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## The Quality-Weighted Matching Function: Did the German Labor Market Reforms Trade-Off Efficiency against Job Quality?

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# The Quality-Weighted Matching Function: Did the German Labor Market Reforms Trade-Off Efficiency against Job Quality?

We evaluate the quantity–quality trade-off on the labor market by estimating an augmented matching function weighting the matches by quality measures. We use the approach to evaluate the German labor market reforms conducted between 2003 and 2005. Indeed, we find a significant quantity–quality trade-off. However, even after controlling for job quality, a good half of the positive effect of the reforms on matching efficiency remains.

*JEL codes:* J11, E02, J65

*Keywords:* matching approach, quantity–quality trade-off, labor market reforms, Germany

WHILE MANY COUNTRIES HAVE SUFFERED from labor market slack following the financial crisis, unemployment in Germany has fallen considerably (see Figure 1 for the development of unemployment and vacancies). Many see in this context an important role of the Hartz reforms of 2003–05. However, re-

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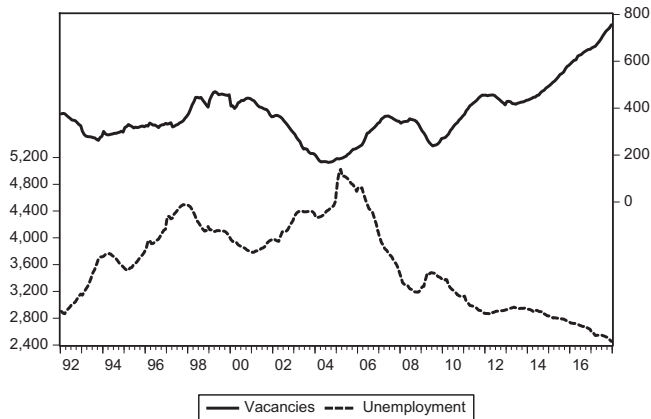


Fig 1. Unemployment and Vacancies in Thousands, 1992–2017.

NOTES: Federal Labour Office. Seasonally adjusted monthly data of registered unemployed and registered vacancies.

forms that boost employment may also increase wage pressure. Indeed, it has been intensely debated why German wage development remained moderate despite strong labor market performance (see, e.g., Klinger et al. 2019). One reason may be that the additional employment came at the cost of fueling a low-wage sector with unfavorable working conditions. This concerns not only phenomena such as weak wage development and rising wage inequality but also potentially decreasing job duration.

Several studies show that job finding rates and matching efficiency considerably increased following the reforms (e.g., Klinger and Weber 2016, Launov and Wälde 2016). In the underlying paper, we augment a typical matching function approach by a quality perspective, introducing the concept of the *quality-weighted matching function*, whereby we take the perspective of the workers welfare regarding the notion of quality, that is, we weight matches by their quality by including measures of wage, wage inequality, and job duration into a matching function.

The weights are determined empirically, thus reflecting the relevance of the different variables in a matching context. Then, we analyze to what extent the matching efficiency has still increased with the reforms, once controlling for the quality changes. Thus, we can address two key questions: Did the reforms lead to real improvements in the functioning of the labor market (e.g., by increasing institutional efficiency as in Launov and Wälde 2016)? Or has only the position in a trade-off between quantity and quality shifted?

While an increase in efficiency would have an expansionary effect on the labor market and the economy, a trade-off would retard macroeconomic development. If the reforms achieved the goal of integrating also low qualified and long-term unemployed job seekers into employment, this is likely to be accompanied by worsening quality measures, for example, the wage. We avoid blaming such effects on the reforms by correcting the quality indices for changes of individual worker characteristics using comprehensive micro data.

Our study contributes to the literature that considers negative side effects of reforms at the micro level, for example, van Ours and Vodopivec (2006), van den Berg and Vikström (2014), and Nekoei and Weber (2017). Many of these papers find a trade-off between the quantity and the quality of the jobs, where the quality is typically measured by wages or job stability.

However, estimates on microlevel may be biased. They rely on the assumption that the job finding probability of a treated person is not affected by the treatment of others. This ignores equilibrium effects. Yet, as Cahuc and Le Barbanchon (2010) point out, equilibrium effects are important for assessing the effects of reforms. For example, the increase of search effort of a treated worker will produce congestion externalities that may reduce the job finding probability of other workers. However, equilibrium effects may also work in the other direction: If the willingness to work rises, the search intensity of firms may increase or the selectivity may decrease (see Carrillo-Tudela, Gartner, and Leo 2020). We account for these effects by using aggregate measures of the reform effects.

Our paper also contributes to the literature that extends the matching function by wage measures. For example, Francesco (1999) and Saglam and Gunalp (2012) use time series and include the real wage. However, they use the average wage for all workers, not specifically for new hires. Moreover, they do not relate the results to a quantity–quality trade-off. Coles and Smith (1996) conduct a regional cross-section matching analysis. They include regional characteristics in their regressions, among them city-specific earnings for the stock of workers. Bouvet (2012) analyzes Beveridge curves for European countries and controls for wage-setting institutions and the composition of the labor force; however, without a discussion of the quantity–quality trade-off. Kohlbrecher, Merkl, and Nordmeier (2016) also extend the matching function. However, they focus on characteristics of the pool of the unemployment as controls, not on characteristics of the new matches such as match quality as we do. In a simulation exercise, but not within the matching function framework, they analyze the role of the wage distribution for labor market cyclicalities, while we focus on shifts in matching efficiency.

Furthermore, our study is also related to the macroeconomic literature on reform effects. Studies on the German labor market reforms in this strand are Krause and Uhlig (2012), Krebs and Scheffel (2013), and more recently Hartung, Jung, and Kuhn (2018) and Hochmuth et al. (2021). They work with calibrated models to evaluate the employment as well as wage effects of the reforms; however, they do not explicitly assess the quantity–quality trade-off.

Lise, Meghir, and Robin (2016) and Acemoglu and Shimer (2000) present models for the U.S. economy that take into account the quantity–quality trade-off. While these models help to understand possible mechanism of reform effects, they rely on strong model assumptions. Our approach estimates an augmented matching function and exploits the variation of time series that are constructed with detailed micro-data information. Thus, the contribution of our study lies in evaluating the overall quantity–quality trade-off from a macro perspective, proposing a labor market matching approach.

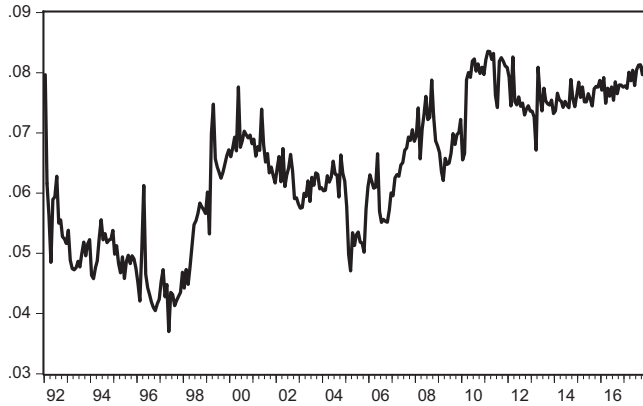


Fig 2. Job Finding Rate, 1992–2017.

NOTES: IAB Employment Biographies. Own calculations. Seasonally adjusted monthly data. The job finding rate is the number of matches per month referred to the unemployment of the previous month.

## 1. DATA

To calculate worker flows and stocks on the individual level, we use a 2% random sample of the Integrated Employment Biographies (IEB), provided by the German Institute for Employment Research (IAB). IEB data are also used, for example, by Rahn and Weber (2019) to calculate the dynamics of job findings or by Schmieder, von Wachter, and Bender (2012) to analyze effects of a change of unemployment benefit duration on employment. The data cover the universe of employees subject to social security and registered unemployed workers from 1980 to 2017 (for further details, see the Online Appendix and Antoni, Ganzer, and vom Berge 2016). We observe the number of spells of registered unemployment  $u_t$  and employment  $e_t$  as well as flows between both states until December 2017. Transitions from  $u$  to  $e$  count as match  $m_t$ . The job finding rate is calculated as  $jfr_t = m_t / u_{t-1}$  (see Figure 2).

As noted above, quality is typically measured by wages and job stability (see Giannelli, Jaenichen, and Rothe 2016, Nekoei and Weber 2017). Both dimensions are available in our data set. We calculate median daily wages and the lowest decile of wages in a new full-time job after unemployment. Part-time workers are excluded in the analysis of wages, because our data do not contain information on hours worked. The wages are deflated by the consumer price index. While 0.64% of wages are right-censored at the threshold for social security contributions, this is unproblematic for lower percentile wages. We use the median entry wages  $w_t$  as a measure for match quality. In addition, we consider the ratio of the lower decile wage to the median wage as a measure of wage equality  $equal_t$  in the lower half of the wage distribution. Thus, we can investigate empirically in how far the dimensions of the wage level and wage inequality play a role. The log-wage difference  $wdif_t$  between the jobs before

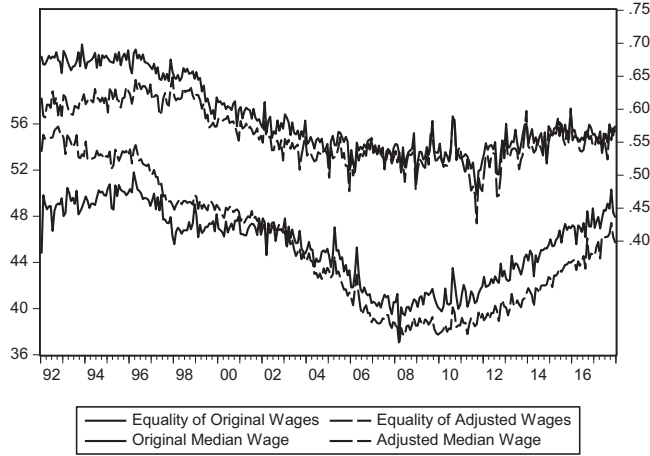


Fig 3. Median Wage and Wage Equality, 1992–2017.

NOTES: IAB Employment Biographies. Own calculations. Seasonally adjusted monthly data. Median (left scale) of the daily wages. The equality measure (right scale) is the ratio of the lowest decile wage to the median wage.

and after a given unemployment spell is used as a further measure. For job stability  $s_t$ , we calculate the share of newly started full- and part-time jobs with a duration of 1 year or more. The median wage and the wage equality are the measures used later in the final regression and are shown in Figure 3. Quality reductions over the period after the Hartz reforms, but also before, are evident.

## 2. ECONOMIC CONCEPT

A typical labor market matching function of Cobb–Douglas type (see Pissarides 2000) is given by

$$m_t = \mu + au_{t-1} + bv_{t-1} + \epsilon_t, \quad (1)$$

where  $m$  is the number of matches,  $u$  the number of unemployed,  $v$  the number of vacancies, and  $\epsilon$  the error term (variables in lower case letters are in logs). Thus, (1) mirrors a production function with matching efficiency  $\mu$  as the equivalent of total factor productivity. We estimate the model for the period 1992–2017 with monthly seasonally adjusted data. Thereby, to measure matching efficiency independent of composition effects, we control for the structure of the pool of unemployed (as Kohlbrecher, Merkl, and Nordmeier 2016 or Gehrke and Weber 2018) by including the shares of low-skilled, of young ( $< 25$  years), old ( $> 55$  years), female, and foreigner workers among the unemployed workers. The data are taken on a monthly

basis from the official statistics of the Federal Employment Agency and are available on request.

As Fahr and Sunde (2009) or Klinger and Rothe (2012), we include shift dummies at the beginning of 2003–05 taking into account the three stages of the Hartz reforms. These dummies capture changes in matching efficiency at the time of the reforms.

We extend this matching function approach by weighting the matches in period  $t$   $M_t$  by their quality  $Q_t$ , that is,  $M_t^* = M_t Q_t$ . Thereby,  $M_t \cdot Q_t$  becomes a sum in the log version and we use asterisks for the new coefficients:

$$m_t + q_t = \mu^* + au_{t-1} + bv_{t-1} + \epsilon_t^*. \quad (2)$$

We represent  $q_t$  by measures of job quality. To be more specific,  $q_t$  is a log-linear combination of a set of quality measures  $q_{it}$ :  $q_t = \beta_1 q_{1t} + \dots + \beta_n q_{nt}$ . For estimating sensible weights  $\beta_i$  for these measures, in (2), we bring  $q_t$  to the right-hand side, resulting in an augmented matching function with the quality measures as controls. We empirically determine the weights in a regression that chooses the weights such that the explanatory power for the matches is maximized. Logically, we can determine the effects of the reform dummies once quality changes are controlled for.

These quality variables are likely to play a role for matching efficiency due to the behavior of both market sides: On the one hand, employers—facing a lower wage—might become less demanding and selective; compare Sedláček (2014) or Hochmuth et al. (2021) for the connection of firms' hiring standards and matching efficiency. On the other hand, the quality variables can be seen as indicators for jobseekers' willingness to compromise, as in Acemoglu and Shimer (2000). According to Lise, Meghir, and Robin (2016) and Acemoglu and Shimer (2000), a lower match quality may induce fewer vacancies and thus a lower job finding rate. Our matching efficiency measure is conditioned on the vacancies. Thus, they rule out this indirect channel in order to focus on the direct channel.

We experimented with several quality measures  $q_{it}$ : The median wage of new jobs, the ratio of the lowest wage percentile to the median as an inequality measure, the wage difference of the jobs before and after unemployment, and as stability measures the duration of the new jobs and the share of jobs that exist for more than a year.

All these quality measures might be influenced by characteristics such as gender, age, nationality, education, work experience, and regional factors. The composition of these characteristics changes over time, partly as an effect of the reform. The effect of compositional changes on the wage structure is, for example, analyzed by Bossler and Schank (2022). However, we ask whether the job quality is lower for given personal characteristics. Therefore, we calculate the quality indices under the condition of a constant composition of the hired workers. As we take the perspective from the workers' side, we did not control for firm characteristics.

Accordingly, we apply a standard Mincer log-wage regression with a sample of all new matches over the whole period. The regressors are dummies for gender, nationality (German or other), working in east Germany, three categories of educational level (no vocational training, with vocational training/university entrance certificate,

college degree or higher) and the continuous variables age, potential experience (both in linear and quadratic terms), and the duration of unemployment before the match. Furthermore, we include a fixed period effect for each month. The index is then calculated as the predicted mean wage that includes the fixed time effects but maintains the controls on their average values. The same applies for the match duration and the log wage difference referred to the previous job. The wage inequality index is defined as relation of the 10th–50th percentile of the predicted wages.

### 3. RESULTS AND DISCUSSION

The baseline matching function (1) including reform dummies estimated by least squares results as:

$$\hat{jfr}_t = 0.17 - 0.38u_{t-1} + 0.50v_{t-1} + 0.004d03_t + 0.14d04_t + 0.10d05_t + controls$$

(1.09)      (0.05)      (0.05)      (0.04)      (0.04)      (0.04)

with  $R^2 = 0.827$ . In sum, the reform dummies ( $d03_t$ ,  $d04_t$  and  $d05_t$ ) stand for an increase in matching efficiency of 24%. We use a general-to-specific approach for selecting the quality variables  $q_{it}$ . It turns out that job stability and the wage difference of the jobs before and after unemployment are quality dimensions that do not affect the number of matches significantly. Taking into account for the remaining quality measures wages and wage-equality, we get the extended estimation:<sup>1</sup>

$$\hat{jfr}_t = 1.07 - 0.42u_{t-1} + 0.43v_{t-1} + 0.01d03_t + 0.11d04_t + 0.01d05_t$$

(0.38)      (0.05)      (0.05)      (0.04)      (0.04)      (0.05)

$$-0.47w_t - 0.34equal_t + controls.$$

(0.19)      (0.13)

First, we check the relevance of the additional quality variables. A likelihood ratio test of the null that the coefficients of both  $w_t$  and  $equal_t$  are 0 leads to a highly significant test statistic of 16.5. Both a high wage level and a more equal wage distribution—controlled for personal characteristics at the micro level—have significantly negative coefficients indicating a trade-off between job quality and the job finding rate. We conducted several robustness checks, among others to account for unobserved worker heterogeneity. The results are robust and can be found in the Online Appendix.

The coefficients are to be read as elasticities. To compare our wage elasticity of  $-0.47$  with the literature, we draw on the simulation exercise by Acemoglu and Shimer (2000) on the effect of a longer duration of the unemployment benefits compared to their benchmark. It lowers the job finding rate from  $1/13.5$  to  $1/14$  by 3.6% and rises the wage from 1.155 to 1.171 by 0.7%. This results in an elasticity of  $-0.2$ . Based on micro data, Nekoei and Weber (2017) analyze the reform effect for Austria.

1. Note that the values of the constant are not comparable between the equations due to the different variable set.



They find that the benefit extension raises the wage by 0.5% and lowers the job finding rate from 1/100 to 1/102 by 2%. The implied elasticity is  $-0.25$ . This means that our estimate is of a similar magnitude. However, according to our results, a drop in the wage for new hires is associated with a stronger boost of new matches than found in previous studies.

Besides country differences, an explanation may be that firms' search intensity or their selectivity margin plays a role. Note also that these studies exclusively consider unemployment insurance reforms, while we have a broader perspective and do not rely on any assumption that the quality changes are exclusively caused by a specific reform. Thus, our approach can also capture institutional complementarities. As several institutional changes often happen at the same time, a total effect may be larger than the sum of several single effects (Coe and Snower 1997). Instead of evaluating a specific institution, we focus on which reform effects on matching efficiency are measured with and without consideration of the quality variables.

It turns out that controlling for the quality variables clearly reduces the measured Hartz effect: The sum of the reform dummies shrinks to 13%. In a Wald test, this sum differs significantly from the sum in the baseline model above. Especially the effect in 2005 vanishes nearly. In this year, Hartz IV, the reform of unemployment assistance and welfare benefits, was implemented.

This part of the reform was especially controversial and has been blamed for exerting pressure on job seekers. Indeed, following our results, in this regard, the Hartz reforms came along with trading off quantity against quality. However, the reforms as a whole also led to real improvements in the functioning of the labor market, which represent a good half of the overall effect on matching efficiency.

#### 4. CONCLUSION

We evaluated whether the speed-up of matching after the German labor market reforms was paid with a poorer quality of the new jobs. To estimate this possible quantity–quality trade-off, we introduce an augmented matching function where the matches are weighted by quality measures. Using rich micro data for the labor market, we correct the quality measures for shifts in the composition of the newly matched worker. Even if we control for job quality, the reforms have still increased the matching efficiency. However, nearly half of the overall effect on matching efficiency turns out to be due to a quantity–quality trade-off. While the increased efficiency has fostered aggregate economic development, the trade-off may be seen as a drag. Indeed, for example, Hutter and Weber (2022) found that rising wage inequality impaired productivity growth.

Enabling such assessments is a major merit of the concept of the quality-weighted matching function. Future research could explore additional fields of application and further develop the definition and measurement of match quality.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table I: Robustness Checks 1 (Standard Errors in Parentheses)

Table II: Robustness Checks 2 (Standard Errors in Parentheses)