orders</b> |             |  |
|--------------------------------------|-------------|--|
| <b>Occupational category</b>         | <b>Code</b> | <b>Title</b>   |
|                                      | 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 |

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| <b>KIdB 88 - occupational orders</b> |             |   |
|--------------------------------------|-------------|---|
| <b>Occupational category</b>         | <b>Code</b> | <b>Title</b>  |
|                                      | 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

| <b>KIdB 88 - occupational orders</b> |             |  |
|--------------------------------------|-------------|--|
| <b>Occupational category</b>         | <b>Code</b> | <b>Title</b>   |
|                                      | 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<br>other natural scientists, otherwise undisclosed |
| [06] EDI simple                      | 685         | Chemist's assistants in pharmacies   |
| service occupations                  | 686         | Filling station attendants   |
|                                      | 706         | Cashiers, ticket agents, Debt- and vending-machine money collectors and<br>ticket inspectors   |
|                                      | 713         | Other brake, signal and switch operators, transport guides and<br>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<br>similar constructions      |
|                                      | 723         | Seagoing ships' deck crews   |
|                                      | 724         | Inland boatmen and related ships' decks crews  |
|                                      | 725         | Ferryman, 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,<br>mountain guides and models         |
|                                      | 911         | Hoteliers, innkeepers, restaurateurs and management assistants in<br>hotels and restaurants    |
|                                      | 912         | Waiters, waitresses, stewards, stewardesses and busepersons                                    |
|                                      | 913         | Porters, bartenders and other hotel and restaurant attendants                                  |
|                                      | 923         | Valets, chambermaids and other housekeeping attendants   |

continued on the next page

| <b>KIdB 88 - occupational orders</b>   |             |   |
|--|-------------|---|
| <b>Occupational category</b>           | <b>Code</b> | <b>Title</b>  |
|  | 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

| <b>KIdB 88 - occupational orders</b>    |  |   |
|---|--|---|
| <b>Occupational category</b>            | <b>Code</b>  | <b>Title</b>  |
| professions                             | 822  | Interpreters, translators   |
|   | 823  | Librarians, archivists, documentalists, curators, library and filing clerks                   |
|   | 853  | Nurses, midwives, 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                         | 682  | Shop, stall and market salespersons and demonstrators   |
| business and administrative occupations | 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                      | 31   | Agricultural production manager   |
| business and administrative occupations | 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   |

continued on the next page

| KIDB 88 - occupational orders |      |  |
|-------------------------------|------|--|
| Occupational category         | 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  $y = [2001, \dots, 2011]$  with reference year 2000 is coded as follows:

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

The occupational labour market dummy variables  $d_b$  with  $b = [2, \dots, 12]$  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  $b = [2, \dots, 12]$  is coded as follows:

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

### 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                 |
| $\beta_{Us}$   | 0.514***<br>(0.003)          | 0.623***<br>(0.003)  | 0.624***<br>(0.003)  | 0.453***<br>(0.003)  | 0.563***<br>(0.003)  | 0.582***<br>(0.003)  |
| $\beta_{Uf}$   |                              |                      |                      | 0.085***<br>(0.002)  | 0.071***<br>(0.001)  | 0.049***<br>(0.001)  |
| $\beta_{Vs}$   | 0.060***<br>(0.001)          | 0.040***<br>(0.001)  | 0.044***<br>(0.001)  | 0.041***<br>(0.001)  | 0.021***<br>(0.001)  | 0.023***<br>(0.001)  |
| $\beta_{Vf}$   |                              |                      |                      | 0.029***<br>(0.001)  | 0.030***<br>(0.001)  | 0.034***<br>(0.001)  |
| <i>Year dummies, effect coded (reference: 2000):</i> |                              |                      |                      |                      |                      |                      |
| $d_{2001}$   |                              |                      | -0.100***<br>(0.001) |                      |                      | -0.101***<br>(0.001) |
| $d_{2002}$   |                              |                      | -0.146***<br>(0.001) |                      |                      | -0.139***<br>(0.001) |
| $d_{2003}$   |                              |                      | -0.135***<br>(0.001) |                      |                      | -0.129***<br>(0.001) |
| $d_{2004}$   |                              |                      | -0.123***<br>(0.001) |                      |                      | -0.121***<br>(0.001) |
| $d_{2005}$   |                              |                      | -0.103***<br>(0.002) |                      |                      | -0.096***<br>(0.002) |
| $d_{2006}$   |                              |                      | -0.023***<br>(0.001) |                      |                      | -0.016***<br>(0.001) |
| $d_{2007}$   |                              |                      | 0.099***<br>(0.001)  |                      |                      | 0.102***<br>(0.001)  |
| $d_{2008}$   |                              |                      | 0.174***<br>(0.002)  |                      |                      | 0.169***<br>(0.002)  |
| $d_{2009}$   |                              |                      | 0.089***<br>(0.001)  |                      |                      | 0.083***<br>(0.001)  |
| $d_{2010}$   |                              |                      | 0.165***<br>(0.001)  |                      |                      | 0.155***<br>(0.001)  |
| $d_{2011}$   |                              |                      | 0.162***<br>(0.002)  |                      |                      | 0.155***<br>(0.002)  |
| a  | -0.428***<br>(0.013)         | -0.970***<br>(0.014) | -0.912***<br>(0.012) | -0.381***<br>(0.012) | -0.888***<br>(0.014) | -0.861***<br>(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.

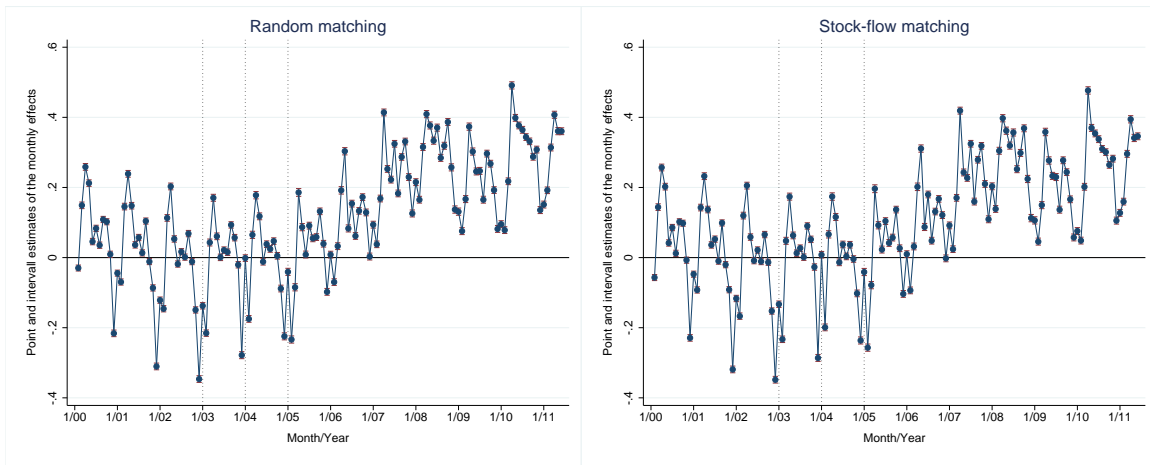


Figure 9: Monthly time fixed effects and 95 per cent confidence band.

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).

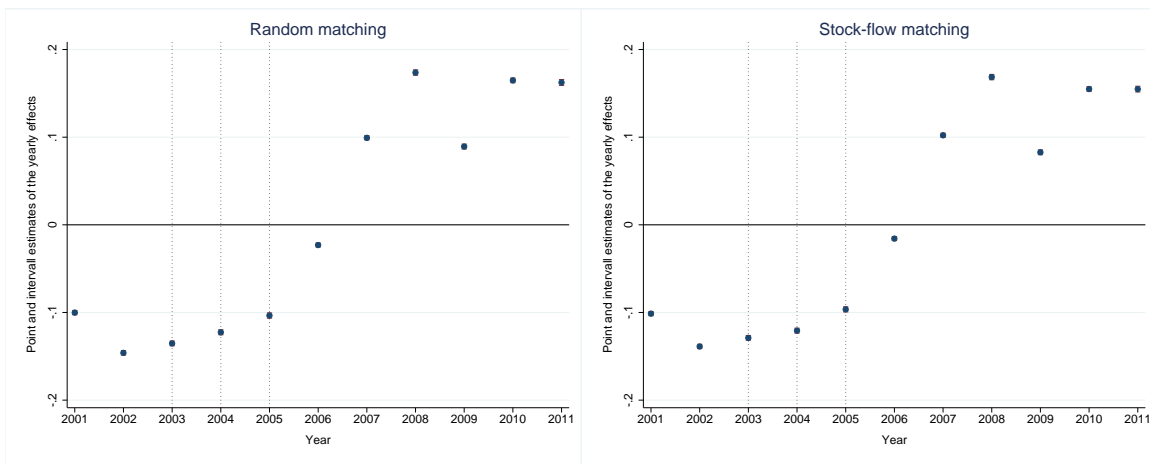


Figure 10: Yearly time fixed effects and 95 per cent confidence band.

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                 |
| $\beta_{Us}$   | 0.469***<br>(0.016)         | 0.469***<br>(0.016) | 0.618***<br>(0.021) | 0.690***<br>(0.024)  | 0.476***<br>(0.019)  | 0.476***<br>(0.019)  | 0.527***<br>(0.024) | 0.745***<br>(0.029)  |
| $\beta_{Vs}$   | 0.123***<br>(0.009)         | 0.123***<br>(0.009) | 0.061***<br>(0.007) | 0.110***<br>(0.008)  | 0.074***<br>(0.012)  | 0.076***<br>(0.012)  | 0.026***<br>(0.008) | 0.031***<br>(0.009)  |
| $\beta_{Uf}$   |                             |                     |                     |                      | -0.056***<br>(0.015) | -0.058***<br>(0.016) | 0.151***<br>(0.016) | -0.109***<br>(0.014) |
| $\beta_{Vf}$   |                             |                     |                     |                      | 0.062***<br>(0.009)  | 0.063***<br>(0.009)  | 0.075***<br>(0.006) | 0.141***<br>(0.007)  |
| <i>Year dummies, effect coded (reference: 2000):</i> |                             |                     |                     |                      |                      |                      |                     |                      |
| $d_{2001}$   |                             |                     |                     | -0.143***<br>(0.005) |                      |                      |                     | -0.195***<br>(0.005) |
| $d_{2002}$   |                             |                     |                     | -0.165***<br>(0.005) |                      |                      |                     | -0.171***<br>(0.005) |
| $d_{2003}$   |                             |                     |                     | -0.099***<br>(0.006) |                      |                      |                     | -0.096***<br>(0.006) |
| $d_{2004}$   |                             |                     |                     | -0.066***<br>(0.006) |                      |                      |                     | -0.057***<br>(0.006) |
| $d_{2005}$   |                             |                     |                     | -0.025***<br>(0.007) |                      |                      |                     | -0.021***<br>(0.007) |
| $d_{2006}$   |                             |                     |                     | -0.003<br>(0.005)    |                      |                      |                     | -0.007<br>(0.006)    |
| $d_{2007}$   |                             |                     |                     | 0.066***<br>(0.005)  |                      |                      |                     | 0.065***<br>(0.005)  |
| $d_{2008}$   |                             |                     |                     | 0.133***<br>(0.007)  |                      |                      |                     | 0.149***<br>(0.007)  |
| $d_{2009}$   |                             |                     |                     | 0.122***<br>(0.009)  |                      |                      |                     | 0.177***<br>(0.010)  |
| $d_{2010}$   |                             |                     |                     | 0.172***<br>(0.006)  |                      |                      |                     | 0.201***<br>(0.007)  |
| $d_{2011}$   |                             |                     |                     | 0.097***<br>(0.008)  |                      |                      |                     | 0.114***<br>(0.009)  |
| $\gamma$   |                             | 0.014<br>(0.066)    | 0.895***<br>(0.156) | 0.921***<br>(0.162)  |                      | -0.203***<br>(0.077) | 1.121***<br>(0.139) | 1.266***<br>(0.162)  |
| $a$  | 1.285***<br>(0.182)         | 1.285***<br>(0.183) | 0.181<br>(0.207)    | -0.685***<br>(0.228) | 1.568***<br>(0.169)  | 1.568***<br>(0.169)  | -0.302<br>(0.196)   | -0.701***<br>(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.



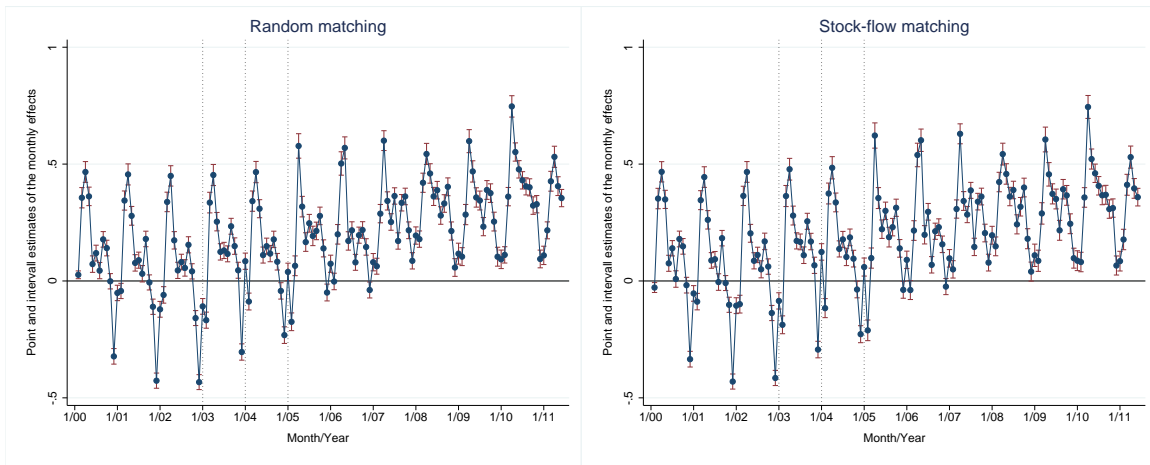


Figure 11: Monthly time fixed effects and 95 per cent confidence band.

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).

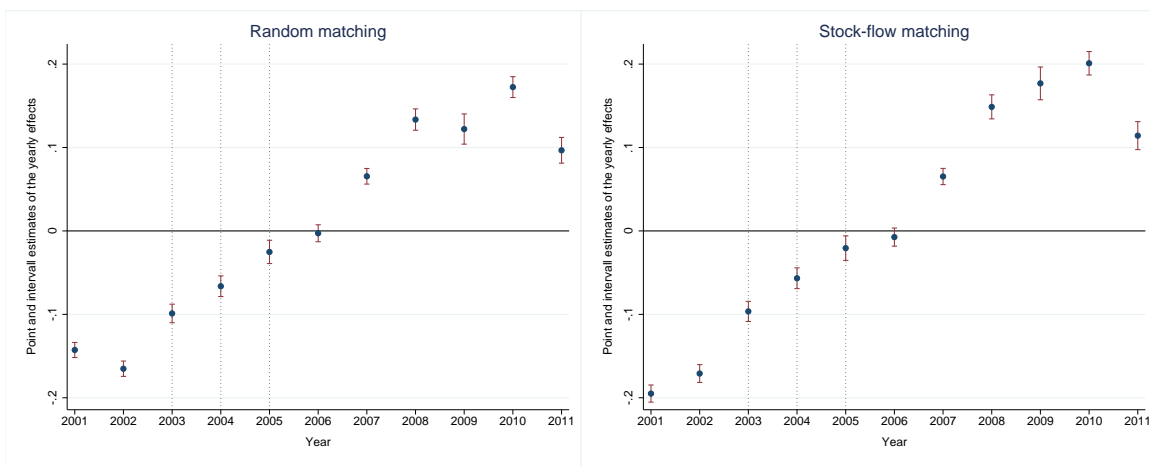


Figure 12: Yearly time fixed effects and 95 per cent confidence band.

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.

| VARIABLES  | Dependent variable: log $M$ |                      |                      |                      |                      |                      |                      |                      |
|--|-----------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|  | FE 1                        | FE 2                 | FE 3                 | FE 4                 | FE 5                 | FE 6                 | FE 7                 | FE 8                 |
| $\beta_{Us}$   | 0.640***<br>(0.017)         | 0.645***<br>(0.017)  | 0.927***<br>(0.018)  | 0.928***<br>(0.018)  | 0.507***<br>(0.028)  | 0.505***<br>(0.028)  | 0.832***<br>(0.043)  | 0.940***<br>(0.039)  |
| $\beta_{Uf}$   |                             |                      |                      |                      | 0.174***<br>(0.038)  | 0.188***<br>(0.039)  | 0.091**<br>(0.042)   | -0.029<br>(0.037)    |
| $\beta_{Vs}$   | 0.138***<br>(0.011)         | 0.132***<br>(0.011)  | 0.087***<br>(0.008)  | 0.098***<br>(0.008)  | 0.092***<br>(0.013)  | 0.085***<br>(0.013)  | 0.031***<br>(0.010)  | 0.035***<br>(0.010)  |
| $\beta_{Vf}$   |                             |                      |                      |                      | 0.052***<br>(0.013)  | 0.048***<br>(0.013)  | 0.071***<br>(0.010)  | 0.083***<br>(0.010)  |
| <i>Year dummies, effect coded (reference: 2000):</i> |                             |                      |                      |                      |                      |                      |                      |                      |
| $d_{2001}$   |                             |                      |                      | -0.260***<br>(0.009) |                      |                      |                      | -0.281***<br>(0.012) |
| $d_{2002}$   |                             |                      |                      | -0.282***<br>(0.008) |                      |                      |                      | -0.282***<br>(0.010) |
| $d_{2003}$   |                             |                      |                      | -0.209***<br>(0.009) |                      |                      |                      | -0.214***<br>(0.011) |
| $d_{2004}$   |                             |                      |                      | -0.141***<br>(0.009) |                      |                      |                      | -0.149***<br>(0.009) |
| $d_{2005}$   |                             |                      |                      | -0.075***<br>(0.009) |                      |                      |                      | -0.084***<br>(0.011) |
| $d_{2006}$   |                             |                      |                      | -0.043***<br>(0.006) |                      |                      |                      | -0.042***<br>(0.007) |
| $d_{2007}$   |                             |                      |                      | 0.113***<br>(0.008)  |                      |                      |                      | 0.126***<br>(0.009)  |
| $d_{2008}$   |                             |                      |                      | 0.237***<br>(0.010)  |                      |                      |                      | 0.254***<br>(0.014)  |
| $d_{2009}$   |                             |                      |                      | 0.279***<br>(0.011)  |                      |                      |                      | 0.292***<br>(0.015)  |
| $d_{2010}$   |                             |                      |                      | 0.320***<br>(0.010)  |                      |                      |                      | 0.330***<br>(0.014)  |
| $d_{2011}$   |                             |                      |                      | 0.248***<br>(0.014)  |                      |                      |                      | 0.265***<br>(0.017)  |
| $d_{q1}$   |                             |                      |                      | 0.361***<br>(0.028)  |                      |                      |                      | 0.352***<br>(0.024)  |
| $d_{q2}$   |                             |                      |                      | 0.224***<br>(0.016)  |                      |                      |                      | 0.215***<br>(0.012)  |
| $d_{q3}$   |                             |                      |                      | 0.114***<br>(0.007)  |                      |                      |                      | 0.113***<br>(0.007)  |
| $\gamma$   |                             | 0.717***<br>(0.146)  |                      | 1.800***<br>(0.180)  |                      | 1.042***<br>(0.175)  |                      | 1.624***<br>(0.177)  |
| $a$  | -0.596***<br>(0.158)        | -0.595***<br>(0.159) | -2.874***<br>(0.148) | -2.723***<br>(0.139) | -0.590***<br>(0.145) | -0.603***<br>(0.145) | -2.696***<br>(0.162) | -2.684***<br>(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&lt;0.01, \*\* p&lt;0.05, \* p&lt;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.

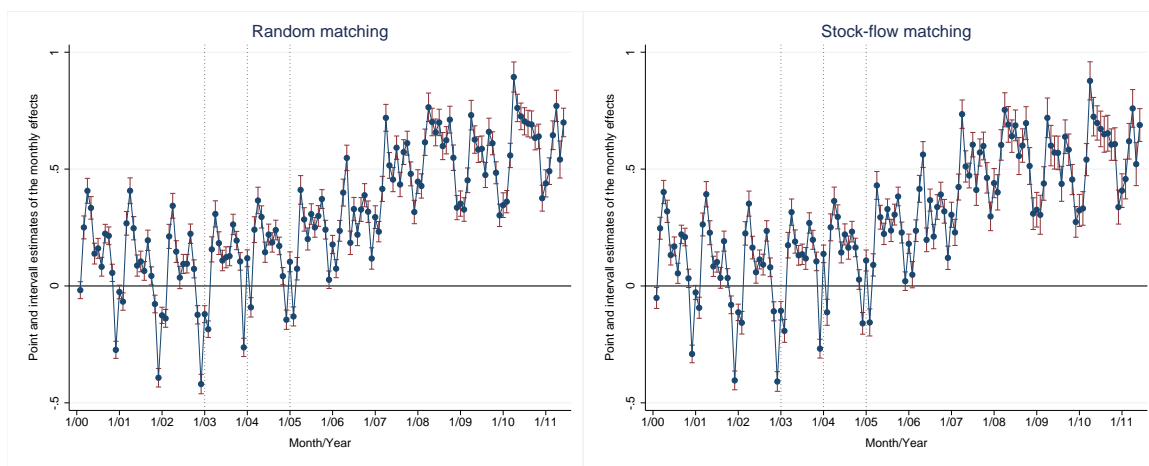


Figure 13: Monthly time fixed effects and 95 per cent confidence band.

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).

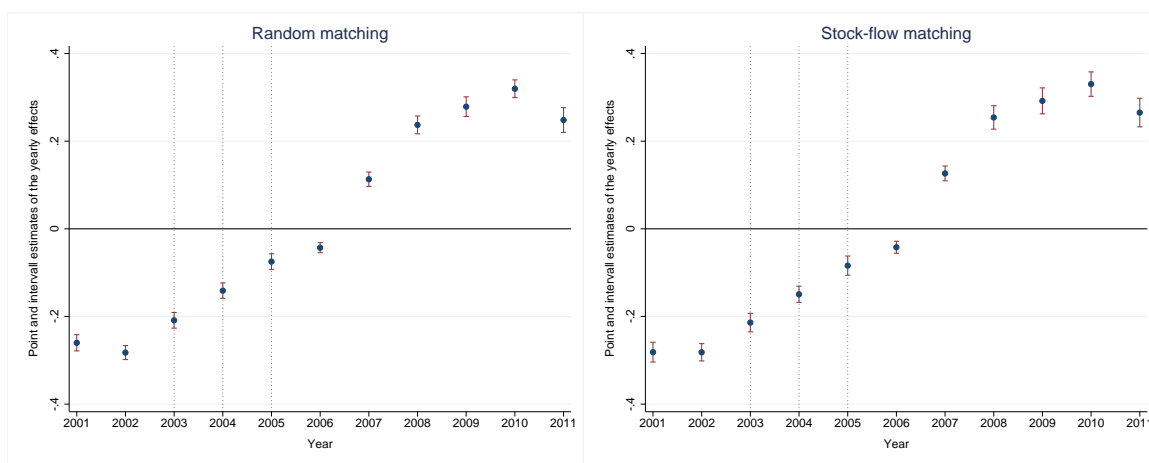


Figure 14: Yearly time fixed effects and 95 per cent confidence band.

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     | <b>0.140</b> | 0.075        | 0.103     | 0.017     | 0.047     | -0.049    |
| [3] QMB               | -0.029    | <b>0.067</b> | 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        | <b>0.124</b> | 0.093     | -0.029    | 0.025     | -0.007    |
| [5] ING               | -0.029    | 0.042        | 0.079        | 0.075     | 0.019        | <b>0.128</b> | 0.103     | 0.000     | 0.003     | 0.016     |
| [6] EDI               | -0.043    | 0.031        | 0.032        | 0.008     | <b>0.099</b> | 0.056        | 0.073     | 0.037     | 0.025     | -0.059    |
| [7] QDI               | -0.031    | 0.054        | 0.017        | -0.038    | -0.024       | <b>0.096</b> | 0.087     | 0.058     | -0.034    | -0.044    |
| [8] SEMI              | -0.011    | 0.031        | 0.063        | 0.073     | -0.024       | <b>0.087</b> | 0.043     | 0.018     | -0.038    | -0.101    |
| [9] PROF              | 0.004     | 0.064        | <b>0.098</b> | 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        | <b>0.099</b> | 0.096     | 0.018     | -0.010    | -0.066    |
| [11] QVB              | -0.046    | 0.052        | 0.051        | 0.012     | -0.013       | <b>0.101</b> | 0.071     | 0.022     | 0.020     | -0.053    |
| [12] MAN              | 0.010     | 0.019        | 0.064        | -0.001    | 0.039        | <b>0.149</b> | 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        | <b>0.125</b> | 0.044        | 0.059     | 0.010        | 0.030     | -0.041    |
| [3] QMB               | -0.002    | <b>0.064</b> | -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        | <b>0.092</b> | 0.057     | -0.035       | 0.035     | 0.000     |
| [5] ING               | -0.021    | 0.039        | 0.062     | 0.085        | 0.022        | <b>0.107</b> | 0.064     | -0.012       | 0.018     | 0.014     |
| [6] EDI               | -0.018    | 0.025        | 0.017     | 0.040        | <b>0.098</b> | 0.038        | 0.036     | 0.027        | 0.012     | -0.053    |
| [7] QDI               | -0.018    | 0.041        | -0.003    | -0.013       | -0.015       | <b>0.078</b> | 0.049     | 0.047        | -0.037    | -0.037    |
| [8] SEMI              | 0.004     | 0.015        | 0.039     | <b>0.084</b> | -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     | <b>0.079</b> | -0.043    | -0.034    |
| [10] EVB              | -0.010    | 0.067        | 0.038     | 0.021        | 0.051        | <b>0.080</b> | 0.055     | 0.009        | -0.011    | -0.063    |
| [11] QVB              | -0.025    | 0.055        | 0.028     | 0.027        | -0.019       | <b>0.078</b> | 0.027     | 0.016        | 0.026     | -0.047    |
| [12] MAN              | 0.018     | 0.025        | 0.045     | 0.005        | 0.034        | <b>0.125</b> | 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.

## References

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