Labor market institutions and worker flows: Comparing Germany and the U.S.

Philip Jung and Moritz Kuhn*

First version: July 16, 2009

Current version: August 8, 2013

Abstract

We compare labor market flows in the United States and Germany between 1980 and 2004. In Germany, average worker flows in and out of unemployment are substantially lower; outflows are equally volatile in both countries; inflows are about twice as volatile in Germany and contribute more to the unemployment rate volatility. We explore four candidates for these differences: unemployment benefits, union bargaining power, employment protection, and the efficiency of matching unemployed workers to open positions. We find that a lower matching efficiency in Germany can explain the bulk of the cross-country differences. It amplifies the business cycle and adds persistence.

JEL: E02, E24, E32

Keywords: Business Cycle Fluctuations, Labor Market Institutions, Unemployment, Endogenous Separation

*Jung: Department of Economics, University of Bonn, Adenauerallee 24-42, 53113 Bonn, Germany, phjung@uni-bonn.de and Institute for the Study of Labor (IZA), Bonn, Germany. Kuhn: Department of Economics, University of Bonn, Adenauerallee 24-42, 53113 Bonn, Germany, mokuhn@uni-bonn.de and Institute for the Study of Labor (IZA), Bonn, Germany. We are grateful for comments received from Klaus Adam, Almut Balleer, Christian Bayer, Michael Burda, Georg Duernecker, Shigeru Fujita, Wouter den Haan, Tom Krebs, Alexander Ludwig, Iourii Manovskii, Christian Merkl, Petr Sedláček, Michèle Tertilt, Thijs van Rens and the participants at the ZEW Conference, the CESIfo conference on Macroeconomics and Survey data, the SED, the Cologne Macro Workshop, the ECB Joint Lunchtime Seminar, and seminar participants in Cologne, Frankfurt, Mannheim and at the IAB in Nuernberg. We are particularly grateful to Markus Gangl and Iourii Manovskii for providing us with data on occupational mobility and Nils Drews and Susanne Steffes for their comments and support in dealing with the IAB data. Jung gratefully acknowledges the Collaborative Research Center SFB - 884 for financial support.

1 Introduction

A large body of literature studies the differences in average unemployment rates between Europe and the United States. Differences in the cyclical behavior of labor market flows across countries have been recently documented as well (see Elsby, Hobijn, and Sahin (2010b) and the survey by Pissarides (2009)). Still, little is known about the underlying causes for these cross-country differences.

In this paper, we compare Germany's labor market to the United States counterpart. Using German micro data for the period from 1980 to 2004, we document four stylized facts about labor market flows: first, the German outflow rate from unemployment to employment (UE rate) is lower by a factor of 5 than the one documented for the U.S. (Shimer (2007)); the inflow rate from employment to unemployment (EU rate) is lower by a factor of 4. Second, (log) UE rates are equally volatile in Germany and the U.S. Third, the (log) EU rate is 2.3 times more volatile in Germany. Fourth, EU flows are the dominant source of German unemployment rate fluctuations accounting for $60-70\%$ of volatility, whereas in the U.S., they account for only $30-40\%$.

Next, we look for an explanation of these differences. We study a standard search and matching model with endogenous separations similar to den Haan, Ramey, and Watson (2000). We explore four candidate explanations for the observed labor market differences, namely, differences in unemployment benefits, union bargaining power, employment protection, and the technological microstructure in matching unemployed workers to open positions (matching efficiency). To do so, we derive analytical expressions for the elasticities with respect to changes in the institutional parameters of both the steady-state values and the volatilities of the transition rates. We find that differences in the matching efficiency can account for the bulk of the documented cross-country differences. Our explanation of a lower matching efficiency in Germany is also supported by the empirical evidence on occupational mobility rates that we discuss.

The argument as to why a lower matching efficiency is important in explaining the stylized facts works as follows: a lower matching efficiency reduces unemployment-to-employment transitions, increases the average search duration, and makes unemployment less attractive. As a result, the steady-state surplus of matches *increases*. This increase makes it less likely that an adverse idiosyncratic shock hitting a particular worker-firm match leads to a separation, meaning fewer transitions from employment to unemployment. This explains the steady-state differences across countries. A lower steady-state UE rate also explains the larger EU rate volatility in Germany. A longer search duration implies that unemployed workers are less affected by cyclical productivity changes because their chances of reemployment are smaller. On the contrary, already employed worker are directly affected. As a result, the worker surplus, the difference between the value of employment and unemployment, becomes more volatile. Because the EU rate is a function of the surplus, this mechanism links steady state UE rates and EU rate volatilities. The simultaneous increase in the steady-state surplus and the surplus volatility keeps the UE rate volatility largely unaffected. An unchanged UE and a higher EU rate volatility lead to an increase in the fraction of the unemployment volatility explained by the inflows rather than the outflows in Germany.

The simultaneous decline in the average UE rate and increase in the average surplus of the match sets this explanation apart from three prominent alternatives proposed in the literature to explain differences in average worker flows between the U.S. and Europe. One alternative argues that the lower UE and EU rates in Europe are caused by a combination of a more generous unemployment insurance system and stricter employment protection (Ljungqvist and Sargent, 2008). In our model, however, such an explanation would lower the average match surplus in Germany. As a result, the UE rate volatility would rise by more than the EU rate volatility. This is counterfactual. A second alternative argues for a stronger bargaining position of workers in Europe (Blanchard and Portugal, 2001). We show that an increase in bargaining power typically lowers the average surplus and thus the EU rate volatility. This is again counterfactual. As a third alternative, we study differences in layoff taxes (Bentolila, Cahuc, Dolado, and Barbanchon, 2010; Costain, Jimeno, and Thomas, 2010). Layoff taxes reduce the match surplus. Steady-state transition rates decrease, but the labor market becomes more sensitive to business cycle shocks. We show analytically that the UE rate volatility increases by more than the EU rate volatility, again making the outflows more important than the inflows in the decomposition of the unemployment rate volatility. This again violates the documented stylized facts.

We then show that our findings are important for the macroeconomy. In particular, in a calibrated version of the model, we show that a lower matching efficiency, which we conjecture is the case in Germany, results in a much stronger propagation of business cycle shocks. In our quantitative model an adverse shock hitting the U.S. economy leads to a peak in the unemployment rate after 3 quarters and levels off fairly quickly afterwards. In contrast, the German unemployment rate peaks 9 quarters after the initial shock. The pattern of a lower speed of the recovery process after a negative shock aligns well with the German experience in the 1980s.

Our empirical work adds to the growing literature that documents the 'ins and outs' of unemployment (Shimer (2007)) by providing a detailed account for Germany.[1] Our paper is, to the best of our knowledge, the first to provide a unified explanation for the cross-country differences in labor market flows as regards to both steady-state transition rates and cyclical volatilities.

The remainder of the paper is organized as follows: Section 2 documents labor market facts for Germany, section 3 develops the model, and section 4 presents the results and provides some evidence on matching inefficiencies in Germany. Section 5 concludes. A detailed description of the data and details of the unemployment decomposition can be found in the appendix.

2 Data

2.1 Data description

Our data set is the IAB employment panel, which comprises a 2% representative sample taken from the German social security and unemployment records for the period $1980 - 2004$. The sample contains employees covered by the compulsory German social security system and excludes self-employed and civil servants. It covers about 80% of Germany's labor force. Because the East German labor market was subject to additional regulations and restructuring after reunification, we exclude all persons with employment spells in East Germany from our sample. For the U.S., we take labor market transition rates based on the Current Population Survey (CPS) from Shimer (2007)

[1] A large literature examines worker flows in the U.S., for example, Fallick and Fleischman (2004), Fujita and Ramey (2009), Elsby, Michaels, and Solon (2009). A number of papers have started to document similar facts on the 'ins and outs' of European unemployment, as discussed by Petrongolo and Pissarides (2008) and Pissarides (2009) based on micro-data and by Burda and Wyplosz (1994) and Elsby, Hobijn, and Sahin (2010b) who use aggregate data. For Germany an early study using IAB data is Bachmann (2005), who focuses mainly on total separations.

and from Fallick and Fleischman (2004) for employer-to-employer transitions. The IAB employment panel provides data at a daily frequency, from which we construct monthly employment histories. We use only information of a fixed reference week within each month as in the U.S. CPS data. In appendix A, we provide additional information on the data set. In the online appendix, we provide details on sample selection and explain how we construct monthly employment histories from the daily data.

The IAB employment panel defines unemployment based on official registration at employment agencies, while the CPS defines unemployment based on a notion of search following survey questions.[2] In comparing the survey and administrative data sets, we follow the literature on the cross-country analysis of labor market flows (see, for example, Burda and Wyplosz (1994), Petrongolo and Pissarides (2008)). To extract business cycle components, we apply a Hodrick-Prescott filter with smoothing parameter $\lambda = 100,000$ that we adopt from other papers in the literature (for example Shimer (2005), Yashiv (2007), Davis, Faberman, and Haltiwanger (2013)).[3] Throughout the main part of the paper, we focus on volatilities of log rates. To address concerns regarding the measurement of the stocks of unemployed and inactive workers, we also provide the volatilities of level rates in online appendix II as a robustness check. Findings are very similar.

2.2 Labor market flows

Table 1 summarizes our results on labor market transition rates for Germany and presents a cross-country comparison along three dimensions: aggregate business cycle fluctuations, steady-state labor market transition rates, and (log) volatilities of transition rates.[4]

Unemployment rates and vacancies are slightly more volatile in Germany compared to the U.S. The

[2] A recent study by Gartner, Merkl, and Rothe (2012) also constructs German labor market flow rates based on the IAB micro data. Their results agree with ours as regards the German EU transition rate. In order to construct the UE rate, they divide the IAB UE flows by a measure of unemployment that is based on survey data (ILO concept). The latter data capture a different universe of workers and define different thresholds for employment regarding hours worked. The results in Gartner, Merkl, and Rothe (2012) regarding UE rates are, therefore, not comparable to ours. Our results on UE rates are based on an internally consistent definition of unemployment that we apply in both the numerator and the denominator.

[3] In an earlier working paper (Jung and Kuhn (2011)), we show that our stylized facts are robust to applying a smoothing parameter $\lambda = 1,600$.

[4] We do not report NU and NE transition rates in table 1 because we do not observe the universe of all inactive individuals in Germany so the transition rates cannot be computed. In an earlier working paper (Jung and Kuhn (2011)), we provide an extended empirical analysis of worker flows in Germany.

Table 1: GDP, unemployment rates, and transition rates over the business cycle

	Series	mean	std	corr	Transition rate	mean	std	corr
Germany	GDP		2.4	1	EU	0.5	15.1	-0.81
U.S.			2.7	1		2.0	6.5	-0.71
Germany	Productivity		1.6	0.77	UE	6.2	10.4	0.40
U.S.			1.4	0.47		30.7	11.2	0.79
Germany	Earnings		1.7	0.84	EE	0.9	15.6	0.65
U.S.			1.8	0.44		2.6	6.3	0.65
Germany	Vacancies		33.4	0.82	EN	1.0	6.2	0.53
U.S.			20.4	0.81		2.7	4.6	0.44
Germany	Urate	8.4	18.1	-0.76	UN	4.9	10.3	0.45
U.S.		6.3	15.1	-0.87		26.6	9.1	0.69

Notes: Data series are quarterly or quarterly averages of monthly data for the period 1980 - 2004. Standard deviations (STD) are given as percentage deviations from an HP-filtered trend ($\lambda = 100,000$) in logs. Correlations (CORR) give the correlation coefficient with GDP. Our productivity measure is GDP per employed. Aggregate data for Germany are from the German statistical office ('Statistische Bundesamt') and the German Employment Agency ('Bundesagentur für Arbeit') and for the U.S. from the BLS. U.S. transition rates are taken from Shimer (2007) and Fallick and Fleischman (2004) for the EE rates that start in 1994. German transition rates are the authors' own calculations based on IAB data.

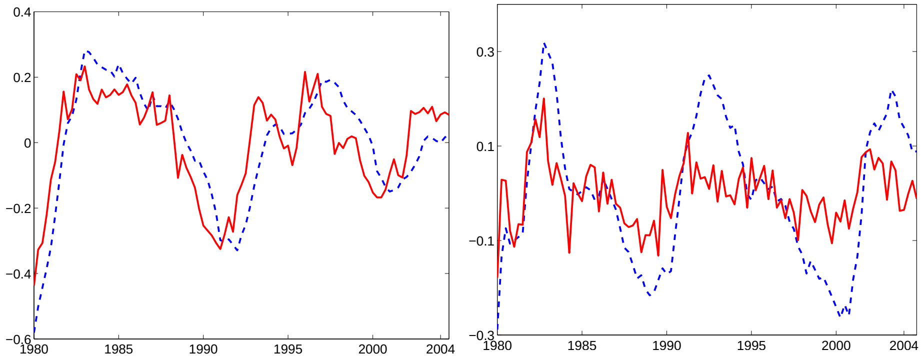
unemployment rate is 1.2 times as volatile, and vacancies are 1.6 times as volatile.[5] Correlations with GDP have the same sign and similar magnitudes across the two countries. Additionally, the Beveridge curve, depicting the correlation between unemployment rates and vacancies, is strongly negative in both countries (Germany: -0.85, U.S.: -0.91).

Average labor market transition rates are substantially lower in Germany. The EU rate is lower by a factor of 4, and the UE rate is lower by a factor of 5. Transition rates to a new employer (EE) and the employment-to-inactivity (EN) rates differ by a factor of approximately 3. The opposite picture arises for volatilities. Although the UE rates in both countries are equally volatile, the German EU rate is 2.3 times more volatile than the U.S. rate. In both countries EU rates are countercyclical while EN rates are procyclical. The similar cyclical pattern of EU and EN flows in both countries suggest that the distinction between unemployment and inactivity captures similar economic states in the administrative and the survey data. Figure 1(a) visualizes the close connection of the cyclical component of the EU rate and the unemployment rate in Germany; the link is present in the U.S. at the onset of recessions but less persistent (Figure 1(b)).

[5]For the U.S., we use the help wanted index as the standard proxy for vacancies. For Germany, we use open positions registered at the job centers as a proxy for vacancies. It must be noted that open positions at the job centers do not constitute the whole universe of open positions. Indeed, a comparison of recent firm survey data with the data on registered vacancies suggests that about 1/3 of all open positions are announced to job centers.

Figure 1: Cyclical component of EU rate and unemployment rate

(a) Germany (b) United States



Notes: The figure shows the cyclical component of the EU rate and the official unemployment rate. The cyclical component has been extracted using an HP-filter ($\lambda = 100,000$). The red solid line is the EU rate and the blue dashed line the unemployment rate.

2.3 Unemployment decomposition

Figure 1 suggests that the cyclical component of the EU rate differs across countries in its importance for explaining unemployment volatility. In table 2, we decompose the unemployment volatility into shares that can be attributed to the corresponding labor market transition rates. We apply the method proposed in Fujita and Ramey (2009) based on a two-state decomposition and also extend their methodology to a three-state decomposition to control for flows into inactivity.[6]

Table 2: Unemployment Volatility Decomposition

Country	Data	# of states	EU	UE	NE	EN	NU	UN	ε
Germany	IAB	2	61.1	38.6					0.3
	IAB	3	42.5	24.6	20.0	−4.5	6.6	11.0	−0.3
U.S.	Shimer	2	32.6	67.6					−0.2
	Fujita/Ramey	2	38.4	61.9					−0.2
	Shimer	3	20.1	48.6	8.8	−3.8	10.4	15.2	0.7

Notes: Data are HP-filtered ($\lambda = 100,000$) for the period $1980 - 2004$. For Germany the transition rates are the authors' own calculations. The U.S. data are obtained from Shimer (2007) and Fujita and Ramey (2009). Contribution shares of flows are given in the corresponding column and are given as percentage numbers. The third column reports the number of states considered in the decomposition. The data source is given in column 2. ε denotes the approximation error of the decomposition.

Based on a two-state decomposition, EU rates account for more than 60% of the unemployment

[6] Details on the volatility decomposition of Fujita and Ramey (2009) and our extension can be found in appendix B. Our decomposition relies only on gross flows from inactivity and does not require observing the inactivity stock. This is important, as we do not observe the stock in the German data.

volatility in Germany, whereas they account for $30-40\%$ in the U.S.[7] The three-state decomposition indicates that German EU rates contribute about twice as much to unemployment volatility as UE rates do, while in the U.S. the opposite is true.

Despite the general caveat of data comparability in cross-country studies, our findings about the importance of the inflows in Germany are corroborated by other studies using different data sources. Elsby, Hobijn, and Sahin (2010b), using annual flows constructed from OECD data, find a contribution of the inflows relative to the outflows in Germany similar to ours. In a recent study Hertweck and Sigrist (2012) follow our approach and confirm the dominance of the EU rate volatility using the survey-based data of the German Socio-Economic Panel (GSOEP).

In the next section, we present a structural search and matching model of the labor market to explore how technological and institutional differences in the labor market can explain the empirical differences.

3 Model

There is a continuum of workers of measure one. Workers and firms are risk neutral. Workers can be either employed or unemployed, denoted by $l \in \{e, u\}$. The aggregate technology state A is random and follows an exogenous AR(1) process. We denote the share of unemployed workers by U and the share of employed workers is $E = 1 - U$.

Time is discrete. At the beginning of the period, each matched worker-firm pair bargains efficiently over the wage and the separation decision for the current period. If the bargaining is successful, they produce output according to the production technology $y = A$, which depends only on the aggregate technology state common to all matches. At the end of the period, but before the realization of tomorrow's state, the firm receives an idiosyncratic cost shock ε. We assume that ε is i.i.d. across firms and over time and logistically distributed with mean zero and variance $\frac{\pi^2}{3}\psi^2$. The assumption of a logistic distribution allows us to obtain closed-form solutions. The firm pays the costs ε only if

[7] For the U.S. Hall (2005) and Shimer (2007) emphasize the importance of the UE flows in understanding labor market dynamics, whereas Fujita and Ramey (2009) and Elsby, Michaels, and Solon (2009) focus more on the EU flows. Our estimates for the contribution of the EU rate volatility are at the upper end of the estimates by Shimer (2007) and the lower end of the estimates by Fujita and Ramey (2009).

it wishes to continue the production process. The costs are sunk after the period and will not affect any future decision. For the separation decision, the firm and the worker agree at the bargaining stage upon a cut-off value $\bar{\varepsilon}$ for the realization of the cost shock ε. If the realized costs are larger than this cut-off value, the match dissolves, the firm pays a layoff tax τ to the government, and the worker becomes unemployed. If the costs are less than the cut-off value, then the firm pays the costs and continues the match. Both the firm and the worker discount the future with a common discount factor β. Given wages $w : \mathbb{R}_+ \times [0,1] \to \mathbb{R}_+$ and cut-off strategies $\bar{\varepsilon} : \mathbb{R}_+ \times [0,1] \to \mathbb{R}$, the firm's surplus is

$$J(A,U) = A - w(A,U) + \int_{-\infty}^{\bar{\varepsilon}(A,U)} \Big(\beta \mathbb{E}\left[J(A',U')\right] - \varepsilon\Big) df(\varepsilon) - \int_{\bar{\varepsilon}(A,U)}^{\infty} \tau df(\varepsilon). \tag{1}$$

The separation probability π_{eu} is[8]

$$\pi_{eu}(A,U) = 1 - Prob(\varepsilon < \bar{\varepsilon}(A,U)) = \left(1 + \exp\left(\frac{\bar{\varepsilon}(A,U)}{\psi}\right)\right)^{-1}.$$

Unemployed workers receive job offers from firms with probability π_{ue}. While unemployed, their flow utility is b. The value functions for employed workers $V_e : \mathbb{R}_+ \times [0,1] \to \mathbb{R}$ and unemployed workers $V_u : \mathbb{R}_+ \times [0,1] \to \mathbb{R}$ are given by

$$\begin{aligned} V_e(A,U) &= w(A,U) + (1-\pi_{eu}(A,U))\beta \mathbb{E}\left[V_e(A',U')\right] + \pi_{eu}(A,U)\beta \mathbb{E}\left[V_u(A',U')\right] && (2) \\ V_u(A,U) &= b + (1-\pi_{ue}(A,U))\beta \mathbb{E}\left[V_u(A',U')\right] + \pi_{ue}(A,U)\beta \mathbb{E}\left[V_e(A',U')\right]. && (3) \end{aligned}$$

We denote the worker's surplus by $\Delta(A,U) = V_e(A,U) - V_u(A,U)$ and the match surplus by $S(A,U) = J(A,U) + \Delta(A,U)$.

[8] Solving the conditional expectation for $\pi_{eu}(A,U)$, the firm's surplus is

$$J(A,U) = A - w(A,U) + (1-\pi_{eu}(A,U))\beta \mathbb{E}\left[J(A',U')\right] - \pi_{eu}(A,U)\tau + \Psi(A,U).$$

The option value Ψ follows directly from the assumption of a logistically distributed cost shock. It captures the value of having a choice to continue the match and is always positive

$$\Psi(A,U) = -\psi_\varepsilon \Big((1-\pi_{eu}(A,U)) \log(1-\pi_{eu}(A,U)) + \pi_{eu}(A,U) \log(\pi_{eu}(A,U)) \Big).$$

An unemployed worker is matched in a matching market governed by a standard Cobb-Douglas matching function that relates unemployed workers U to posted vacancies V and created matches M by $M = \varkappa V^{1-\varrho} U^{\varrho}$. The parameter ϱ denotes the matching elasticity and $\varkappa$ captures the efficiency of the matching process. Labor market tightness is defined as the ratio of vacancies to searching workers $\theta := \frac{V}{U}$. The probability that a searching worker will meet a firm is $\pi_{ue} = \frac{M}{U} = \varkappa \theta^{1-\varrho}$ and the probability that a firm posting a vacancy will meet a worker is $\pi_{ve} = \frac{M}{V} = \varkappa \theta^{-\varrho}$.

To determine the number of vacancies posted, we impose a standard free-entry condition $\kappa = \pi_{ve} \beta \mathbb{E}\left[J(A', U')\right]$, where κ denotes the vacancy posting costs per period. We assume Nash bargaining jointly over wages w and cut-off values $\bar{\varepsilon}$. The outcome of the bargaining process is characterized by

$$\{w, \bar{\varepsilon}\} = \arg\max_{w,\bar{\varepsilon}} \quad \mu \log\left(\Delta(A, U)\right) + (1-\mu) \log\left(J(A, U)\right),$$

where μ denotes the bargaining power of the worker. The first-order conditions of the problem $\bar{\varepsilon}(A, U) = \beta \mathbb{E}\left[S(A', U')\right] + \tau$ yield that the cut-off value $\bar{\varepsilon}$ is increasing in the match surplus. The technology state $A = \exp(a)$ evolves exogenously according to $a' = \rho a + \eta'$, where ρ denotes the auto-correlation coefficient and innovations η are normally distributed $\mathrm{N}(0,\tilde{\sigma}_a^2)$.

4 Results

The model is block-recursive in the sense of Menzio and Shi (2009), so the employment measure does not enter the policy functions. This allows us to derive analytical results for the impact of parameters on the steady states and volatilities of the transition rates. In section 4.1, we use the closed-form solution to analyze the basic mechanism that links lower steady-state UE rates to higher EU volatilities and a higher contribution of the EU rate in the decomposition of the unemployment volatility. In section 4.2, we provide a mapping to the underlying institutional factors, and section 4.3 studies the quantitative performance and shows that the differences matter for the propagation of aggregate shocks. In section 4.4, we explore the impact of various parameters quantitatively. Finally, section 4.5 offers micro-evidence for a lower matching efficiency in Germany.

4.1 Basic mechanism

The second column of table 3 reports some analytical expressions for the steady state and for the volatilities. Expressions for the volatilities are based on a first-order approximation. The third column further approximates the resulting expressions using some simplifying assumptions. Throughout the text, the steady state of a variable y is denoted by $\bar{y}$ and the coefficient of the first-order approximation by σ_y. If productivity deviates by $\hat{a}$ from its steady state, then it holds up to first order that $y = \bar{y} + \sigma_y \hat{a}$. Furthermore, we use $\tilde{\sigma}_y \equiv \frac{\sigma_y}{\bar{y}}$ to denote percentage deviations from the steady state. The absolute value of $\tilde{\sigma}_y$ coincides with the log standard deviation of a variable y relative to the standard deviation of productivity.

Table 3: Steady states and volatilities

$\bar{S}$	$\frac{\bar{A}-b-\psi\log(1-\bar{\pi}_{eu})}{1-\beta(1-\bar{\pi}_{ue}\mu)}$	$\frac{\bar{A}-b}{\bar{\pi}_{ue}\mu}$
$\bar{\pi}_{ue}$	$\varkappa\left(\frac{(1-\mu)\varkappa\beta\bar{S}}{\kappa}\right)^{\frac{1-\varrho}{\varrho}}$	$\varkappa\left(\frac{1-\mu}{\mu}\frac{\bar{A}-b}{\kappa}\right)^{1-\varrho}$
$\bar{\pi}_{eu}$	$\left(1+\exp\left(\frac{\beta\bar{S}+\tau}{\psi}\right)\right)^{-1}$	$\left(1+\exp\left(\frac{\bar{A}-b}{\bar{\pi}_{ue}\mu\psi}+\frac{\tau}{\psi}\right)\right)^{-1}$
σ_S	$\left(1-\beta\rho\left(1-\bar{\pi}_{eu}\right)+\beta\rho\bar{\pi}_{ue}\frac{\mu}{\varrho}\right)^{-1}$	$\frac{\varrho}{\bar{A}-b}\bar{S}$
$\tilde{\sigma}_{ue}$	$(1-\varrho)\frac{\rho}{\varrho}\frac{\sigma_S}{\bar{S}}$	$\frac{1-\varrho}{\bar{A}-b}$
$\tilde{\sigma}_{eu}$	$-(1-\bar{\pi}_{eu})\frac{\rho\beta}{\psi}\sigma_S$	$-\frac{\varrho}{\bar{A}-b}\frac{\bar{S}}{\psi}$

Notes: Variable names are in the first column. Analytic expressions for the first-order approximations are in the second column. In the third column, additional approximations use $\beta \approx 1$, $\rho \approx 1$, and $\pi_{eu} \approx 0$. The coefficients capturing volatilities result from a first-order approximation around the steady state.

The two bottom rows of table 3 uncover the difference in the reaction of the EU and UE rate to business cycle shocks. The EU rate volatility ($|\tilde{\sigma}_{eu}|$) is proportional to the *absolute* surplus volatility σ_S scaled by ψ.[9] In contrast, the UE rate volatility ($|\tilde{\sigma}_{ue}|$) is proportional to the *relative* surplus

[9] The parameter ψ is proportional to the standard deviation of the idiosyncratic cost shock. Taken together this yields the standard effect for generating countercyclical EU rates in models with endogenous destruction and also applies to models using log-normal multiplicative shocks. Intuitively, less dispersed idiosyncratic cost shocks have more mass around the cut-off value $\bar{\varepsilon}$. For a given shock distribution, a decline in the surplus due to a negative business cycle shock will lead to more firms drawing cost shocks below the cut-off value and to more separation. At the aggregate level the EU rate increases and is countercyclical.

volatility $\tilde{\sigma}_y \equiv \frac{\sigma_S}{S}$. Using the approximation from the third column, we obtain

$$\tilde{\sigma}_{ue} \approx \frac{1-\varrho}{A-b} \qquad |\tilde{\sigma}_{eu}| \approx \frac{\varrho}{\mu\psi}\bar{\pi}_{ue}^{-1}$$

Two facts stand out: first, the UE volatility is a direct function of the outside option b, a fact that has been discussed in the recent literature (see Shimer (2005) and Hagedorn and Manovskii (2008)). Second, the EU rate volatility is inversely related to the steady-state UE rate. Hence, the model predicts high EU volatilities at low steady-state UE rates.

To develop intuition for the inverse relation of steady-state UE rates and EU rate volatility, we obtain a surplus formula from equations (1), (2) and (3), where we set $\psi \log(1-\pi_{eu}) \approx 0$ for simplicity

$$S \approx A - b + \beta\mathbb{E}\left[S'\right] - \pi_{ue}\mathbb{E}\left[\Delta'\right]. \tag{4}$$

There are two components with opposite signs: the discounted surplus of the current match $A - b + \beta\mathbb{E}[S']$ and the worker's expected reemployment gain $\pi_{ue}\mathbb{E}[\Delta']$.

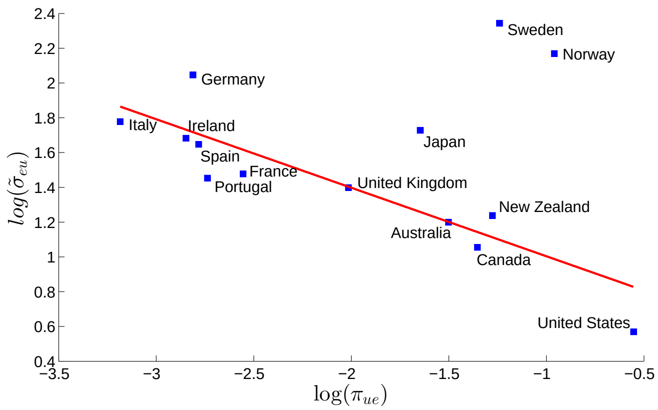
To understand what this implies, consider a positive business cycle shock: the surplus of the current match increases, so the EU rate falls. However, the expected reemployment gain rises, too, because π_{ue} and Δ increase. This gain dampens the increase of the total surplus. The strength of the dampening effect depends on the level of the UE rate. A lower UE rate implies a longer search duration, so the worker would miss a larger fraction of the time when it is particularly productive to work. Hence, the dampening effect from the reemployment gain is weaker. A similar argument applies to a recession where the dampening effect arises because the value of the current match and the reemployment gain decrease. Hence, a lower average reemployment probability makes the total surplus more cyclical. This explains the inverse relation between the steady-state UE rate and the EU rate volatility.

The inverse relation does not only hold empirically when considering the U.S. and Germany but also in a larger set of OECD countries considered in Elsby, Hobijn, and Sahin (2010b).[10] Figure

[10] Elsby, Hobijn, and Sahin (2010b) use annual OECD data on unemployment duration to construct unemployment in- and outflow rates, see their paper for details of the construction. The data series cover different time periods the earliest starting in 1968 for the U.S. and the latest in 1986 for Portugal and New Zealand. The data for Germany start in 1983. All data series end in 2007.

2 plots the inverse relation for the set of OECD countries. We also show the regression line from an OLS regression of $\log(\tilde{\sigma}_{eu})$ on a constant and $\log(\pi_{ue})$. For the regression we drop two obvious outliers, Norway and Sweden.[11]

Figure 2: Cross-country evidence



Notes: The figure shows the data and the fitted regression line from a linear regression of the log EU rate volatility on the log UE rate and a constant. For the regression the two outliers Norway and Sweden have been dropped.

Differences in the steady-state surplus also translate into differences in the decomposition of the unemployment volatility. The unemployment rate volatility in the model is given by

$$\begin{aligned} |\tilde{\sigma}_u| &= \frac{|\sigma_{eu}(1-\bar{u}) - \sigma_{ue}\bar{u}|}{\bar{u}\sqrt{1-(1-\bar{\pi}_{ue}-\bar{\pi}_{eu})^2}} \sqrt{\frac{1+\rho(1-\bar{\pi}_{ue}-\bar{\pi}_{eu})}{1-\rho(1-\bar{\pi}_{ue}-\bar{\pi}_{eu})}} \\ &\approx (|\tilde{\sigma}_{eu}| + |\tilde{\sigma}_{ue}|)(1-\bar{u}), \end{aligned} \tag{5}$$

The contribution of the EU rate volatility to the unemployment volatility depends on the relative size of $|\tilde{\sigma}_{eu}|$ to $|\tilde{\sigma}_{ue}|$. It follows from the approximation in table 3 that this contribution is proportional to the steady-state surplus $\frac{|\tilde{\sigma}_{eu}|}{|\tilde{\sigma}_{ue}|} = \frac{\varrho}{1-\varrho}\frac{\bar{S}}{\psi}$. Hence, to explain a higher contribution of EU rate volatility to the volatility of the unemployment rate, the steady-state surplus has to be larger in Germany.

[11]The negative correlation still holds when we include these two countries but becomes weaker.

4.2 Structural parameters

What structural or institutional differences can explain the observed differences in labor market flows between the U.S. and Germany? Table 4 reports elasticities of steady-state transition rates and their volatilities with respect to a change in a given parameter. The analytical expressions can be used to determine the sign of the impact of each of the structural parameters on the four endogenous dimensions considered in this paper.[12]

Table 4: Steady-state elasticities

p	PARAMETER	$\frac{p}{\pi_{ue}}\frac{d\pi_{ue}}{dp}$	$\frac{p}{\pi_{eu}}\frac{d\pi_{eu}}{dp}$	$\frac{p}{\tilde{\sigma}_{ue}}\frac{d\tilde{\sigma}_{ue}}{dp}$	$\frac{p}{\lvert\tilde{\sigma}_{eu}\rvert}\frac{d\lvert\tilde{\sigma}_{eu}\rvert}{dp}$
$\varkappa$	MATCHING EFFICIENCY	$\frac{\varrho}{1-\varrho}$	$\frac{\varrho}{1-\varrho}\frac{\bar{S}}{\psi}$	0	$-\frac{\varrho}{1-\varrho}$
μ	BARGAINING POWER	$-\frac{1-\varrho}{1-\mu}$	$-\frac{\mu-\varrho}{1-\mu}\frac{\bar{S}}{\psi}$	0	$\frac{\mu-\varrho}{1-\mu}$
b	OUTSIDE OPTION	$-\frac{(1-\varrho)b}{\bar{A}-b}$	$\frac{\varrho b}{\mu\psi\bar{\pi}_{ue}}$	$\frac{b}{\bar{A}-b}$	$(1-\varrho)\frac{b}{\bar{A}-b}$
τ	LAYOFF TAX	$-\frac{(1-\varrho)\tau\bar{\pi}_{eu}}{\bar{A}-b}$	$-(1-\frac{\varrho\bar{\pi}_{eu}}{\mu\bar{\pi}_{ue}})\frac{\tau}{\psi}$	$\frac{\tau\bar{\pi}_{eu}}{\bar{A}-b}$	$(1-\varrho)\frac{\tau\bar{\pi}_{eu}}{\bar{A}-b}$
ψ	IDIOSYNCRATIC RISK	$-\frac{\bar{\Psi}(1-\varrho)}{\bar{A}-b}$	$\frac{\tau+\bar{S}}{\psi}+\frac{\bar{\Psi}\varrho}{\psi\mu\bar{\pi}_{ue}}$	$\frac{\bar{\Psi}}{\bar{A}-b}$	$-\left(1-\frac{\bar{\Psi}(1-\varrho)}{\bar{A}-b}\right)$

Notes: Approximation to steady-state elasticities. Rows give the parameters and columns the variables to which the elasticities apply. $\bar{\Psi}$ is the steady-state value of the option value from the separation decision. The approximation uses $\beta \approx 1$, $\rho \approx 1$, $1-\pi_{eu} \approx 1$, $\pi_{eu}(1-\pi_{eu}) \approx 0$, and $\pi_{eu} + \frac{\mu}{\varrho}\pi_{ue} \approx \frac{\mu}{\varrho}\pi_{ue}$.

4.2.1 Matching efficiency

A lower matching efficiency $\varkappa$ (table 4, row 1) directly decreases the steady-state UE rate. The surplus of the match increases and lowers the steady-state EU rate. The UE rate volatility remains unchanged because the increase in the surplus is accompanied by an increase in the surplus reaction to business cycle shocks. The EU rate volatility increases. All else equal, a lower matching efficiency in Germany can therefore explain all documented cross-country differences qualitatively.

[12]To obtain the elasticities, we implicitly differentiate the system of steady-state equations and the analytical expressions for the volatilities. To improve readability, we use some simple approximations. The exact elasticities are available upon request.

4.2.2 Bargaining power

A greater bargaining power of the worker μ (table 4, row 2) in Germany lowers the share of the surplus accruing to the firm. This reduces the incentives to create jobs, so that the steady-state UE rate declines.[13] The effect of greater bargaining power on the steady-state surplus is ambiguous and depends on the distance to the Hosios point of efficiency, i.e. the point where the bargaining power of the worker equals the matching elasticity.[14]

We see the two counteracting forces at work when we consider the steady-state approximation $\frac{A-b}{\pi_{ue}\mu}$ from the last column of table 3. First, a direct effect of greater bargaining power is a decrease in the steady-state surplus. Second, an indirect effect are lower profits. This lowers vacancy postings and therefore the steady-state UE rate, so that the surplus increases. At the Hosios point, the two effects cancel, so that the steady-state surplus is minimized with respect to bargaining power. To derive this formally, we implicitly differentiate the steady-state surplus with respect to bargaining power:

$$\frac{\partial S}{\partial \mu} = \frac{\mu - \varrho}{1-\mu} \frac{\beta \bar{S} \bar{\pi}_{ue}}{\varrho \left(1 - \beta + \beta \left(\bar{\pi}_{eu} + \frac{\mu}{\varrho} \bar{\pi}_{eu}\right)\right)}.$$

It can be immediately verified that the surplus has its minimum at the Hosios condition.[15] Intuitively, in the benchmark scenario of a perfectly competitive market without search frictions, the surplus would be competed to zero, making all workers employed, and force wages to be equal to productivity. The search friction imposes a deviation from this benchmark, leading to a positive surplus. The deviation is minimized at the Hosios point of efficiency.

Interestingly, the volatility of the EU rate is also minimized at this point and the sign of the elasticity switches sign (see table 4, row 2). Due to the sign switch in the elasticity of $|\tilde{\sigma}_{eu}|$ at the Hosios condition, a cross-country change in bargaining power can increase or decrease the EU rate's volatility depending on the initial condition. If the change in bargaining power is large enough, the channel works similarly to a change in matching efficiency. It lowers the gains from

[13] Blanchard and Portugal (2001) use this mechanism to argue that employment protection legislation implicitly increases the threat point of the worker, thereby raising the worker's bargaining power.

[14] Despite endogenous separations, showing that the Hosios condition still holds in our framework is straightforward, conditional on interpreting the outside option as home production or the value of leisure, not as a choice of the government.

[15] The second term is always positive, so the extremum must be a minimum.

posting a vacancy and simultaneously increases the surplus of the match. However, as we show in our calibrated model in the next section, quantitatively the effect is too weak to explain the cross-country difference in EU rate volatility.

4.2.3 Outside option

A higher outside option b (table 4, row 3), as argued in Ljungqvist and Sargent (2008), lowers the surplus of the match, profits, and the steady-state UE rate. The lower surplus leads to a counterfactual increase in the steady-state EU rate, so this option has to rely on additional layoff taxes τ to jointly explain the differences in the steady states across countries. Still, the mechanism will be inconsistent with the observed volatilities. The reaction of the EU rate volatility ($|\tilde{\sigma}_{eu}|$) is always lower by a factor of $1 - \varrho$ compared to the reaction of the UE rate volatility ($|\tilde{\sigma}_{ue}|$). Therefore, a decline in the surplus unambiguously decreases the contribution of EU rates relative to UE rates in the decomposition of the unemployment volatility and is therefore inconsistent with our empirical evidence.

4.2.4 Layoff tax

An increase in the layoff tax τ (table 4, row 4) lowers the steady-state EU rate by increasing the region of inactivity with respect to idiosyncratic shocks where both the firm and the worker find it optimal not to separate ($\bar{\varepsilon}$ increases).[16] The resulting impact on the unemployment rate is ambiguous due to counteracting effects on UE and EU rates. However, in our calibrated model the effect on the EU rate dominates and lowers the unemployment rate. Interestingly, and in contrast to some findings in the literature (Bentolila and Bertola (1990)), we find that within our model an increase in layoffs taxes increases both the (log) EU and the (log) UE rate volatility and, therefore, overall unemployment volatility. The increase in the volatility of the UE rate unambiguously dominates that of the EU rate (see table 4, row 4). Therefore, the contribution of the EU rate volatility in the unemployment volatility decomposition declines.[17] The finding of

[16] The increase in layoff tax does not affect the threat point of the bargaining in our specification. Ljungqvist (2002) discusses the various modeling alternatives.

[17] If we consider level volatilities in EU rates instead, they decrease with an increase in layoff taxes. However, these fluctuations are relative to a much lower steady-state EU rate.

an increasing EU rate volatility would change if we follow Bentolila and Bertola (1990) and treat a large fraction of separations as exogenous. A rise in layoff taxes would then decrease the share of endogenous in total separations. As a result total separations would decline and become less volatile. Independently of these details, all modeling alternatives have in common that an increase in layoff taxes unambiguously increases the contribution of the UE rate in the decomposition of unemployment volatility. This is in contrast to our stylized fact.

4.2.5 Idiosyncratic risk

Differences in idiosyncratic risk ψ (table 4, row 5) affect the steady-state UE rate, but this effect occurs only through the impact of ψ on the steady-state EU rate. Their impact however turns out to be quantitatively too small to explain the large UE rate differences.

4.3 Quantitative results

The theory guides us in determining which parameters have the potential to account for the observed cross-country differences. In this section, we investigate how the identified channels can account for the differences quantitatively.

4.3.1 Calibration

To calibrate the model, we set four parameters to be equal across countries and allow five parameters to differ. The model is set at monthly frequency, results are reported after aggregation to a quarterly frequency. We set the monthly autocorrelation of the aggregate shock to $\rho = 0.975$ to match the average quarterly autocorrelation coefficient of productivity of the two countries and we normalize the volatility of productivity $\tilde{\sigma}_a$ to 1.4% for both countries. We set the discount factor $\beta = 0.996$, implying an annual interest rate of 4% and the matching elasticity $\varrho = 0.5$, in line with estimates reported in Petrongolo and Pissarides (2001). We set the vacancy posting costs to $\kappa = 0.38$ to obtain a probability of filling a vacancy of 90% per month for the U.S.[18] We assume that these four

[18] The model dynamics depend only on the ratio $\frac{\varkappa}{\kappa}$, so our discussion would also apply to a change in vacancy posting costs. However, an increase in vacancy posting costs κ increases the probability of finding a worker π_{ve} from the firm's perspective, while a lower matching efficiency $\varkappa$ lowers the probability. Evidence on open positions shows that firms search considerably longer in Germany, in line with a decline in the average matching efficiency.

parameters are equal across countries.

The remaining parameters b, ψ, τ, and $\varkappa$ are chosen to exactly match the two steady-state transition rates $\bar{\pi}_{eu}$ and $\bar{\pi}_{ue}$ and their volatilities $\tilde{\sigma}_{eu}$ and $\tilde{\sigma}_{ue}$. Additionally, we follow the ideas in Hagedorn and Manovskii (2008) and choose the bargaining power μ to match the wage elasticity $|\sigma_w| \approx \mu\sigma_S\left(\bar{\pi}_{eu} + \frac{\bar{\pi}_{ue}}{\varrho}\right)$.[19] Haefke, Sonntag, and van Rens (2007) report estimates for the U.S. of around 0.8 for newly employed workers, whereas they report wage elasticities for job-stayers of 0.4. For Germany, we estimate for newly employed workers wage elasticities in the range of $0.55 - 0.85$ and for job-stayers in the range of $0.6 - 0.8$.[20] We target $\sigma_w = 0.8$ in both countries, which is at the upper range of the estimates, to allow for fairly flexible wages. Data moments and estimated parameters are given in table 5.

Table 5: Calibration

PARAMETER	$\varkappa$	μ	b/w	τ	ψ
U.S.	0.52	0.27	0.95	3.23	0.98
Germany	0.23	0.55	0.95	3.38	0.90
DATA TARGET	$\bar{\pi}_{ue}$	$\bar{\pi}_{eu}$	$\tilde{\sigma}_{ue}$	$\lvert\tilde{\sigma}_{eu}\rvert$	$\tilde{\sigma}_w$
U.S.	30.7	2.0	11.2	6.5	0.8
Germany	6.2	0.5	10.4	15.1	0.8

Notes: Data targets and calibrated parameters.

4.3.2 Fit of the model

We first show that the simple shock structure of the model captures important aspects of the data. We then report impulse response functions to highlight differences in the propagation of shocks. For both countries, we estimate the realization of the underlying shocks using a Kalman filter on GDP growth. We feed the estimated shocks back into the model using the calibrated parameters

Evidence for the U.S. on this point is presented in Davis, Faberman, and Haltiwanger (2009) and can be compared to establishment level data on open positions for Germany ('IAB Erhebung des gesamtwirtschaftlichen Stellenangebots'). We discuss this point in detail below. The calibration targets are derived using this evidence.

[19]The first-order approximation for the wage elasticity is

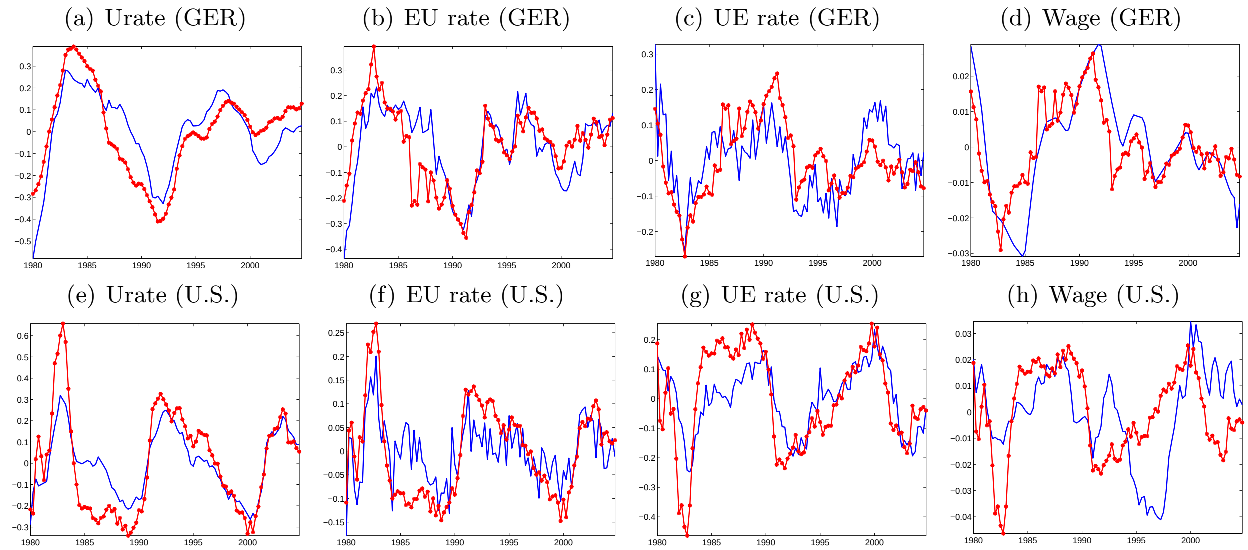
$$\sigma_w = \mu\sigma_S\left(1 - \beta\rho(1 - \bar{\pi}_{eu} - \bar{\pi}_{ue}) + \beta\rho\bar{\pi}_{ue}\frac{1-\varrho}{\varrho} - \bar{\pi}_{eu}(1-\bar{\pi}_{eu})\beta\frac{\bar{S}}{\psi}\right)$$

In an earlier working paper (Jung and Kuhn (2011)), we show that our results do not depend on the small surplus calibration but that the findings are robust to a large surplus calibration with wage rigidities as in Blanchard and Gali (2010).

[20]The estimation results are part of an earlier working paper (Jung and Kuhn (2011)).

and predict all endogenous variables, applying an HP-filter ($\lambda = 100,000$) to the resulting time series. Figure 4 illustrates the success of the model.

Figure 4: Data and predicted series



Notes: The figure plots the model predictions (red dotted lines) and the data (blue solid line). The prediction is based on a technology process obtained from a Kalman filter on GDP growth. Model and data are in logs and are HP-filtered with $\lambda = 100,000$.

The time series pattern of the unemployment rate is predicted well, and the model captures both the EU and the UE rate dynamics in both countries. The model reproduces the time series pattern of wages in Germany, yet it fails to predict the wages in the 1990s for the U.S. Overall, the success for both countries lends credibility to the underlying mechanism explored in this paper.[21]

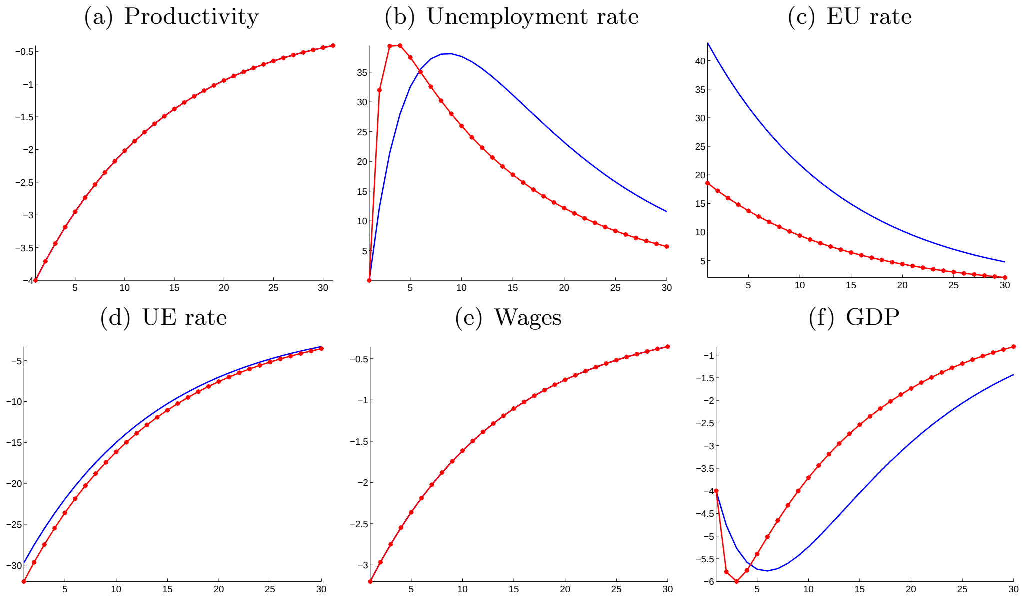
4.3.3 Transmission of shocks

Do the calibrated differences matter for the transmission of shocks? Figure 4 shows the impulse response functions for the calibrated economies after a large negative productivity shock of 4%. This roughly matches the increase in the unemployment rate at the beginning of the major recession

[21]The model is also consistent with the empirically documented fact that German vacancies are more volatile than their U.S. counterpart (a standard deviation of 11.4 relative to 8.46), but misses on the magnitude in both countries. The correlation between the unemployment rate and vacancies (Beveridge curve) is too small in the model, a well-known problem in models with endogenous separations. One straightforward solution to the problem is to add job-to-job transitions. This increases the number of searching workers and therefore the denominator in the matching function. This dampens the effect of the large inflow in the search pool on impact of a negative business shock due to endogenous separations. The remaining dynamics of the model are not much affected; see Fujita and Ramey (2009) for a discussion and a quantitative assessment.

in Germany in the 1980s after the second oil crisis. We find that the lower matching efficiency induces significant propagation to shocks in Germany, in line with Germany's sluggish recovery in the aftermath of the oil price shocks. The impulse responses reveal the key cross-country difference in the reactions to a productivity shock. In the U.S., the unemployment rate peaks three quarters

Figure 4: Impulse response functions



Notes: The figure plots the impulse response functions for the U.S. (red dotted lines) and Germany (blue solid line) on a quarterly scale. The initial productivity shock is -4%.

after the initial shock, whereas in Germany there is a substantial propagation to shocks and the unemployment rate peaks after nine quarters. Afterwards, the German recovery is very sluggish. In fact, five years after the shock hit, the German unemployment rate is still 23% away from its steady state, while the U.S. rate is only 12% above its steady state. Peak unemployment is similar across the two countries, but the unconditional standard deviation of the unemployment rate for Germany is still 29% larger than it is for the U.S., consistent with our empirical findings.

Figures 4(d) and 4(e) show that the different reactions of the unemployment rate to shocks are not generated by differences in the reaction of UE rates or wages. Recall that the wage reaction is calibrated to be the same across the two countries. The sluggish response in Germany is caused by an interplay of the strong reaction in the EU rate causing a rise in unemployment (figure 4(c)) and the lower steady-state UE rate. Furthermore, the model generates positive output growth in

Germany after 6 quarters that is accompanied by unemployment rates that continue to increase for an additional $3-4$ quarters.

4.4 Quantitative investigation

To complement the qualitative insights based on table 4 we now use the calibrated model to quantify the effect of parameter changes on the steady state transition rates and their volatilities. In table 6, we report the results of five experiments. In each experiment, we change one parameter from its U.S. calibration to match one target of the German data (bold number). The second column shows the parameter that has been changed and the corresponding value.

Table 6: Parameter experiments

		$\bar{\pi}_{ue}$	$\bar{\pi}_{eu}$	$\tilde{\sigma}_{ue}$	$\lvert\tilde{\sigma}_{eu}\rvert$	$\lvert\tilde{\sigma}_{w}\rvert$	$\frac{\lvert\tilde{\sigma}_{eu}\rvert}{\lvert\tilde{\sigma}_{eu}\rvert+\lvert\tilde{\sigma}_{ue}\rvert}$
	U.S. (benchmark)	30.7	2.0	11.2	6.5	0.8	36.7
	Germany (benchmark)	6.2	0.5	10.4	15.1	0.8	59.2
(1)	$\varkappa = 0.14$	**6.2**	0.6	11.5	20.5	0.6	64.1
(2)	$\mu = 0.89$	**6.2**	1.6	11.4	9.0	0.9	44.1
(3)	$b/w = 0.99$	**6.2**	3.2	125.3	14.6	0.5	10.4
(4)	$\tau = 4.6$	25.8	**0.5**	16.5	8.2	0.9	33.0
(5)	$\psi = 0.7$	25.2	**0.5**	17.1	11.5	0.8	40.0
	U.S. calibration	$\varkappa = 0.52$	$\mu = 0.27$	$b/w = 0.95$	$\tau = 3.23$	$\psi = 0.98$	

Notes: The second column gives the parameter that has been changed relative to the calibrated U.S. economy and the corresponding value. The bold number shows the targeted data point. The parameters of the calibrated U.S. economy are repeated in the last line.

The unemployment decomposition formula based on equation (5) displayed in the last column works well in both benchmark calibrations and very closely approximates the data decomposition. Experiment (1) shows that a decline in matching efficiency $\varkappa$ can qualitatively and to a large extend also quantitatively account for the cross-country differences in steady-state transition rates and volatilities. Only the EU rate volatility is too high and the wage elasticity is too low.

Experiment (2) shows that an increase in bargaining power could dampen the overshooting in the EU-rate volatility and the wage elasticity. To examine the non-monotone effect of bargaining power around the Hosios condition, we perform an additional exercise. First, we look at the U.S. with a calibrated bargaining power $\mu = 0.27$ below the Hosios condition ($|\tilde{\sigma}_{eu}| = 6.5$). At the Hosios condition $\mu = 0.5$, the volatility of the EU rate decreases to its minimum ($|\tilde{\sigma}_{eu}| = 5.9$). At a symmetric deviation from the Hosios condition ($\mu = 0.73$), the EU rate volatility is again equal to the initial value of $|\tilde{\sigma}_{eu}| = 6.5$. Increasing the bargaining power from this point further increases the EU rate volatility but is quantitatively too small to account for the empirical differences. Overall, an increase in bargaining power alone moves the economy qualitatively in the right direction but leaves it quantitatively away from the observed differences.

Experiment (3) shows that a rise in the outside option b increases the UE rate volatility substantially, while the EU rate volatility increases only slightly.

Experiment (4) shows that an increase in layoff taxes lowers the steady-state EU rate but has only a modest effect on the steady-state UE rate. It has almost no impact on the (log) EU volatility while increasing the (log) UE volatility. As we show in the online appendix II, the volatility of level rates declines. They decrease by less than the steady-state rates, so the volatility measured as log deviation increases.

Finally, experiment (5) shows that an increase in the variance of the idiosyncratic shocks induced by a change in ψ lowers the steady-state EU rate, but increases both the EU and UE rate volatilities. This leaves the contribution rates in the decomposition of the unemployment volatility unaffected.

Our exploration suggests that differences in the matching efficiency can explain qualitatively and quantitatively the bulk of the empirical cross-country differences and might be an important driver of the cross-country differences.[22] We now provide some empirical evidence for a lower matching efficiency in Germany.

4.5 Empirical evidence for a lower matching efficiency in Germany

The quantitative findings suggest that the microstructure of matching unemployed workers to open positions plays an important role in explaining the cross-country differences both in steady-state transition rates and in their volatilities. To keep our model tractable the microstructure of the

[22] In an earlier working paper (Jung and Kuhn (2011)), we show that the basic mechanisms also extend to a richer search model with heterogeneous match and worker types. There we explore the idea that interactions of unemployment insurance benefits, employment protection legislation, and the human capital accumulation process can explain differences in average transition rates between the U.S. and Europe as has been proposed by Ljungqvist and Sargent (2008) and Wasmer (2006).

matching process is condensed in a single parameter, the matching efficiency. There is direct empirical evidence on the cross-country difference of this broad summary measure in Burgess and Mawson (2003), who estimate a substantially lower matching efficiency for Germany than for the U.S. over the period $1967 - 1997$.

Looking at the microfoundations of this parameter, Petrongolo and Pissarides (2001) survey the literature and distinguish two sets of factors, orthogonal to the level of benefits, the employment protection legislation, or the power of unions, that can influence matching efficiency. They suggest that the first set captures individual search behavior such as, for example, the decision on how many applications to make or how and where to apply. The second set includes the institutional setup and the physical search technology such as the equipment and services offered at employment offices, measures of active labor market policies, or the details of the application and hiring process. Our structural analysis also assumes orthogonality and treats matching efficiency as an exogenous parameter. Other labor market models have an endogenous component to matching efficiency.[23] According to these models the estimated differences in matching efficiency could also comprise effects resulting from differences in other labor market institutions. With this caveat in mind, we discuss next empirical evidence that supports the view of important differences in the search process and in the search technology between the U.S. and Germany.

Turning to the first set of variables related to the search process, we start by looking at the firm's side of the match: Davis, Faberman, and Haltiwanger (2009) use JOLTS data to estimate an average daily job filling rate of 5% and a corresponding average vacancy duration of 16.25 working days for the period $2001 - 2006$ for the U.S. Adding in weekends and holidays, this period increases to $19 - 29$ calendar days. For Germany the most comparable search duration is from the beginning of search to signing the contract.[24] For the period from $2001 - 2006$ the average vacancy duration

[23] One prominent example is the learning model of Pries and Rogerson (2005). In their model, firms receive a noisy signal about the match when hiring and match-quality is learned over time. This leads to a selection effect at the hiring stage that can depend on labor market institutions. An indicator for the importance of the selection mechanism is the steepness of the separation profile by job tenure. In an earlier working paper (Jung and Kuhn (2011)), we report EU rates by tenure for the U.S. and Germany (see also Jung and Kuhn (2012) for a detailed analysis of transition rates by age and tenure for the U.S.). According to our micro-data, we find that the steepness by tenure is similar across countries. Moreover, German law allows for a probation period of 6 month during which workers can be dismissed without cost. This would further mitigate the effect quantitatively. We thank an anonymous referee for pointing out this possibility.

[24] Since 1989, the IAB has collected establishment-level data on open positions (*'IAB Erhebnung des*

for Germany has been 42 calendar days, slightly lower than the long-run average for $1989-2006$ of 46 calendar days. After controlling for weekends and holidays, an average duration of 42 days corresponds to a daily job filling rate of 2.9%, i.e., more than 40% lower than for the U.S.[25] With a standard aggregate matching function as in our model above, a lower job filling rate can stem either from a higher labor market tightness or a lower matching efficiency. Given that a higher labor market tightness would also imply a higher job finding rate for Germany, a lower matching efficiency must reconcile the evidence and the theory.

On the worker's side the explanation that the lower matching efficiency in Germany is responsible for the low transition rates and the sluggish labor market response has been very prominent since the 1980s, when the empirical literature documented a strong outward shift of the Beveridge curve for Germany, e.g., Gross (1993) and Schettkat (1992). Petrongolo and Pissarides (2001) and Franz (2009) provide detailed surveys of this literature. Petrongolo and Pissarides (2001) conclude after summarizing the evidence that *'(...) the literature often attributes it to unmeasured elements of the unemployment insurance system and mismatch. It is interesting that measured components of the unemployment insurance system do not play a role in the deterioration of the matching rate.'* (p.410) More recently, the outward shift of the Beveridge curve in the U.S. during the recent crisis has also been discussed as a consequence of a decrease in matching efficiency (Elsby, Hobijn, and Sahin (2010a), Kocherlakota (2010)).

The aggregate picture just outlined is commonly attributed to the particular *'credential-based occupational structure'* of the German labor market (Diprete, Graaf, Luijkx, Tahlin, and Blossfeld (1997), p.325).[26] If workers and firms meet randomly in the market and face the same contact rate in Germany and the U.S. but less matches can be formed due to missing occupational credentials or, for example, due to larger moving costs,[27] the resulting matching efficiency parameter $\varkappa$ is

gesamtwirtschaftlichen Stellenangebots'). The data for Germany have been kindly provided by the IAB and are taken from this survey.

[25] If instead of considering the time from opening the position to signing the contract, we consider the period from opening the position to the actual start of working, the average vacancy duration increases for $2001-2006$ to 67 calendar days, again slightly below the long-run average of 72 days.

[26] Soskice (1994) provides an excellent and comprehensive overview of the German apprenticeship system that underlies this 'credential-based occupational structure.'

[27] Molloy, Smith, and Wozniak (2011) document substantially higher regional mobility rates for the U.S. in comparison to Germany for 2005.

estimated to be lower in Germany. In this case, the range of offers considered by a worker and the range of worker types considered by a firm shrinks which leads to a lower aggregate matching efficiency.[28] In the empirical literature, this channel has been held responsible for the low matching efficiency in Germany (cp. Schioppa (1991), Franz (2009)).

The most closely related empirical study along this dimension offering micro-evidence is Gangl (2004), who provides a direct comparison of German and U.S. occupational mobility rates using the same IAB data source for Germany. He contrasts occupational mobility in Germany with U.S. data from the Survey of Income and Program Participation (SIPP) over the period from 1984−1995, partly covering our sample period. He finds that occupational mobility out of unemployment is about 40% higher in the U.S. Diprete, Graaf, Luijkx, Tahlin, and Blossfeld (1997) document gross flow rates across industries in the U.S. and in Germany. They also find that the gross flow rates for the U.S. are substantially higher. The high mobility rates for the U.S. have also been documented in Kambourov and Manovskii (2008) and Moscarini and Thomsson (2007) and evidence on low occupational mobility for Germany can be found in Franz (2009) and Hecker (2000). The study by Hecker (2000) shows further that holding an occupational degree significantly reduces occupational mobility. She reports for 1999 that 53% of workers without an occupational degree report at least one occupational change in their careers (18% report more than one change), while for workers with an occupational degree only 26% report an occupational change (6% report more than one change). Hecker documents that the occupational mobility in Germany has been stable since the beginning of the 1980s, with a decrease at the end of the 1970s, which marks the beginning of our sample period.

The importance of the institutional setup of the search process can be indirectly inferred from the recent large labor market reform in Germany. The reform was proposed by a commission of experts from business, unions, academia, politics, consulting, and the labor market agency and was commonly referred to as *Hartz reform*.[29] The explicitly stated goal of a substantial part of the reform package (Hartz I-III) was to enhance the efficiency in the matching process of labor demand

[28] From an earlier IAB survey on vacancies (Cramer (1990)), it can be seen that occupational barriers might play an important role. In 1989 firms report that 21% of applicants are not considered for a position because of missing or too little occupational training.

[29] Named after the commission's chair, Peter Hartz, who at that time was director of human resources at Volkswagen.

and supply.[30] The last part of the reform package (Hartz IV) enacted in 2005 changed the rules for benefit entitlements. The first two parts of the reform Hartz I and Hartz II were enacted in 2003 and were targeted at fostering alternative forms of employment (Hartz I) and reducing employment in the shadow economy by making marginal employment more attractive (Hartz II). The third part of the reform (Hartz III) was enacted in 2004 and in particular was targeted to the organizational structure of the matching process. It led to substantial changes in the organizational structure of the employment agencies and the placement process. Furthermore, the rules to enforce regional and occupational mobility, especially among young workers, have been substantially tightened with the reform. In the course of the reform, the market for private-sector placement agencies has been liberalized to increase competition. Fahr and Sunde (2009) provide the first empirical evidence that the reform steps of Hartz I-III have been successful in increasing matching efficiency but further research is still in order.

The evidence discussed in this section supports the finding from our structural analysis that differences in matching efficiency might be an important contributor to the cross-country differences in labor market flows.

5 Conclusions

In this paper, we document large differences in average transition rates and their volatilities between Germany and the U.S. We provide some analytical results on the impact of various parameters that, in a fairly standard search and matching model, typically capture institutional differences across countries. We find that a lower matching efficiency can largely explain the cross-country differences. We discuss empirical evidence that supports a lower matching efficiency in Germany. We suggest that barriers to switching occupations are an important source for these matching imperfections and largely responsible for the propagation of shocks in Germany. While the crucial step taken in this paper is to show how model parameters capturing labor market institutions in most search and

[30] This goal is explicitly formulated in the first evaluation of the reform by the German government (see Bundesministerium für Arbeit und Soziales (2006)). Further details regarding the commission's proposal can be found in the final report of the commission (Hartz, Bensel, Fiedler, Fischer, Gasse, Jann, Kraljic, Kunkel-Weber, Luft, Schartau, Schickler, Schleyer, Schmid, Tiefensee, and Voscherau (2002)).

matching models simultaneously affect the steady-state transition rates and volatilities, we must leave it to future research to understand the details of the identified labor market friction in a more micro-founded way. In particular, the large labor market reform in Germany, the so-called *Hartz reform*, was explicitly directed to increase the efficiency in the matching process. Our findings suggest that the reform could also have an impact on business cycle dynamics in Germany. We plan to explore the effects of the reform on worker flows in our future research.

References

Bachmann, R. (2005): "Labour Market Dynamics in Germany: Hirings, Separations, and Job-to-Job Transitions over the Business Cycle," *Humboldt University: SFB Discussion Paper 2005-45*.

Bentolila, S., and G. Bertola (1990): "Firing Costs and Labour Demand: How Bad Is Eurosclerosis?," *Review of Economic Studies*, 57(3), 381–402.

Bentolila, S., P. Cahuc, J. J. Dolado, and T. L. Barbanchon (2010): "Unemployment and Temporary Jobs in the Crisis: Comparing France and Spain," *working paper*.

Blanchard, O., and J. Gali (2010): "Labor Markets and Monetary Policy: A New Keynesian Model with Unemployment," *working paper*, 2008(1).

Blanchard, O., and P. Portugal (2001): "What Hides Behind an Unemployment Rate: Comparing Portuguese and U.S. Labor Markets," *American Economic Review*, 91(1), 187–207.

Bundesministerium für Arbeit und Soziales (2006): "Bericht 2006 der Bundesregierung zur Wirksamkeit moderner Dienstleistungen am Arbeitsmarkt," Deutscher Bundestag Drucksache 16/3982.

Burda, M., and C. Wyplosz (1994): "Gross worker and job flows in Europe," *European Economic Review*, 38(6), 1287–1315.

Burgess, S., and D. Mawson (2003): "Aggregate Growth and the Efficiency of Labour Reallocation," CEP Discussion Papers dp0580, Centre for Economic Performance, LSE.

Costain, J., J. Jimeno, and C. Thomas (2010): "Employment fluctuations in a dual labor market," *Working Paper, Baco de Espana*, 1013.

Cramer, U. (1990): "Probleme bei der Besetzung von offenen Stellen: Ergebnisse einer Betriebsbefragung," Mitteilungen aus der Arbeitsmarkt- und Berufsforschung 2, Institut für Arbeitsmarkt- und Berufsforschung.

Davis, S. J., J. R. Faberman, and J. C. Haltiwanger (2009): "The Establishment-Level Behavior of Vacancies and Hiring," Federal Reserve Bank of Philadelphia working paper.

Davis, S. J., R. J. Faberman, and J. C. Haltiwanger (2013): "The Establishment-Level Behavior of Vacancies and Hiring," *The Quarterly Journal of Economics*, 128(2), 581–622.

den Haan, W., G. Ramey, and J. Watson (2000): "Job Destruction and Propagation of Shocks," *American Economic Review*, 90, 482–498.

Diprete, T. A., P. M. D. Graaf, R. Luijkx, M. Tahlin, and H.-P. Blossfeld (1997): "Collectivist versus individualist mobility regimes? Structural change and job mobility in four countries," *American Journal of Sociology*, 103(2), pp. 318–58.

Elsby, M., B. Hobijn, and A. Sahin (2010a): "The Labor Market in the Great Recession," *Brookings Panel on Economic Activity*.

Elsby, M., B. Hobijn, and A. Sahin (2010b): "Unemployment dynamics in the OECD," *NBER working paper 14617*.

Elsby, M., R. Michaels, and G. Solon (2009): "The Ins and Outs of Cyclical Unemployment," *American Economic Journal: Macroeconomics*, 1(1), 84–100.

Fahr, R., and U. Sunde (2009): "Did the Hartz Reforms Speed-Up the Matching Process? A Macro-Evaluation Using Empirical Matching Functions," *German Economic Review*, 10(3), 284–316.

FALLICK, B., AND C. A. FLEISCHMAN (2004): "Employer-to-employer flows in the U.S. labor market: the complete picture of gross worker flows," Finance and Economics Discussion Series 2004-34, Board of Governors of the Federal Reserve System (U.S.).

FRANZ, W. (2009): *Arbeitsmarktökonomik*. Springer, 7 edn.

FUJITA, S., AND G. RAMEY (2009): "The Cyclicality of Separation and Job Finding Rates," *International Economic Review*, 50(2), 415–430.

GANGL, M. (2004): "Labor market structure and re-employment rates: Unemployment dynamics in West Germany and the United States," *Research in Social Stratification and Mobility*, 20, 185–224.

GARTNER, H., C. MERKL, AND T. ROTHE (2012): "Sclerosis and large volatilities: Two sides of the same coin," *Economics Letters*, 117(1), 106–109.

GROSS, D. M. (1993): "Equilibrium vacancy and unemployment: A flow approach to the beveridge curve," *Journal of Macroeconomics*, 15(2), 301 – 327.

HAEFKE, C., M. SONNTAG, AND T. VAN RENS (2007): "Wage rigidity and job creation," *working paper*.

HAGEDORN, M., AND I. MANOVSKII (2008): "The cyclical behavior of equilibrium unemployment and vacancies revisited," *American Economic Review*, 98(4), 1692–1706.

HALL, R. E. (2005): "Employment Fluctuations with Equilibrium Wage Stickiness," *American Economic Review*, 95(1), 50–65.

HARTZ, P., N. BENSEL, J. FIEDLER, H. FISCHER, P. GASSE, W. JANN, P. KRALJIC, I. KUNKEL-WEBER, K. LUFT, H. SCHARTAU, W. SCHICKLER, H.-E. SCHLEYER, G. SCHMID, W. TIEFENSEE, AND E. VOSCHERAU (2002): "Moderne Dienstleistungen am Arbeitsmarkt," Bericht der Kommission.

Hecker, U. (2000): "Berufliche Mobilität und Wechselprozesse," in *Wandel der Erwerbsarbeit: Arbeitssituation, Informatisierung, berufliche Mobilität und Weiterbildung. BeitrAB 231.*, pp. 67–98.

Hertweck, M. S., and O. Sigrist (2012): "The Ins and Outs of German Unemployment," Working Paper.

Jung, P., and M. Kuhn (2011): "Labor Market Rigidity and Business Cycle Volatility," working paper, University of Bonn.

——— (2012): "Earnings Losses and Labor Mobility over the Lifecycle," IZA Discussion Papers 6835, Institute for the Study of Labor (IZA).

Kambourov, G., and I. Manovskii (2008): "Rising occupational and industry mobility in the United States: 196897," *International Economic Review*, 49(1), 41–79.

Kocherlakota, N. (2010): "Inside the FOMC," Speech, Marquette, Michigan, Federal Reserve Bank of Minneapolis.

Ljungqvist, L. (2002): "How Do Lay-off Costs Affect Employment?," *The Economic Journal*, 112(482), 829–853.

Ljungqvist, L., and T. Sargent (2008): "Two Questions about European Unemployment," *Econometrica*, 76(1), 129–149.

Menzio, G., and S. Shi (2009): "Efficient Search on the Job and the Business Cycle," Working Paper 14905, National Bureau of Economic Research.

Molloy, R., C. L. Smith, and A. Wozniak (2011): "Internal migration in the United States," *Journal of Economic Perspectives*, 25(2), 1–42.

Moscarini, G., and K. Thomsson (2007): "Occupational and Job Mobility in the US.," *Scandinavian Journal of Economics*, 109(4), 807–836.

Petrongolo, B., and C. A. Pissarides (2001): "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, 2001(2), 390–431.

——— (2008): "The Ins and Outs of European unemployment," *American Economic Review*, 98(2), 256–262.

Pissarides, C. (2009): "The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?," *Econometrica*, 77(5), 1339–1369.

Pries, M., and R. Rogerson (2005): "Hiring policies, labor market institutions, and labor market flows," *Journal of Political Economy*, 113(4), 811–839.

Schettkat, R. (1992): "Mismatch in the West German Labour Market? Economic Restructuring and Unemployment in the 1980s," *LABOUR*, 6(1), 121–140.

Schioppa, F. P. (1991): *Mismatch and labour mobility*, Cambridge and New York. Cambridge University Press.

Shimer, R. (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, 95(1), 25–49.

——— (2007): "Reassessing the Ins and Outs of Unemployment," working paper 13421, National Bureau of Economic Research.

Soskice, D. (1994): "Reconciling Markets and Institutions: The German Apprenticeship System," in *Training and the Private Sector*, pp. 25–60.

Wasmer, E. (2006): "Interpreting European and US Labour Market Differences: The Specificity of Human Capital Investments," *American Economic Review*, 96(3), 811–831.

Yashiv, E. (2007): "U.S. Labor Market Dynamics Revisited," *The Scandinavian Journal of Economics*, 109(4), pp. 779–806.

A Data

This study uses the factually anonymous BA-Employment Panel (Years 1975 – 2004). Data access was provided via a Scientific Use File supplied by the Research Data Centre (FDZ) of the German

Federal Employment Agency (BA) at the Institute for Employment Research (IAB). Transition rates for the U.S. are taken from Shimer (2007) except for EE rates, which are obtained from Fallick and Fleischman (2004).

The German IAB data consist of daily employment records of workers that have been employed for at least one day in a job under mandatory social security. The data set comprises a 2% representative subsample of workers drawn from these records. The sample does not contain spells in public service (*'Beamte'*), self-employment, and periods of inactivity. Still, the data cover about 80% of the German workforce. For information regarding job status and earnings, the data contain virtually no measurement error because the information is taken from the social security records that are used to determine social security contributions and benefits.

Our basic time period is one month. We adopt a CPS-like timing convention to measure the employment status of a person in a given month. For each month we identify the date of the Monday of the second week in the month and take the week starting from this Monday as our reference week. We look at all spells that overlap with this week. If only one spell overlaps, then this spell determines the labor market status in the current month. If several spells overlap, we use a hierarchical ordering of spells.[31] From this classification of monthly employment states, we construct monthly time series. To check whether a person stays with the same employer, we use the establishment number of employment spells. Thus, the transition of a person between establishments but within the same firm is counted as a job-to-job transition. The definition of who is counted as unemployed follows from the content of the data set. A person is unemployed if she receives unemployment benefits or other benefits on the basis of the Social Security Code III ('Sozialgestzbuch III'). We cannot follow the CPS definition, which is based on interview questions about an unemployed individual's job search and willingness to take up employment, because this information is unobservable in our sample.

The online appendix comprises a detailed discussion on the sample selection, the construction of employment spells, and the aggregate data used.

[31] A full-time employment spell dominates part-time spells and any employment spell trumps unemployment or inactivity spells.

B Unemployment decomposition

We describe here the decomposition proposed in Fujita and Ramey (2009) and our extension. The decomposition of Fujita and Ramey is a two-state decomposition with two transition rates. The idea of the decomposition of the unemployment volatility into contribution rates from EU and UE flows is to take an approximation around trend unemployment

$$\begin{aligned}
u_t &\approx \frac{\pi_{eu,t}}{\pi_{eu,t}+\pi_{ue,t}} \\
\log\left(\frac{u_t}{\bar{u}_t}\right) &= (1-\bar{u}_t)\log\left(\frac{\pi_{ue,t}}{\bar{\pi}_{ue,t}}\right) - (1-\bar{u}_t)\log\left(\frac{\pi_{eu,t}}{\bar{\pi}_{eu,t}}\right) + \epsilon_t \\
du_t &= dUE_t + dEU_t + \epsilon_t
\end{aligned}$$

where $\pi_{eu,t}$ denotes the EU rate and $\pi_{ue,t}$ the UE rate. A bar denotes the trend component of the respective variable. $\log(u_t/\bar{u}_t)$ measures the relative deviation of the unemployment rate from its trend.

Fujita and Ramey show that the variance of $\ln(u_t/\bar{u}_t)$ can then be decomposed such that $1 = \beta_{\pi_{ue}} + \beta_{\pi_{eu}} + \beta_{\epsilon}$ where $\beta_x = \frac{cov(du_t,dx)}{var(du_t)}$. Their decomposition allows us to obtain two separate components (and an error term) for the contribution of the corresponding series in explaining the cyclical variation of the unemployment rate. Using an equivalent steady-state approximation for the three-state case and defining weights $\alpha := \frac{\bar{\pi}_{nu}}{\bar{\pi}_{ne}+\bar{\pi}_{nu}}$ and $\lambda_{ij} := (1-\bar{u})\frac{\bar{\pi}_{ij}}{\bar{\pi}_u}$, as well as the (weighted) average of separation and hiring rates $\bar{\pi}_u := \bar{\pi}_{eu} + \frac{\bar{\pi}_{nu}}{\bar{\pi}_{ne}+\bar{\pi}_{nu}}\bar{\pi}_{en}$ and $\bar{\pi}_e := \bar{\pi}_{ue} + \frac{\bar{\pi}_{un}}{\bar{\pi}_{ne}+\bar{\pi}_{nu}}\bar{\pi}_{ne}$, we obtain an extended decomposition

$$\begin{aligned}
\log\left(\frac{u_t}{\bar{u}}\right) &= \log\left(\frac{\pi_{eu,t}}{\bar{\pi}_{eu}}\right)\lambda_{eu} - \log\left(\frac{\pi_{ue,t}}{\bar{\pi}_{ue}}\right)\lambda_{ue} \\
&\quad + \log\left(\frac{\pi_{en,t}}{\bar{\pi}_{en}}\right)\alpha\lambda_{en} - \log\left(\frac{\pi_{ne,t}}{\bar{\pi}_{ne}}\right)(1-\alpha)(\lambda_{ue}+\lambda_{un}-\lambda_{eu}) \\
&\quad + \log\left(\frac{\pi_{nu,t}}{\bar{\pi}_{nu}}\right)\alpha(\lambda_{eu}+\lambda_{en}-\lambda_{ue}) - \log\left(\frac{\pi_{un,t}}{\bar{\pi}_{un}}\right)(1-\alpha)\lambda_{un} + \varepsilon_t \\
du_t &= dEU_t + dUE_t + dEN_t + dNE_t + dNU_t + dUN_t + \varepsilon_t
\end{aligned}$$

Again using $\beta_x = \frac{cov(du_t, dx)}{var(du_t)}$ a similar covariance decomposition as in Fujita and Ramey (2009) of the form $1 = \sum \beta_x + \varepsilon_t$ applies. The formula is similar to the first-difference filter obtained in Petrongolo and Pissarides (2008), although they essentially lump together the rates $dEN_t + dUN_t$ and the corresponding inflow rate into $dNE_t + dNU_t$. In fact, the inactivity flows are hard to interpret in their decomposition.

Remark: *Note that the decomposition does not rely on knowing the stock of inactive workers (N), which is not available for Germany. To derive the decomposition only the (gross) flows from inactivity are needed because the stocks cancel from the formula. This is because the following equality holds*

$$(1-\alpha)(\lambda_{ue} + \lambda_{un} - \lambda_{eu}) = \alpha(\lambda_{eu} + \lambda_{en} - \lambda_{ue})$$

so that the two terms that involve the stock of inactive workers are multiplied by the same factor with opposite signs and the stocks cancel. This follows directly after plugging in the definitions and rearranging terms. A detailed derivation is available upon request.

Online Appendix
Not for Publication

This online appendix accompanies the paper *'Labor market institutions and worker flows: Comparing Germany and the U.S.'*. It comprises two parts. Part I provides details on the German IAB data and the construction of labor market flows. Part II provides a robustness analysis.

I Data details

I.1 Sample selection

Due to problems in measuring unemployment during the years 1977 and 1978, we start our analysis in 1980.

In a first step, we drop all individuals where the East-West information (2,787 individuals) or information regarding the current job is missing[32] (14,490 individuals). Furthermore, we drop homemakers ('Heimarbeiter') from the sample (7,315 individuals). This results in a dropping rate of 1.81% for the whole sample and leaves us with a sample of employment histories for 1,336,357 individuals. After German reunification, the data contain employment histories with spells that are located in East Germany. Because the East German labor market was subject to additional regulations and restructuring after the reunification, we exclude, in a second step, all persons with employment spells in the East from our sample. This leaves us with a final sample of 1,087,555 individuals. From these records we drop all marginal employment spells to avoid mismeasurement because marginal employment spells are only reported for the last five years of the sample period.

I.2 Construction of monthly employment spells

The employment history is given as a collection of employment spells on a daily basis. For an individual who has been put into the sample the full employment history during the sampling period is observed. A new spell can either occur for administrative reasons of the social security system or changes within a given firm. Importantly for our analysis, every change of employer or the

[32] Information for variable *stib* is missing.

beginning of an unemployment or inactivity spell is recorded in the data. Individuals in the sample regularly have periods of parallel employment, which are reported as multiple spells. For every spell, we observe whether it is full-time, part-time, or, starting in 1999, marginal employment. We apply a hierarchical ordering to classify these spells. If persons have parallel spells in their employment history, we consider only what we call *primary spells*. The idea is to consider the employment spell that yield the highest earnings and occupies most of an individual's working time. To identify the *primary spell*, we apply a hierarchical selection procedure. If a person is simultaneously employed full-time and part-time, we label him or her as employed full-time and drop the part-time spells. If a person has two part-time jobs, we follow the ordering in the data set, which applies a hierarchical ordering based on earnings and part-time status over parallel spells. Finally, if a person has simultaneous employment and unemployment spells, we label the employment spells as primary to be consistent with the procedure in the next step of determining the employment status. This problem only arises with marginal employment and can be disregarded for the analysis in this paper.

Intervals during which an individual in the data is not working are labeled as inactive employment periods. These spells are periods of sustained employment relationships that are currently inactive, i.e., the worker does not work and earnings are zero. Examples of these periods are maternity leave, long periods of illness, and sabbaticals. We construct additional inactivity spells as residual spells in the data. The additional spells are included if a person is not observed in the sample for some time period between two spells. To deal with persons entering or dropping out of the sample, we introduce additional labor market states that we label *labor market entry* and *retirement*. The labor market entry state is an artificial state that we add before the first employment state. The retirement state is an artificial state at the end of the labor market history. We assign it to persons who are 55 years or older when they have their last observed spell. The retirement state is, by construction, an absorbing state and persons who enter will be dropped from the analysis one month later. Persons who are below 55 and have no future spells in the sample are labeled as *other employment* and are no longer considered after the transition into this inactivity state, i.e., they do not generate transitions out of inactivity. Persons who are younger than 55 but have future spells are labeled as *out of the labor force*. The *labor market entry* state, the reported spells of inactivity, and the *out of the labor force* spells constitute the pool from which all inactivity transitions originate.

To construct employment spells, we need the person's age from time to time. We use year of birth and the date of the spell to construct age. However, the variable year of birth is censored for all observations in the employment history, if a person is at least at one spell below age 16 or older than 62 years. Due to the sample length both cases cannot occur simultaneously. In the first case, we set year of birth as if the person is 15 at the first spell and in the second case as if the person is 63 at the last spell. We recover age at all spells consistently.

I.3 Aggregate data

Our GDP measure for Germany is GDP per capita. We use GDP per capita because of the large inflows to West Germany after the fall of the Berlin Wall but before the official reunification. To obtain productivity, we divide by the number of employed persons. The time series for West Germany at quarterly frequency are available until $1992Q4$; afterwards the GDP series are only available for unified Germany at a quarterly frequency. We merge the two series in $1992Q4$ and run an ARIMA X-12 outlier correction on the combined series. The outlier correction controls for additive outliers, and temporary and permanent shifts in the data. The earnings series for Germany are median earnings of full-time employed workers from the IAB data. We deflate all series using the CPI. The unemployment rates for Germany are available at monthly frequency for West Germany, and we aggregate to quarterly frequency by taking quarterly averages of monthly rates. GDP, GDP per employed (productivity), earnings, and unemployment rates for the U.S. are obtained from the Bureau of Labor Statistics (BLS).

II Robustness

This section provides a robustness check for the analysis in the main part of the paper. We focus on the volatilities of the transition rates instead of their logarithmic transformation and decompose the unemployment rate volatility in levels. We then recalibrate the model to the new targets and perform the parameter experiments as in the main part of the paper. If additive measurement error is present in transition rates, for example, due to misclassification in the stocks of unemployed and inactive workers, the logarithmic transformation might affect the volatility estimates. Instead, if the measurement error is multiplicative, the logarithmic transformation would be unaffected. Table A reports the standard deviations of the unemployment rate and transition rates together with the implied coefficient of variation (CV). The volatility of the unemployment rate is larger in Germany than in the U.S., while both the UE rate volatility and the EU rate volatility are smaller. Looking at the coefficient of variation, we see that a similar picture emerges as for the log volatilities. The volatility of both the unemployment volatility and the UE rate is roughly equal, while the EU rate volatility in Germany is substantially larger.

Table A: Transition rates over the business cycle (table 1, no logs)

	Transition rate	Mean	Std	CV	Corr.
Germany	Urate	8.4	1.29	15.4	−0.77
U.S.		6.3	0.97	15.5	−0.86
Germany	EU	0.5	0.07	14.2	−0.82
U.S.		2.0	0.14	7.0	−0.67
Germany	UE	6.2	0.74	11.9	0.44
U.S.		30.7	3.41	11.1	0.79
Germany	EE	0.9	0.14	16.1	0.62
U.S.		2.6	0.16	6.3	0.62
Germany	EN	1.0	0.06	6.3	0.58
U.S.		2.7	0.13	4.6	0.47
Germany	UN	4.9	0.68	13.9	0.53
U.S.		26.6	2.38	8.9	0.67

Notes: Data series are quarterly averages of monthly data for the period $1980q1-2004q3$. Standard deviations (STD) are for deviations from an HP-filtered trend ($\lambda = 100,000$). The column CV reports the coefficient of variation and correlations (CORR) refer to the correlation coefficient with GDP. All statistics have been multiplied by 100 to ease readability.

Table B presents a decomposition of the unemployment rate volatility based on ideas in Petrongolo and Pissarides (2008). Their approach allows for a decomposition of the unemployment rate but comes at the cost that for the three-state decomposition we cannot separately assign contributions to 6 different flow rates but only to 4 components. The same findings as for log volatilities emerge.

Table B: Unemployment volatility decomposition (table 2, no logs)

Country	Data	# of states	EU	UE	NU + EN	UN + NE	ε
Germany	IAB	2	58.5	41.5			0.0
	IAB	3	39.4	26.0	18.1	16.6	0.0
U.S.	Shimer	2	34.1	65.9			0.0
	Fujita/Ramey	2	37.3	62.7			0.0
	Shimer	3	21.4	48.1	6.8	23.7	0.0

Notes: Data are HP-filtered ($\lambda = 100,000$) for the period $1980q1 - 2004q4$. For Germany the transition rates are the authors' own calculations. The U.S. data are obtained from Shimer (2007) and Fujita and Ramey (2009). Contribution shares of flows are given in the corresponding column and are given as percentage numbers. The third column reports the number of states considered in the decomposition. The data source is given in column 2.

Table C reports how the calibration changes when we calibrate to the targets from table A. We see that the parameters are very similar, notably the layoff tax now becomes somewhat larger.

Table C: Calibration (table 5, no logs)

Parameter	$\varkappa$	μ	ψ	b/w	τ
U.S.	0.52	0.27	0.91	0.96	2.95
Germany	0.24	0.53	0.97	0.96	3.91
Data target	$\bar{\pi}_{ue}$	$\bar{\pi}_{eu}$	$\lvert\tilde{\sigma}_{eu}\rvert$	$\tilde{\sigma}_{ue}$	$\tilde{\sigma}_{w}$
U.S.	30.7	2.0	0.14	3.4	0.8
Germany	6.2	0.5	0.07	0.7	0.8

Notes: Data targets and calibrated parameters.

Table D shows the corresponding results when we change one parameter at a time as described in the main text. We use the level approximation for the unemployment decomposition, which does not approximate the empirical decomposition as well as the logarithmic approximation. Similar findings emerge. We see that a change in the matching efficiency, targeted to explain the change in the UE rates across countries, exactly matches the decline in the steady-state EU rate and the UE rate volatility; it captures the decline in the EU rate volatility but is still too strong. Findings for the other parameters are similar to those in the discussion in the main part of the paper. Notably, an increase in layoff taxes lowers the EU rate volatility but again increases the share of outflows in the contribution of unemployment volatility relative to the inflows.

Table D: Parameter experiments (table 6, no logs)

		$\bar{\pi}_{ue}$	$\bar{\pi}_{eu}$	σ_{ue}	$\lvert\sigma_{eu}\rvert$	$\lvert\sigma_{w}\rvert$	$\frac{\lvert\sigma_{eu}\rvert(1-\overline{u})}{\lvert\sigma_{eu}\rvert(1-\overline{u})+\sigma_{ue}(\overline{u})}$
	U.S. (benchmark)	30.7	2.0	3.4	0.14	0.8	38.6
	Germany (benchmark)	6.2	0.5	0.7	0.07	0.8	54.5
(1)	$\varkappa = 0.13$	**6.2**	0.5	0.7	0.12	0.6	66.3
(2)	$\mu = 0.89$	**6.2**	1.6	0.7	0.15	0.9	46.2
(3)	$b/w = 0.99$	**6.2**	3.3	7.6	0.51	0.5	11.2
(4)	$\tau = 4.26$	26.2	**0.5**	4.2	0.05	0.9	35.3
(5)	$\psi = 0.66$	25.7	**0.5**	4.2	0.06	0.8	42.6
	U.S. calibration	$\varkappa = 0.52$	$\mu = 0.27$	$b/w = 0.96$	$\tau = 2.95$	$\psi = 0.90$	

Notes: The second column gives the parameter that has been changed relative to the calibrated U.S. economy and the corresponding value. The bold number shows the targeted data point. The parameters of the calibrated U.S. economy are given in the last line.