They Are Even Larger! More (on) Puzzling Labor Market Volatilities

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July 24, 2009

Abstract

This paper shows that the German labor market is more volatile than the US labor market. Specifically, the volatility of the cyclical component of several labor market variables (e.g., the job-finding rate, labor market tightness, and job vacancies) divided by the volatility of labor productivity is roughly twice as large as in the United States. We derive and simulate a simple dynamic labor market model with heterogeneous worker productivity. This model is able to explain the higher German labor market volatilities by the longer job tenure.

JEL classification: J6, E24, E32

Keywords: Labor Market Volatilities, Unemployment, Worker Flows, Vacancies, Job-Finding Rate, Market Tightness

1 Introduction

It is well known for the United States that the standard deviation of the cyclical component of labor market variables (e.g., the job-finding rate, job vacancies, and unemployment) is much larger than the standard deviation of the cyclical component of labor productivity (see Shimer, 2005). However, so far there is no comprehensive empirical evidence for European countries on this issue (e.g., comparable to Shimer, 2005, for the United States).[1] We close this gap by

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[1]This is partly related to data availability or construction problems. Eurozone data can, for example, only be constructed synthetically using country-specific datasets. Christoffel et al. (2009) provide some evidence for the eurozone. However, their sample period is shorter than ours and they do not show any evidence for some important variables, such as the job-finding rate or the separation rate.

constructing labor market time series for Europe's largest economy, Germany, based on data provided by the Institute for Employment Research and the German Federal Employment Agency. The job-finding and separation rates were calculated with a large register data set that contains spells of employment and unemployment for every worker covered by the German social security system.

Interestingly, and maybe surprisingly at first sight, German labor market variables are very volatile; even more so than the US labor market variables. The standard deviation of the vacancy-unemployment ratio for Germany is almost 40 times larger than the standard deviation of labor productivity. The standard deviation of vacancies is about 24 times larger, and the standard deviation of the job-finding rate is about 17 times larger, than the standard deviation of the labor productivity. Overall, these labor market variables are roughly two times more volatile (compared to labor productivity) than in the United States.[2]

These results raise a number of research questions: Why are labor market variables in Germany so much more volatile than in the United States, although Germany is often considered to be eurosclerotic (Giersch, 1985)? Can the workhorse labor market model (search and matching) account for this phenomenon? Or are there other mechanisms that account for this phenomenon?

This paper provides tentative theoretical answers to these questions. We show analytically that the textbook search and matching model can only replicate the observed evidence if a more extreme version of Hall's (2005) rigid wage solution or Hagedorn and Manovskii's (2008) small surplus calibration is chosen. However, this would aggravate well-known problems with the application of the model in this context. Therefore, we employed a simple model of unemployment that is based on heterogenous idiosyncratic labor productivity and various wage formation mechanisms. We show analytically that this model is able to amplify the volatility of macroeconomic shocks substantially and therefore to account for the high volatilities of labor market variables observed in Germany.[3] Further, the new model is able to explain why the labor market in Germany is more volatile than in the United States. Job tenure is longer in Germany (due to lower turnover rates), which causes productivity shocks to have a greater effect on firms' behavior. When job tenure is longer, firms can expect to retain workers longer, whereby autocorrelated profits generate a larger change in the present value of profits.

We calibrated our labor market model to German data and show that the model is able to generate a substantial part of the observed labor market volatility. Further, by calibrating the model for an economy with higher labor market flows, we illustrate that this model would predict higher volatilities for Germany than for the United States.

[2]Only the volatility of the separation rate does not fit this pattern. The separation rate in our dataset is basically acyclical. This may be due to high firing costs or to a countercyclical reaction of households.

[3]For comparability reasons (to Hagedorn and Manvoskii, 2008, Hall, 2005, and Shimer, 2005), we focus on productivity shocks. However, this is without loss of generality. In a general equilibrium setting with aggregate demand shocks the amplification mechanism would work in similar manner (see, e.g., Lechthaler et al., 2008).

The rest of the paper is structured as follows. In Section 2, we provide a detailed description of German labor market dynamics, making it as comparable as possible to Shimer (2005). In Section 3, we compare analytically the ability of the search and matching model and our model to generate labor market variables that are highly sensitive to macroeconomic shocks. Our results provide a first tentative answer to why Germany's labor market dynamics may be different from the United States. In Section 4, we calibrate our model to German data and simulate macroeconomic shocks. Our results show potential differences between Germany and the United States. Section 5 briefly concludes.

2 Volatilities in Germany

2.1 Overview

Before we discuss all the labor market variables in detail (data sources, time patterns, etc.), we provide in Table 1 an overview of the cyclical behavior of unemployment, vacancies, labor market tightness, the job-finding rate, the separation rate, wages, and labor productivity.[4] To compare the cyclical patterns of the labor market in Germany with those in the United States, we calculated a correlation matrix for Germany (Table 1) and we present Shimer's (2005) corresponding summary statistics for the United States in Table 2. Like Shimer (2005), we used seasonally adjusted quarterly data and a Hodrick-Prescott (HP) filter with the smoothing parameter $\lambda = 10^5$ to obtain the log-deviations from the trend. The deviations from the trend were used to calculate the labor market volatilities.

The standard deviation of the vacancy-unemployment ratio, $v/u = \theta$, is 38 times larger than the standard deviation of labor productivity in Germany. The standard deviation of vacancies is 24 times larger and the standard deviation of the job-finding rate is 17 times larger than the standard deviation of productivity. These results are striking. All these variables are roughly twice as volatile (compared to labor productivity) as in the United States. In similar vein, the standard deviation of unemployment is about 14 times larger than the standard deviation of labor productivity.

Table 2 shows that the corresponding volatility ratios in the United States are a lot smaller. Only the separation rate does not fit this pattern. The standard deviation for separations in Germany is similar to the standard deviation in the United States (both in absolute and relative terms).

We conducted several robustness checks to test whether they overturn the result that labor market volatilities in Germany are larger than those in the United States. The robustness tests all deliver the same results. First, we restricted Shimer's job-finding rate for the United States to the same sample period (1977-2003) that we use for Germany, whereby we obtained very similar

[4] We constrain our data to quarterly western Germany from 1977 to 2004. Data for unified Germany is only available from 1991 onwards. To prevent structural breaks, we exclude the eastern German data. Further, data for the job-finding rate is only reliable from 1977 onwards.

Table 1: Summary Statistics and Correlation Matrix for Western Germany 1977-2004

	u	v	v/u	η	ϕ	w	a
Standard deviation	0.180	0.313	0.505	0.229	0.065	0.018	0.013
Relative to prod.	13.520	23.560	37.980	17.200	4.890	1.379	1.000
Autocorrelation	0.979	0.965	0.977	0.928	0.754	0.907	0.832
				correlation			
u Unemployment	1	-0.875	-0.906	-0.913	0.449	-0.564	-0.436
v Vacancies		1	0.977	0.904	-0.444	0.496	0.401
v/u			1	0.948	-0.453	0.535	0.440
η Job-Finding Rate				1	-0.530	0.477	0.462
ϕ Separation Rate					1	0.257	0.048
w Wages						1	0.611
a Labor Productivity							1

Notes: Quarterly data, seasonally adjusted using censusX12, log deviation from HP-trend with $\lambda = 10^5$, $log(X/X_{hp})$. 1977 to 2004; registered unemployment u was provided by the German Federal Employment Agency; vacancies, v, adjusted by market share of the Federal Employment Agency; the job-finding rate, η, is computed as the new hirings divided by the registered unemployment; the separation rate, ϕ, is the separations divided by employment; productivity, a, and wages, w, per working hour.

Table 2: Summary Statistics for the United States, 1951-2003

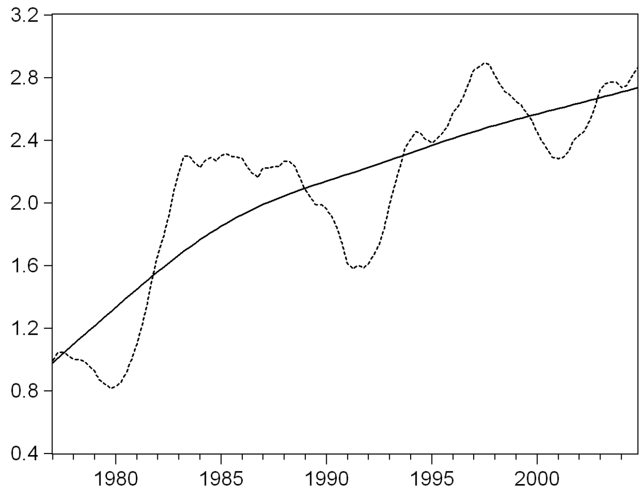
	u	v	v/u	η	ϕ	a
Standard deviation	0.190	0.202	0.382	0.118	0.075	0.020
Relative to prod.	9.500	10.100	19.100	5.900	3.750	1.000

Source: Shimer (2005)

results. Second, visually, it seems that there is a structural break in our job-finding rate (with considerably lower rates after 1982). However, we restricted our sample to the period after 1982, and the results continued to hold. Third, we used an HP-filter with $\lambda = 1600$ instead of 10^5 and compared the results with Hornstein et al. (2005). This leads to a drop of the volatilities of all variables (including the labor productivity). However, the volatility of different labor market variables (compared to the labor productivity) in Germany remain considerably higher than in the United States (except for the separation rate). Thus, main conclusion also does not depend on the smoothing parameter of the HP-filter. Further robustness checks will be provided in the next subsections.

Interestingly, the correlation of the various variables is very similar to the correlation for the United States. The correlation matrix in Table 1 shows a large negative correlation between unemployment and vacancies (Beveridge curve) and a large positive correlation between labor market tightness, θ, and the job-finding rate. More details on each of the variables are provided in the next subsections.

Figure 1: Quarterly Unemployment (in Millions) in Western Germany and Trend, 1977-2004



Note: Registered unemployment by the Federal Employment Agency. Seasonally adjusted quarterly averages of monthly data and the HP-filtered trend with smoothing parameter 10^5.

2.2 Unemployment

We calculated the quarterly data of unemployment as mean of the monthly data.[5] Following Shimer (2005: p.27), we used the unemployment level rather than the unemployment rate. On average, 2.1 million people, or 8.05 percent of the labor force, in western Germany were registered as unemployed and actively searching a job. Unemployment peaked in 1983 (2.3 million) and 1997 (2.8 million) and shows an upward trend over the last three decades (see Figure 1). The standard deviation of the cyclical component is 0.18.

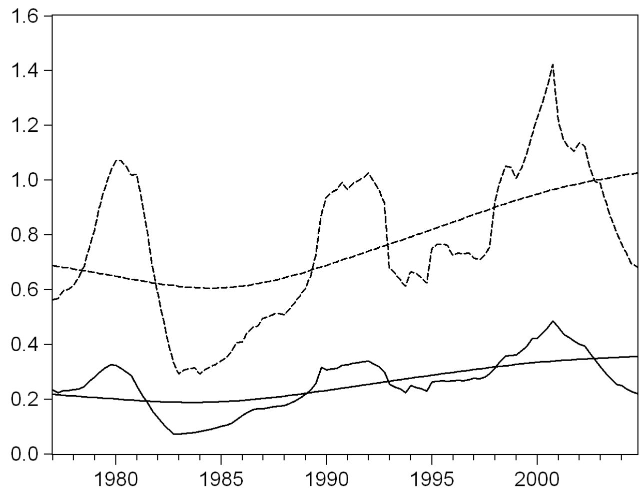
2.3 Vacancies

There are various ways to measure job vacancies. Shimer (2005) uses an advertising index as a proxy for vacancies because the Job Opening and Labor Turnover Survey (JOLTS) was not conducted before 2000. In contrast to the United States, there is an official monthly time series for vacancies in western Germany after 1950 (the statistics of the German Federal Employment Agency provide information on vacancies reported by firms actively searching for employees). However, firms do not have to report their vacancies.

To prevent our results from being biased due to non-reported vacancies,

[5]Monthly time series for registered unemployment in western Germany are provided by the German Federal Employment Agency.

Figure 2: Quarterly Reported Vacancies (solid line) and Corrected Vacancies (dashed line) in Western Germany and Trend (in Millions), 1977-2004



Note: Reported vacancies by the German Federal Employment Agency. Corrected vacancies extrapolated by the market share of the Employment Agency (see text). Both vacancy series are seasonally adjusted quarterly averages of monthly data (the trend is calculated with an HP smoothing parameter 10^5).

we made use of a second data set, which is available as of 1992, namely, the German Job Vacancy Survey (see Kettner et al., 2007). This survey shows about 35 percent of all vacancies were reported between 1992 and 2005 (the percentage of reported vacancies to overall vacancies varies over time).

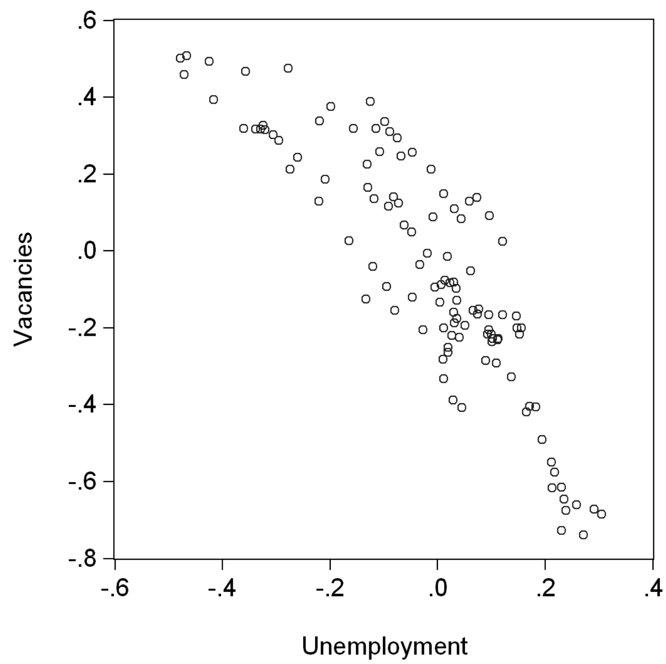
We corrected the reported vacancies for the years 1977 to 1991 according to Franz's (2006: p.106) method, i.e., we used the share of new reported vacancies to all hires:

$$\frac{\text{reported vacancies}}{\text{all vacancies}} \approx \frac{\text{new reported vacancies}}{\text{all hires}} \tag{1}$$

From 1992 on, we used the proportion of reported vacancies on all vacancies in western Germany reported yearly by the German Job Vacancy Survey to extrapolate the job vacancies for all the quarters of the respective year. Both methods are suitable to estimate the total number of all job vacancies taking the market share of the German Federal Employment Agency into account.

Both the reported and the corrected vacancies are very volatile. The standard deviation of reported vacancies is 0.35, while the standard deviation of corrected vacancies is 0.31. The reason is that the share $\frac{\text{(reported vacancies)}}{\text{(all vacancies)}}$ is procyclical. Thus, our main conclusion that the volatility of vacancies is larger

Figure 3: Quarterly Beveridge Curve for Western Germany, 1977-2004



Note: The vacancies reported by the Federal Employment Agency are corrected by the market share of the Employment Agency (see text). Registered unemployment is provided by the Federal Employment Agency. Both are seasonally adjusted quarterly averages of monthly series. The figure shows the log deviation from the HP-filter with the smoothing parameter 10^5.

in Germany than in the United States is not driven by the vacancy correction method, since it reduces the volatility of vacancies in our sample.

To test for robustness, we also calculated the volatility of vacancies from 1950 to 2004[6] and found the same volatility pattern (the standard deviation of the cyclical component of the reported vacancies is 0.33). This shows once more that our main conclusion is not affected by the choice of the observation period.

Vacancies and unemployment show a strong negative correlation (-0.88, see Table 1): The Beveridge curve in Figure 3 shows that macroeconomic shocks generate movements of vacancies and unemployment in opposite directions. The standard deviation of the vacancy-unemployment ratio around its trend is 0.51. Therefore, it is 38 times lager than the volatility of productivity.

[6]In contrast to other labor market variables, such as the job-finding rate, vacancies are available for a long time period.

2.4 Job-Finding Rate

The job-finding rate can be calculated from gross worker flows. However, Shimer uses the dynamic behavior of unemployment to compute the job-finding rate (2005: p.31) for data availability reasons. Shimer's job-finding rate is calculated as the share of unemployed workers who leave unemployment within a month. With this definition it makes no difference whether a person finds a job or moves into non-employment (e.g., to go to school or to retire). We calculated the job-finding rate as the share of entries into employment (job-findings) divided by the number of unemployed workers. When someone finds a job, it makes no difference for us whether she was (registered as) unemployed or not before the match occurred.

To analyze the job-finding and the separation rate for western Germany, we used the IAB-Employment Sample (IABS). The IABS is a 2 percent sample of all employees subject to social security as well as unemployed benefit recipients for the years 1975 to 2004. We excluded 1975 and 1976, as the data for these years is not reliable. For every person in the dataset, we determined their main employment status (employed, unemployed, or out of labor force) in January, April, July, and October.[7] Every change in employment status between these dates was considered as an exit from one status and an entry into another status.

Figure 4 shows very high values for the seasonally adjusted job-finding rate in 1980 and 1981 and a sharp decline in the following years. This decline is due to an increase in the number of unemployed (rose from 800,000 in the second quarter of 1980 to 2.2 million in the second quarter of 1983, while the new hires remain almost constant), which is the denominator for the job-finding rate.[8]

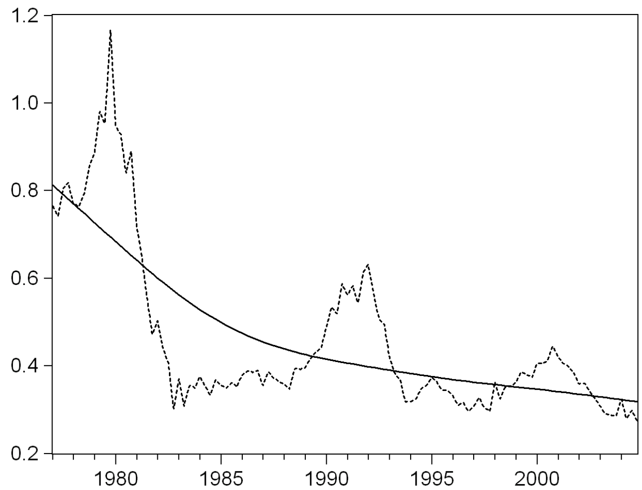
To test for robustness, we also calculated job findings as exits from unemployment, which is more in line with Shimer (2005), instead of entries into employment. With this definition of job-findings, the level of the job-finding rate is lower, but the volatility is higher. Thus, our conclusion of a high volatility of job-findings is independent of the definition of job-findings. We presented the results for entries into employment because in our theoretical discussions (see Section 3) we will also focus on entries into employment.

The average job-finding rate is 0.46 *per quarter*, whereas the rate computed by Shimer (2005: p.31) is 0.45 *per month*. Hence, the quarterly job-finding rate is much lower in Germany than in the United States. The standard deviation of the detrended job-finding rate is 0.229, which is higher than in the United States (0.118). The cyclical comovement of the job-finding rate, η, and the vacancy-unemployment ratio, θ, is presented in Figure 5, which shows a strong positive correlation between the two variables.

[7] 10th day of the month.

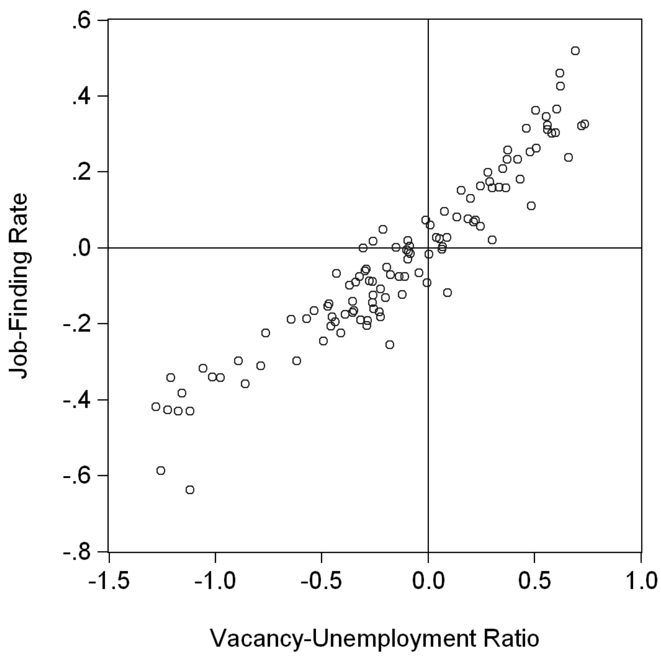
[8] For one quarter, the job-finding rate is even larger than one: the number of job-findings in this quarter is higher than the average number of unemployed.

Figure 4: Quarterly Job-Finding Rate for Western Germany and Trend, 1977-2004



Note: The job-finding rate was calculated as entries into employment referring to unemployment. Seasonally adjusted quarterly data are from the IAB Employment Sample (IABS) and the HP-filtered trend with smoothing parameter 10^5.

Figure 5: Quarterly Job-Finding Rate and Vacancy-Unemployment Ratio for Western Germany, 1977-2004



Note: The job-finding rate was calculated as entries into employment (data source: IABS) divided by unemployment. Corrected vacancy data were provided by the German Federal Employment Agency. Seasonally adjusted quarterly data, log of deviation from HP-filtered trend with smoothing parameter 10^5.

2.5 Separation Rate

When computing the separation rate, Shimer (2005) again focuses on the unemployed, because "whenever an employed worker loses her job, she becomes unemployed" (see p.32). But that is not necessarily true. It is also possible to leave the labor force voluntarily (to retire, go to school, or stay at home for personal reasons) or involuntarily (because of illness or discouragement) or to take up a new job without becoming unemployed.

Shimer's average monthly separation rate is 3.4 percent with a standard deviation of 8 percent around trend. As expected, he finds that the separation rate is negatively correlated with labor market tightness, θ.

We used IABS data to measure the separation rate as the share of outflows from employment divided by the stock of employment. As with the job-finding rate, a change in employment status between the two reference days was counted as a transition. Thus, a direct change from job-to-job was not counted as a separation. The same holds if a person loses her job and finds a new job before the next reference day. For western Germany, we obtained an average quarterly separation rate of 4 percent and a standard deviation of the HP-filtered time series of 6.5 percent.

In contrast to the job-finding rate (Figure 4), which shows a downward trend, the separation rate (Figure 6) shows an upward trend, especially after German unification in 1990.

2.6 Wages

Our wage time series contains the sum of gross wages divided by working hours, deflated by the GDP deflator (see Figure 7).[9] The standard deviation from trend is 0.018. The wages are negatively correlated with unemployment and positively correlated with the job-finding rate. We also find that the wages are procyclical (correlation with productivity is 0.611).

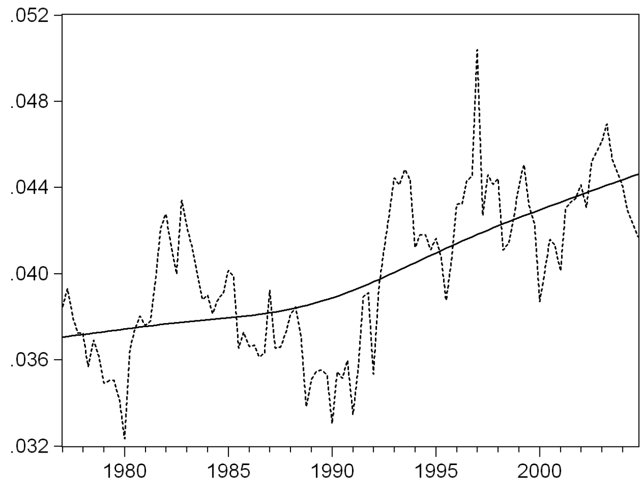
2.7 Labor Productivity

Labor productivity is another key variable in Shimer's (2005) paper, in which it is measured as real output per worker in the nonfarm business sector and has a standard deviation from trend of 0.020 in the United States.

However, unlike Shimer, we used real average output per working hour to measure labor productivity, because we consider this measure unsuitable for the analysis of German data. Germany has seen considerable changes in working time (e.g., more part time work, across-the-board reductions in working time, etc.). Especially part-time employment has become considerably more prevalent in Western Germany (see Klinger and Wolf, 2008). To rule out that changes

[9] We took the time series on wages from the Federal Statistical Office. Data for western Germany on wages and productivity are not available on a quarterly basis after the German unification. Therefore, from 1992 to 2004, we use data for unified Germany, where the index is scaled to the western German level. Eastern Germany makes up only one-fifth of the German economy. Thus, the variation in the variables is due mostly to western Germany.

Figure 6: Quarterly Separation Rate for Western Germany and Trend, 1977-2004



Note: The separation rate is the ratio of outflows from employment. Seasonal adjusted quarterly data from the IAB Employment Sample (IABS) and the HP-filtered trend with smoothing parameter 10^5.

in working time drive volatilities,[10] we measured productivity as output per working hour. The standard deviation from the trend is 0.013 (see Figure 8).

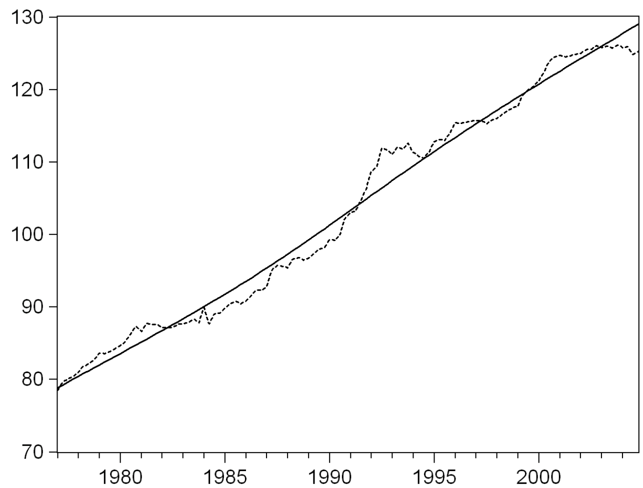
For robustness reasons, we also computed the volatility of output per worker. As the correlations with the labor market variables, such as the job-finding rate, vacancies, and market tightness, are a lot lower, output per worker seems less suitable as a potential driving force for the business cycle. The deviation from trend is a quarter higher. Therefore, even if we had used output per worker in our analysis, our main conclusion would remain unaffected.

3 Two Labor Market Models in Perspective

In this section, we compare two different theoretical labor market models and their ability to generate the sufficiently high labor market volatilities of labor market variables, that can be found in the data. First, we briefly explain the mechanism in the workhorse search and matching model, and the underlying intuition. Second, we derive and describe a model with heterogeneous productivity among workers and different wage setting mechanisms.

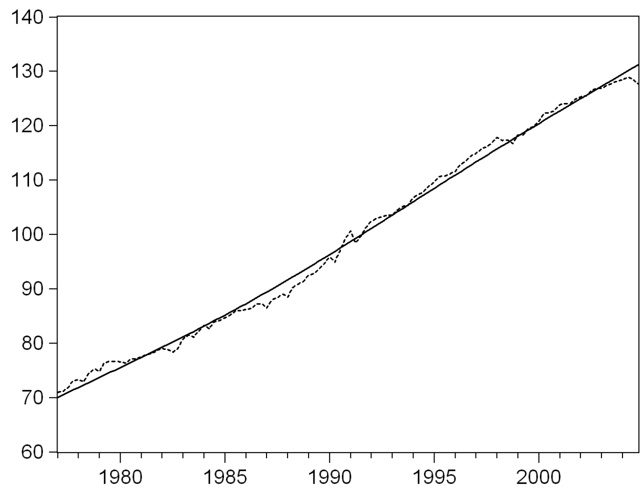
[10]Otherwise, an across-the-board reduction of the working time might show up as a productivity decrease (as production per worker falls).

Figure 7: Quarterly Wages per Working Hour in Western Germany and Trend, 1977-2004



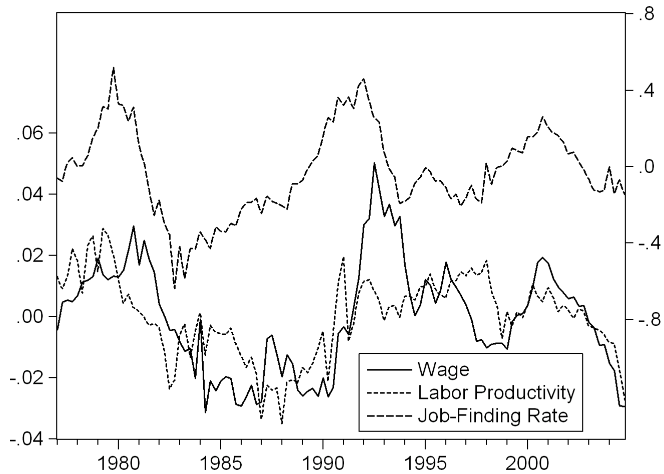
Note: Seasonally adjusted quarterly data of the real wage per working hour, provided by the German Federal Statistical Office. Normalized to 100 in 1990. HP-filtered trend with smoothing parameter 10^5.

Figure 8: Quarterly Labor Productivity in Western Germany and Trend, 1977-2004



Note: Seasonal adjusted quarterly data of the real average output per working hour, constructed by the Federal Statistical Office. Normalized to 100 in 1990. HP-filtered trend with smoothing parameter 10^5.

Figure 9: Quarterly Labor Productivity, Wages and Job-Finding Rate in Western Germany, 1977-2004



Note: Job-finding rate is the ratio of outflows from employment, quarterly data from the IAB Employment Sample (IABS). Labor productivity and wages as real values per working hour constructed by the Federal Statistical Office. Time series are seasonally adjusted quarterly data. The lines show log of deviation from HP-trend with smoothing parameter 10^5.

3.1 The Search and Matching Model

Pissarides (2000, p.3) outlines underlying idea of the search and matching model: "The central idea of the model is that trade in the labor market is a decentralized economic activity. It is uncoordinated, time-consuming, and costly for both firms and workers. Firms and workers have to spend resources before job creation and production can take place, and existing jobs command rents in equilibrium, a property that does not characterize Walrasian labor market."

The matching model assumes that the matches (i.e., new hires) in an economy can be described as a functional form of vacancies and the unemployment rate, $m = f(u, v)$, comparable to an aggregate production function. Matches generate rents in equilibrium, which are shared by Nash bargaining (based on the value of a job for the firm and the difference of the value of employment and unemployment for the worker). The value of a vacancy is driven to zero, due to a free entry condition. For a detailed description of the standard model see Pissarides' (2000) text book.

The matching model has become an important tool for analyzing the labor market. Costain and Reiter (2008) and Shimer (2005), however, argue that a business cycle version of the standard matching model is not able to generate sufficiently high labor market volatilities in response to macroeconomic shocks (comparable to the unconditional volatility values in the U.S. data).[11] There is extensive discussion in the literature on calibration strategies that bring the model closer to the data. Two main strands to generate higher volatilities can be distinguished: The first strand (see, e.g., Hall, 2005, and Hall and Milgrom, 2008) proposes a rigid wage mechanism. If wages adjust sluggishly, a larger part of the surplus goes to the firm, providing larger incentives for firms to post vacancies, thereby increasing labor market volatilities. The second strand (see Hagedorn and Manovskii, 2008) proposes a small surplus calibration, i.e., firms' steady state profits are small. Thus, a productivity shock leads to a large relative change in profits, inducing a volatile reaction in vacancy posting.

Haefke et al. (2008, p. 21) pin down nicely the intuition for these two solutions to one equation:

$$\frac{d \log \eta_t (\theta_t)}{d \log a_t} = \frac{1-\mu}{\mu} \left(\frac{\bar{a}_t}{\bar{a}_t - \bar{w}_t} - \frac{\bar{w}_t}{\bar{a}_t - \bar{w}_t} \frac{d \log \bar{w}_t}{d \log \bar{a}_t} \right), \tag{2}$$

where μ is the elasticity of matches with respect to unemployment in the matching function, θ_t is market tightness, $\bar{a}_t$ is the 'permanent' level of productivity, $\bar{w}_t$ is the 'permanent' level of wages, and η_t is the job-finding rate.

[11] These authors focus on productivity shocks. However, even without looking at the world through the lenses of the Real Business Cycle theory, it remains an essential questions whether labor market models can amplify macroeconomic shocks, because we observe a much larger volatility of the labor market variables compared to different measures of aggregate production (e.g., labor productivity or overall output). In this paper, we remain agnostic on the driving forces of the business cycle. Our productivity movements can be considered as actual productivity shocks or as a result of other macroeconomic shocks (e.g., aggregate demand shocks) that change the price of the labor good.

Given that wages are perfectly flexible (Shimer's calibration, i.e., $\frac{d\log \bar{w}_t}{d\log \bar{a}_t} = 1$) and given that plausible values for μ are in the range 0.5-0.7 (according to Petrongolo and Pissarides, 2001), the reaction of the job-finding rate to changes in productivity is at most 1. This reaction can only be increased by either making the wage very unresponsive to productivity changes ($\frac{d\log \bar{w}_t}{d\log \bar{a}_t} \rightarrow 0$) or by making the profit share very small ($\bar{a}_t - \bar{w}_t \rightarrow 0$).

As shown in our empirical part (see Section 2), the ratio of the job-finding rate volatility and the labor productivity volatility is about twice as large in Germany as in the United States. This creates a serious challenge for the search and matching model. To replicate this evidence using the search and matching model, wages would either have to be much more rigid in Germany than in the United States or the profit rate would have to be even smaller than with the small surplus calibration used by Hagedorn and Manovskii (2008).

Both solutions have negative side effects. The rigid wage solution may be difficult to reconcile with the empirical evidence. First, it is unclear whether real wages are more rigid in Europe than in the United States.[12] Second, Merkl and Schmitz (2009) show that different degrees of real wage rigidities in the eurozone do not correlate with macroeconomic volatilities in statistically significant manner. Third, there is empirical evidence (Haefke et al., 2008) that wages for new jobs (i.e., those relevant for the job-finding rate) are actually not rigid.

The even smaller"small surplus calibration" may be defended on grounds of higher replacement rates in Germany, which improve workers' fall-back option. However, Hagedorn and Manovskii (2008) set the value of nonmarket activity to 95.5 percent of the productivity for the United States. They defend this number by referring to a high valuation of leisure, whereby unemployment benefits slightly cointribute to this value. Therefore, they argue, even large differences in the generosity of unemployment benefits across countries do not translate into large differences in the value of nonmarket activity. Thus, we cannot necessarily expect a higher value of leisure in Germany than in the United States.

3.2 A Worker Heterogeneity Model

In this section, we offer an alternative model, which is based on heterogeneity in workers' productivity. The model details are presented in Brown et al. (2009), Merkl and Snower (2008), and Snower and Merkl (2006). For simplicity and for comparability with the standard search and matching model, we assume an exogenous separation rate, ϕ.[13] Vacancies are not modeled, because in this

[12] Hornstein et al. (2005, p. 39) write that regressing the cyclical component of wages on the cyclical component of productivity (HP-filter with $\lambda = 10^5$), they obtain a coefficient of 0.72 for the United States. When we do the same exercise for Germany for our observation period, we obtain a coefficient of 0.82. Thus, at least from the aggregate perspective there is no evidence for more rigid wages in Germany.

[13] To make the model analytically tractable, only unemployed workers are subject to idiosyncratic productivity shocks. It can be shown numerically that all the analytical results that are derived below also hold for a model with endogenous firing decisions.

model, unemployment does not exist due to the search frictions, but due to stochastic heterogeneities in workers' productivity, hiring costs, and a wage setting curve; the latter being particularly realistic for European economies. Some workers are hit by a bad productivity shock and are thus not profitable for the firm at a given wage. There are several reasons for a wage above the market clearing level, e.g., insider or union bargaining, a minimum wage legislation, an implicit minimum wage due to unemployment benefits, social norms, or some efficiency wage type mechanism. For illustration purposes, we first explain the mechanism of the model with an exogenous wage. Second, we show analytically that the intuition also holds under various wage setting mechanisms. We use one insider bargaining scheme and one individualistic wage formation scheme with a lower bound on the wages (e.g., due to a minimum wage legislation).

3.2.1 The Model

We assume an aggregate productivity per worker, a_t. There is a random operating cost, ε_t, iid across workers and time, with a cumulative distribution $F(\varepsilon_t)$. ε_t is observed by the firms and can be interpreted as an idiosyncratic productivity shock. Thus, the expected discounted profit, $E_t(\pi_t)$, of hiring an unemployed worker is equal to the current productivity minus the current wage, w_t,[14] minus the idiosyncratic operating cost, ε_t, plus the expected discounted future profits:

$$E_t(\pi_t) = (a_t - w_t - \varepsilon_t) + \delta E_t(\pi_{t+1}), \tag{3}$$

with

$$E_t(\pi_{t+1}) = (1-\phi) E_t(a_{t+1} - w_{t+1} + \delta\pi_{t+2}). \tag{4}$$

The firm hires an unemployed worker whenever the expected discounted profits of this worker exceed the hiring costs, i.e., $E_t(\pi_t) > h$. All other workers who are below this threshold are not hired. One time period afterwards, a new idiosyncratic shock is drawn from the distribution.

Thus, the job-finding rate is given by the following function:

$$\eta_t = P(\varepsilon_t < a_t - w_t - h + \delta E_t(\pi_{t+1})). \tag{5}$$

The higher the expected discounted profits of a worker, the higher the hiring rate will be (i.e., also less productive workers will be hired). The exact hiring rate is determined by the distribution of the operating costs.

To be able to make comparative static exercises, we assume for this section that the aggregate productivity is deterministic and that it has the same value in each period (i.e., when it changes, this affects the current and all future periods). Therefore, we can drop the expectation terms and the job-finding rate becomes equal to

[14] For simplicity, we assume the wage to be exogenous and the same for all workers. But we will relax this assumption later.

$$\eta_t = F(e), \tag{6}$$

where e is the hiring threshold, i.e., the point in the distribution of ε where firms are indifferent between hiring and not hiring. The hiring threshold can be expressed as

$$e = a - w - h + \delta(1-\phi)(a-w) + \delta^2(1-\phi)^2(a-w) + ..., \tag{7}$$

or

$$e = \frac{a-w}{1-\delta(1-\phi)} - h. \tag{8}$$

To illustrate our point further, we assume that the operating costs, ε, follow a unit distribution with $E(\varepsilon)$ normalized to zero and with lower support $-z$ and upper support z. Then, the job-finding rate can be expressed as

$$\eta = \frac{e+z}{2z}, \tag{9}$$

for $e \in (-z, +z)$.

3.2.2 The United States versus Germany

The first derivative of the job-finding rate with respect to productivity shows that the sensitivity of the job-finding rate particularly depends on job tenure:

$$\frac{\partial \eta}{\partial a} = \frac{1}{2(1-\delta(1-\phi))z}. \tag{10}$$

The longer the average duration of a job, which is defined by $(1/\phi)$, the more sensitive the job-finding rate will be with respect to changes in productivity. When a positive aggregate productivity shock hits the economy, the hiring threshold will be raised. Thus, less productive workers will become employed. When the firm employs a worker who has a longer job tenure, it will obtain the higher future productivities for a longer time period (the same intuition would hold under an autocorrelated stochastic productivity shock). Therefore, the firm will also hire workers who are hit by larger current idiosyncratic productivity shocks (as the higher productivities increase the present value).

This effect provides an intuitive answer to why the job-finding rate may be more volatile in Germany than in the United States (in line with the presented empirical data). The average separation rate in Germany is known to be lower than in the United States. According to Shimer's (2005) separation rate, an average U.S. worker has a job tenure of 2.5 years. According to the quarterly separation rate of 0.04 in Germany, an average worker has a job tenure of 6.25 years. Therefore, an aggregate productivity shock has a larger effect on the firm's value of a job and the job-finding rate reacts more volatile.

The reader may object that the longer job tenure in Germany is driven by higher firing costs, which should in principal dampen employment volatility. However, Hall (2006) shows that the voluntary quit rate was higher than the involuntary separation rate from 2000 to 2004. The voluntary quit rate in the United States was even higher than the overall separation rate in Germany. Therefore, it is highly plausible to assume that U.S. firms face higher exogenous separations than German firms.[15]

3.2.3 Alternative Wage Setting Mechanisms

Up to now, for illustration reasons, we have assumed that the wage is given exogenously. It is well known from the search and matching model that the bargaining mechanism is important for labor market volatilities. Therefore, we analyze the robustness of our results using two different wage setting mechanisms. First, we assume that the wage for the entire economy is set by bargaining between a median worker and a firm. Second, we assume that the job entrants are paid their average expected productivity and that firms are not allowed to pay wages below a certain threshold (e.g., due to minimum wage legislation). In the first case, there is a uniform wage for the entire economy, while there is a wage distribution in the second case.

Let us assume first, that there is bargaining between a median worker and a firm. The firm faces the following present value under bargaining agreement

$$V^F = a - w + \delta \left(1 - \phi\right) V^F, \tag{11}$$

and fallback option

$$V^{F,FB} = 0 + \delta \left(1 - \phi\right) V^F. \tag{12}$$

(i.e., we assume that there is no production in the case of disagreement.) Future profits are not affected in the case of disagreement.

The median worker faces the following present value under a bargaining agreement

$$V^I = w + \delta \left(1 - \phi\right) V^I + \delta \phi V^O, \tag{13}$$

and under disagreement

$$V^{I,FB} = b + \delta \left(1 - \phi\right) V^I + \delta \phi V^O, \tag{14}$$

where b is the payment under disagreement (e.g., due to a strike fund).

When we maximize the Nash product, we obtain the wage

[15] There is a second potential explanation. The sensitivity on the job-finding rate with respect to productivity also depends on the dispersion of operating costs/ idiosyncratic productivity. The larger the number of workers that are near the hiring threshold (this would translate into a smaller z under the employed simple unit distribution), the more sensitive is the reaction of the job-finding rate in response to productivity changes. The aggregate productivity shock raises workers beyond the hiring threshold. If more of them are close to the initial labor demand constraint, the job-finding rate will react more sensitively. We conjecture that a larger share of the workforce may be subject to a labor demand constraint in Germany than in the United States (e.g., due to unions or the welfare system). As a consequence, a productivity shock may lift more of them beyond the threshold, thereby leading to a more volatile reaction. However, we do not elaborate this issue in the numerical simulation.

$$w = \beta a + (1 - \beta)\, b, \tag{15}$$

where β is the bargaining power of the median insider. This can be substituted into the hiring threshold:

$$e = \frac{(1 - \beta)\, a - (1 - \beta)\, b}{1 - \delta\,(1 - \phi)} - h, \tag{16}$$

Thus, we obtain the following first derivative of the job-finding rate with respect to productivity:

$$\frac{\partial \eta}{\partial a} = \frac{1 - \beta}{(1 - \delta\,(1 - \phi))\, 2z}. \tag{17}$$

Compared to the exogenous wage case, the sensitivity of the job-finding rate is weakened by the factor $1 - \beta$, as part of the higher productivity goes to the workers and does not increase firms' incentives to hire additional workers. However, as long as wages do not increase faster than productivity,[16] the reaction of the job-finding rate remains positive. As before, in principle, the job-finding rate can be very sensitive to changes in a (for a small z).

To see whether the same mechanism holds with a wage distribution (instead of the uniform wage), we assume there is an auction for unemployed workers and a minimum wage of w_{min}. Imagine an economy with indefinitely many firms that agree on long-term contracts with their new employees. The firms will overbid the wage offers $w_i \in (w_{min}, \infty)$ until the zero-profit condition holds (i.e., until expected future productivity minus the wage and non wage costs, ε_i and h, is zero):

$$0 = \frac{a - w_i}{1 - \delta\,(1 - \phi)} - \varepsilon_i - h. \tag{18}$$

Since the wage offer for the worker with the lowest productivity is w_{min}, the threshold is

$$e = \frac{a - w_{min}}{1 - \delta\,(1 - \phi)} - h. \tag{19}$$

When we plug the threshold into $\eta = F(e)$ and take the partial derivative with respect to a, we obtain

$$\frac{\partial \eta}{\partial a} = \frac{1}{2\,(1 - \delta\,(1 - \phi))\, z}. \tag{20}$$

Interestingly, the sensitivity of the job-finding rate is the same as under the exogenous wage. The reason is that the threshold is determined the same way. If the wage in the exogenous wage model is on the same level as w_{min}, the hiring

[16] In this bargaining framework, $\beta > 1$ would not make any sense, as this would mean that the entire surplus and more goes to the worker, therefore leading to $w > a$, which would bring production to a halt.

threshold is also on the same level. The difference between the models is that in the case of an exogenous wage w for all workers, the firms receive the entire rent $a - \varepsilon_i - w$, whereas in the case of a wage distribution with the lower bound, w_{min}, the workers receive the rent $a - \varepsilon_i - w_{min}$.

To sum up, our result that the workers' heterogeneity model can generate high labor market volatilities does not depend on the exogenous wage assumption, and we come to the same conclusion with median worker bargaining and a competitive wage structure. The analysis could be extended to more complicated wage formation equations. However, then these equations would have to be solved numerically.

4 Inspecting the Mechanism Numerically

4.1 Calibration

To illustrate the mechanism of the model further, we used the wage bargaining version of the heterogenous productivity model and calibrated it to German data. For simplicity, we constrained ourselves to productivity shocks in the model simulation. Thus, we obtain results that are comparable to Shimer (2005). In a richer dynamic stochastic general equilibrium model, we would have an economy with several sectors (e.g., one sector with the frictional labor market and one sector with monopolistic competition and price staggering, see Lechthaler et al., 2008, for an illustration). In such a setting, other shocks (e.g., demand shocks) would affect the relative price of the labor good, leading to similar effects as our productivity shock in the partial equilibrium framework.

As usual in the literature, we assumed an annual real interest rate of 4 percent,[17] i.e, the quarterly discount factor, δ, is $1/1.04^{1/4}$. The average productivity, a, is normalized to 1. The hiring costs in our model are meant to capture both search costs (such as the cost of posting a vacancy) and training costs.[18] The hiring costs, h, were set to 1. The unemployment benefits, b, are set to 0.73.[19] When we regressed the cyclical component of wages on the cyclical component of productivity (for the time span from 1977 to 2004), we obtained a coefficient of 0.82 for the chosen observation period. Therefore, we

[17] This number is in line with the average interest rate on domestic bonds for the observation period from 1977-2004.

[18] Mortensen and Pissarides (1999) assume a value of 0.3 for search costs and 0.3 for training costs (i.e, the overall hiring costs would be 60 percent of the quarterly productivity). However, empirical studies on training costs show that these numbers for the training costs should be considered as lower bound. Dolfin (2006) shows that the average new employee in the United States spends 201 hours in training activities during her first quarter and other employees spend 146 hours training her (based on the Employment Opportunity Pilot Project survey). When we assume an eight hour day and 20 working days per month, the training costs amount to 43 working days or about 70 percent of the quarterly working time. Due to a lack of data for Germany, we rely on U.S. data.

[19] This is the average of the net replacement rate data for Germany across three different income groups, six different family types and two different unemployment durations (short-term and long-term unemployed) from 2001-2004 (see OECD, 2006). Data before 2001 are not available for the net replacement rates.

Table 3: Simulation Calibrated for Germany

	Unemployment u	Job-Finding η	Wage w	Productivity a
Standard deviation	0.122	0.148	0.011	0.013
Relative to prod.	9.275	11.313	0.863	1.000
(Standard error)	(0.0389)	(0.0398)	(0.0021)	(0.0025)
Autocorrelation	0.925	0.827	0.830	0.830

Notes: Results from simulating the model calibrated for the German economy. All variables are reported in logs as deviations from an HP-trend with smoothing parameter 10^5. Standard errors across 500 simulations in parentheses. The text provides details on the specification.

chose a bargaining parameter, β, of 0.82 for the median insider. In line with our dataset, the exogenous separation rate, ϕ, was set to 0.04. Finally, the distributional parameter, z, was chosen such that we obtained the average job-finding rate (0.46) in our sample. The standard deviation and the autocorrelation of the aggregate productivity shock were chosen to match the respective values in the data.

4.2 Simulation Results

We simulated the reaction of our model in response to random productivity shocks for 500 quarters and discarded the first 388 quarters to obtain the same sample length as in our empirical exercise. This exercise was repeated 500 times (standard errors across model simulations are in brackets). We used a HP-filter with smoothing parameter $\lambda = 10^5$ and report the standard deviations as log-deviations from the HP-trend.

Table 3 shows that the simulated model can explain about two thirds of both the empirical unemployment volatility and the job-finding rate volatility. This is remarkable, as the model's performance is due to a single shock, namely, the aggregate productivity shock. A decomposition of the contribution of different shocks on aggregate volatility would be an interesting topic for future research, but goes beyond the scope of this paper.

In addition, the model simulation generated a negative correlation between the job-finding rate and the unemployment rate of -0.98. This is also in line with the empirical cross-correlation.

4.3 Comparison to a High-Flow Economy

To illustrate our analytical claim that the model is able to explain differences in the labor market volatilities for the United States, we modified the calibration in the following two ways. First, we increased the exogenous firing rate to 0.1. Second, we halved the value of unemployment benefits to 0.365. Thus, we obtained a steady-state job finding rate of 0.63.[20]All these numbers are in line

[20]The resulting job-finding rate is lower than suggested by Shimer's (2005) monthly numbers. However, it has to be taken into account that the quarterly job-finding rate cannot

Table 4: Simulation Calibrated for High-Flow Economy

	Unemployment	Job-Finding	Wage	Productivity
	u	η	w	a
Standard deviation	0.053	0.064	0.012	0.013
Relative to prod.	4.015	4.870	0.924	1.000
(Standard error)	(0.0113)	(0.0126)	(0.0023)	(0.0024)
Autocorrelation	0.891	0.830	0.831	0.831

Notes: Results from simulating the model calibrated for an economy with high flow rates. All variables are reported in logs as deviations from an HP-trend with smoothing parameter 10^5. Standard errors across 500 simulations in parentheses. The text provides details on the specification.

with U.S. evidence. For comparability reasons, we kept all other parameters constant. The reader may object that the different volatilities of labor market variables in the high-flow economy are purely driven by the lower unemployment benefits. However, this is not the case. We could also have increased the firing rate and reduce the hiring costs to obtain U.S.-style labor market flow numbers. This would have produced a reduction in the volatility of similar magnitude.

Table 4 shows that the volatilities in unemployment and the job-finding rate are cut by about one-half compared to the previous simulation. This is in line with the relative magnitudes between Germany and the United States. Thus, our model does not only deliver the correct qualitative statement (as shown in the analytical part), but also captures the relative magnitudes well, by only taking the appropriate job separation rates into account.

5 Conclusions

We have shown that the volatility of the unemployment, vacancies, job-finding rate, and wages (compared with productivity) is higher in Germany than in United States. The labor market is about two times more volatile in Germany than in the U.S. (relative to the volatility of labor productivity).

Our model suggests that the higher volatility of the job-finding rate in Germany compared to the United States is driven by longer job-tenure in Germany. Firms can expect a higher discounted return from a positive macroeconomic shock and they will hire more workers.

We have calibrated our model with heterogeneous workers for Germany and for the United States and shown that the model can generate the empirical patterns for Germany. Further, it can explain the differences between Germany and the United States, by making use of the fact that the job destruction rates are about twice as large in the United States as in Germany.

take into account high-frequency movement (i.e., multiple transitions during a quarter). The employed job-finding rate of 0.63 is in line with the numbers employed by Fujita and Ramey (2005). Our main conclusion is unaffected when we increase the job-finding rate further (e.g., by lowering the unemployment benefits by more).

Obviously, this paper provides only a first step towards a better understanding of the dynamics of the German labor market. It remains for future research to decompose which macroeconomic shocks are the actual driving forces for the very high labor market volatilities in Germany.

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