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

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Abstract

This paper shows that the German labor market is more volatile than the US labor market at the business cycle frequency. Specifically, the volatility of the cyclical component of several labor market variables (e.g., the job-finding rate, the labor market tightness and vacancies) divided by the volatility of labor productivity is roughly twice as large as in the United States. We derive and simulate a simple model to explain this seemingly puzzling result. This new model provides explanations for this phenomenon, in particular the longer job tenure in Germany.

Zusammenfassung

Wir zeigen empirisch, dass die konjunkturellen Schwankungen am Arbeitsmarkt in Deutschland höher sind als in den USA. Insbesondere ist die Volatilität von Arbeitsmarktvariablen (etwa der Vakanzen, der Arbeitsmarktanspannung oder der Wahrscheinlichkeit Arbeit zu finden) im Verhältnis zur Volatilität der Arbeitsproduktivität etwa doppelt so hoch wie in den USA. Wir präsentieren und kalibrieren ein einfaches Modell, das dieses scheinbare Rätsel löst. Das Modell bietet als Erklärung für dieses Phänomen insbesondere die längere Betriebszugehörigkeitsdauer in Deutschland an.

JEL classification: J6, E24, E32

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

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

Interestingly and maybe surprisingly at first sight, German labor market variables are very volatile; even more than the US counterparts. The standard deviation of the vacancy-unemployment ratio is almost 40 times larger than the standard deviation of the 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 the labor productivity) than in the United States.[2]

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

This paper provides tentative theoretical answers to all 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 the well known existing problems. Therefore, we offer a simple model of unemployment, which is based on heterogenous idiosyncratic labor productivity and different wage setting mechanisms. We show analytically that this model is able to amplify the volatility of macroeconomic shocks substantially and therefore to account for the observed high volatilities of labor market variables in Germany.[3] Further, the new model offers explanations for the larger volatility of the labor market in Germany compared to the United States. A longer job tenure (due to lower turnover rates in Germany) leads to a larger effect of macroeconomic shocks on

[1] This is partly related to data availability or construction problems. Eurozone data can, for example, only be constructed synthetically based on 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.

[2] Only the volatility of the separation rate does not fit into 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).

firms' behavior. With a longer job tenure, firms can expect to retain the respective worker for a longer time period, whereby autocorrelated profits generate a larger change in the present value of profits.

We calibrate 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.

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 high sensitivities of labor market variables in response to productivity changes. Based on this, we provide a first tentative answer why Germany's labor market dynamics may be different from the United States. Section 4 calibrates our model to German data and simulates it in response to macroeconomic shocks. In addition, it shows potential differences between the US and German economy. Section 5 briefly concludes.

2 Volatilities in Germany

2.1 Overview

Before we discuss all the labor market variables in detail (data sources, time pattern, etc.), we provide in Table 1 an overview about the cyclical behavior of the unemployment, vacancies, the labor market tightness, the job-finding rate, the separation rate, wages and the labor productivity.[4] To compare the cyclical patterns of the labor market in Germany with the US, we present Shimer's (2005) summary statistics for the US in Table 2. As Shimer (2005), we use seasonal adjusted quarterly data and a Hodrick-Prescott (HP) filter with smoothing parameter $\lambda = 10^5$ to expose the business-cycle-frequency of the labor market fluctuations.

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. The German unemployment is also significantly more volatile. The standard deviation is about 14 times larger than the standard deviation of labor productivity. Shimer (2005, p. 28) reports a ratio of 10 for the United States. Only the separation rate does not fit into this pattern. The standard deviation is similar to the US counterpart (both in absolute and relative terms).

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

Table 1: Summary Statistics and Correlation Matrix for West-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, seasonal adjusted with censusX12, log deviation from HP trend with $\lambda = 10^5$, $log(X/X_{hp})$. 1977 to 2004; registered unemployment u is provided by the Federal Employment Agency; vacancies v adjusted by market share of the Federal Employment Agency; the job-finding rate η is computed as share of hirings on registered unemployment; the separation rate ϕ is the share of separations on employment; productivity a and wages w per working hour.

Table 2: Summary Statistics for US, 1951-2003

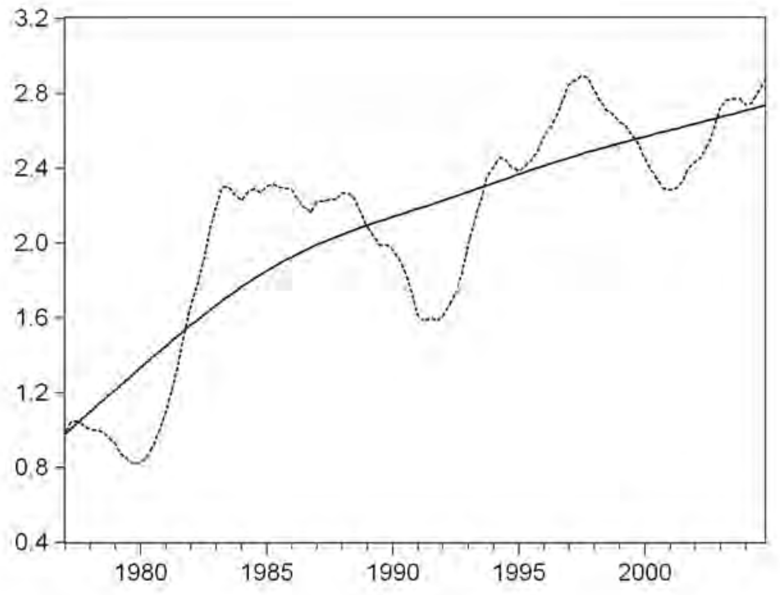
	u	v	v/u	η	ϕ	a
Standard deviation	0.190	0.202	0.382	0.118	0.075	0.020
Relative to prod.	9.500	10.100	19.100	5.900	3.750	1.000

Source: Shimer (2005)

Our main conclusion remains the same when we vary the observation period or when we change the HP smoothing parameter. The volatility of the cyclical component of various labor market variables divided by the cyclical component of the labor productivity is considerably larger in Germany than in the United States. Let us mention a few examples for robustness checks: First, when we restrict Shimer's job-finding rate for the United States to the same sample period (1977-2003) that we use for Germany, we obtain very similar results. Second, optically, it seems that there is a structural break in our job-finding rate (with considerably lower rates after 1982). However, when we restrict our sample to the period after 1982, the results continue to hold. Third, the results also do not depend on the smoothing parameter of the HP filter. We use an HP filter with $\lambda = 1600$ instead of 10^5 and compare the results with Hornstein et al. (2005). In this exercise the volatilities of all variables (including the labor productivity) drop. However, the volatility of different labor market variables (compared to the labor productivity) in Germany are still considerable higher than in the US (except for the separation rate).

Interestingly, the correlation of the different variables is very similar to 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 the labor market tightness θ and the job-finding rate. More details on each of the variables are provided below.

Figure 1: Quarterly Unemployment (in Millions) in West-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

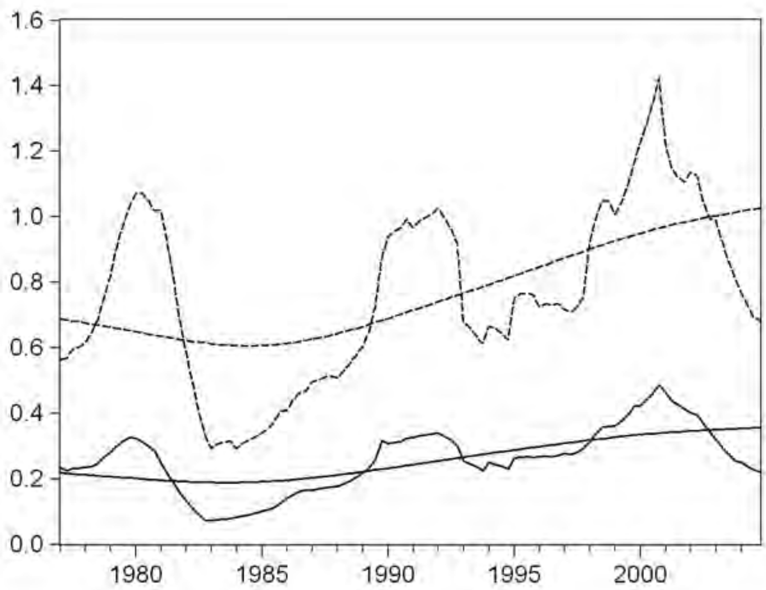
Monthly time series for registered unemployment in West-Germany are provided by the Federal Employment Agency. The quarterly data are calculated as mean of the monthly data. Following Shimer (2005, p. 27) we used the level of unemployment rather than the rate. On average, 2.1 million people or 8.05 percent of the labor force in West-Germany were registered as unemployed who were actively searching a job. Unemployment reached its peaks in 1983 (2.3 mil.) and in 1997 (2.8 mil.) 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 different ways to measure job vacancies. Shimer (2005) uses an advertising index as proxy for vacancies, because the Job Opening and Labor Turnover Survey (JOLTS) began only in 2000. In contrast to the US, there is an official monthly time series for vacancies in West-Germany since 1950: The statistics of the Federal Employment Agency provide information for reported vacancies of firms searching actively for employees. However, firms do not have to report their vacancies.

To prevent that our results are biased due to non-reported vacancies, we make use of a second data set, which is available since 1992, namely, the German Job Vacancy Survey (see Kettner et al., 2007). This survey shows that the reported vacancies covered 35 percent of all vacancies between 1992 and 2005, whereby the share of reported vacancies to overall vacancies varies over time.

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



Note: Reported vacancies by the Federal Employment Agency. Corrected vacancies extrapolated by the market share of the Employment Agency (see text). Both time series are seasonally adjusted quarterly averages of monthly data. The lines show seasonal adjusted data and the HP filtered data with smoothing parameter 10^5.

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

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

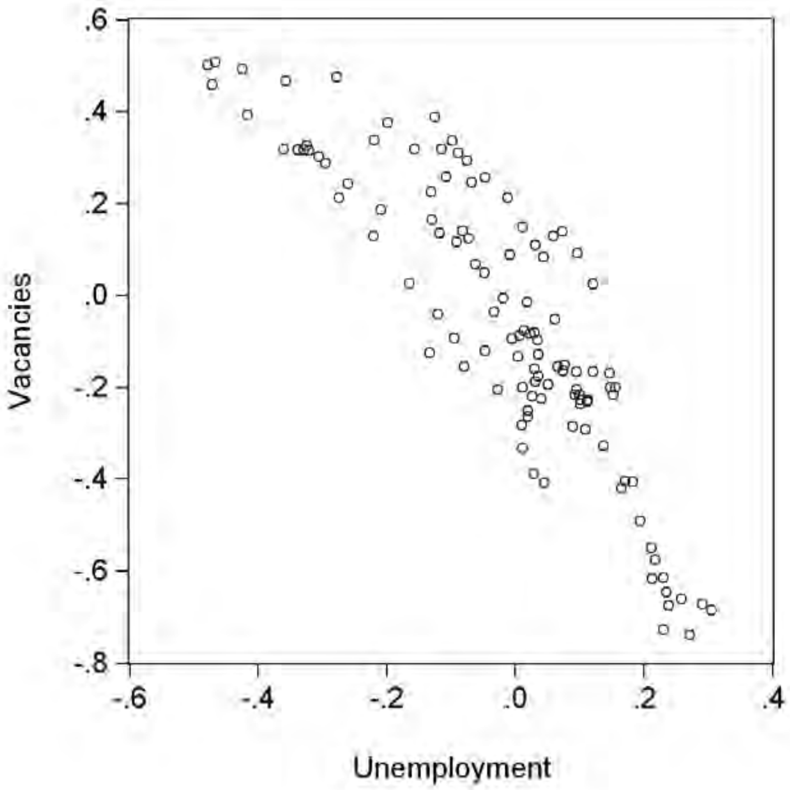
From 1992 on we use the share of reported vacancies in West-Germany given yearly by the German Job Vacancy Survey to correct the reported vacancies for all quarters of the respective year.

Both, the reported and the corrected vacancies, are very volatile. The standard deviation of the cyclical component for the corrected vacancies is 0.31. The actually reported vacancies are even more volatile (0.35) because the share $\frac{\text{reported vacancies}}{\text{all vacancies}}$ is procyclical. Thus, the conclusion that the volatility of vacancies is larger in Germany than in the US is not driven by the vacancy correction method, since it reduces the volatility of vacancies in our sample.

As a robustness check, we also calculate the volatility of vacancies from 1950 to 2004[5] and find 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.

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

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



Note: Reported vacancies of 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 smoothing parameter 10^5.

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 direction. 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.

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 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 school, university or retirement). We calculate 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 a (registered) unemployed or not before the match occurred.

To analyze the job-finding and the separation rate for West-Germany, we use 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. Because the data are partly not reliable in the first years, we exclude 1975 and 1976. For every person in the dataset, we define the main employment status (employed, unemployed, or out of labor force) at the 10th of January, April, July, October. Every change in employment status between these dates is accounted as an exit from one status and as an entry into another status.

Figure 4 shows very high values for the seasonal adjusted job-finding rate in 1980 and 1981 and a sharp decline in the following years. This decline is due to the increased number of unemployed (they rose from 800.000 in the second quarter of 1980 to 2.2 mil. in the second quarter of 1983, while the new hires remain almost constant), which is the denominator for the job-finding rate.[6]

For a test of robustness, we also calculate the job findings as exits from unemployment, which is more in line with Shimer (2005), instead of entries in employment. With this definition of job-findings, the level of the job-finding rate is lower, but the deviation from trend is higher. Thus, our finding of a high volatility of job-findings is independent of the definition of job-findings. We present the results for entries in employment because in our theoretical discussions we also focus on entries in 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 US. The standard deviation of the detrended job-finding rate is 0.229 and higher than in the US with 0.118. The cyclical comovement of the job-finding rate η and the vacancy-unemployment ratio θ is presented in Figure 5. There is a strong positive correlation between the two variables.

2.5 Separation Rate

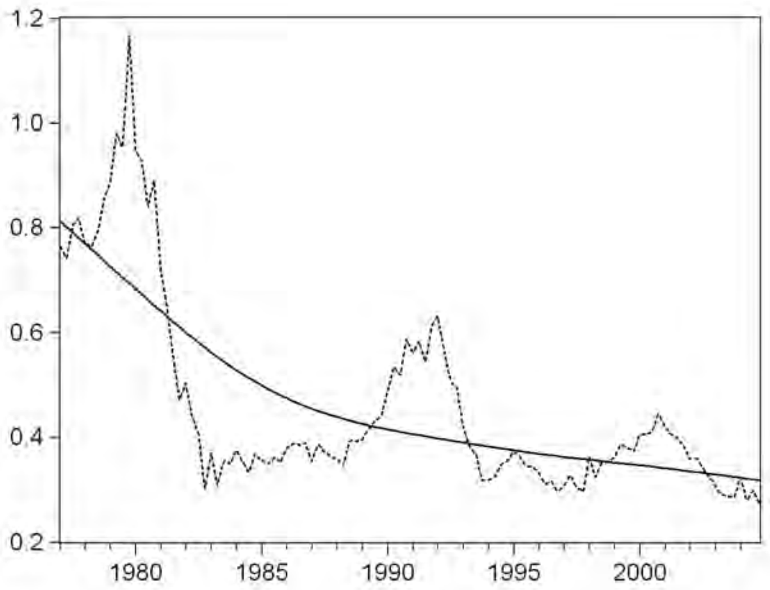
Computing the separation rate, Shimer (2005) again focuses on the unemployed, because "whenever an employed worker loses her job, she becomes unemployed" (see p. 32). But that is not necessarily true. It is also possible to leave the labor force voluntarily (to retire, go to university, or stay at home for personal reasons) or involuntarily (because of illness or discouragement) or to change into 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. He finds a negative correlation of the separation rate with the labor market tightness θ as expected.

We use IABS-data to measure the separation rate as the share of outflows from employment divided by the stock of employment. Similar to the job-finding rate, every change in

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

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



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

employment status between the two reference days is counted as a transition. By this definition a direct change from job-to-job is no separation. The same holds if a person loses her job and finds a new job before the next reference day. For West-Germany we obtain 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 the German unification in 1990.

2.6 Wages

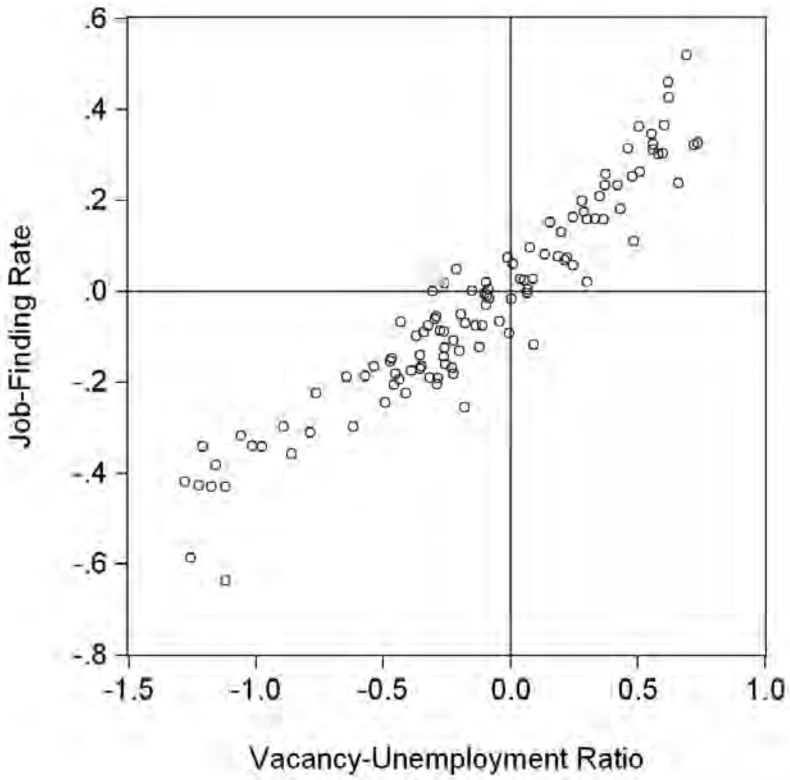
The time series on wages is taken from the Federal Statistical Office.[7] It is the sum of gross wages divided by working hours, deflated by the GDP-deflator (see Figure 7). The standard deviation from trend is 0.018. The wages are negatively correlated with unemployment and positively correlated with 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. It is measured as real output per worker in non-farm business sector and has a standard deviation from trend of

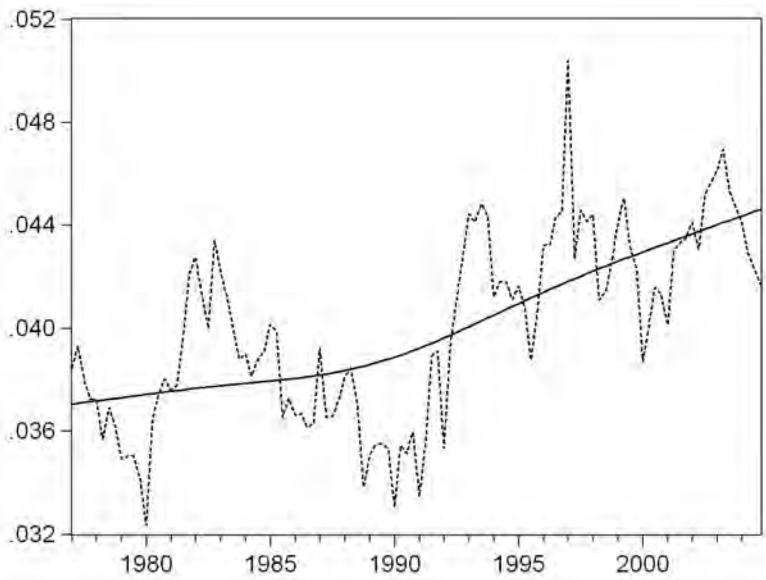
[7] Data for West Germany on the sum of wages as well as on productivity are not available on a quarterly basis after the German unification. Therefore, from 1992 to 2004, we use data for unified Germany, where the index is scaled to the West German level. East Germany makes up only one fifth of the German economy. Thus, the variation of the variables is strongly dominated by West Germany.

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



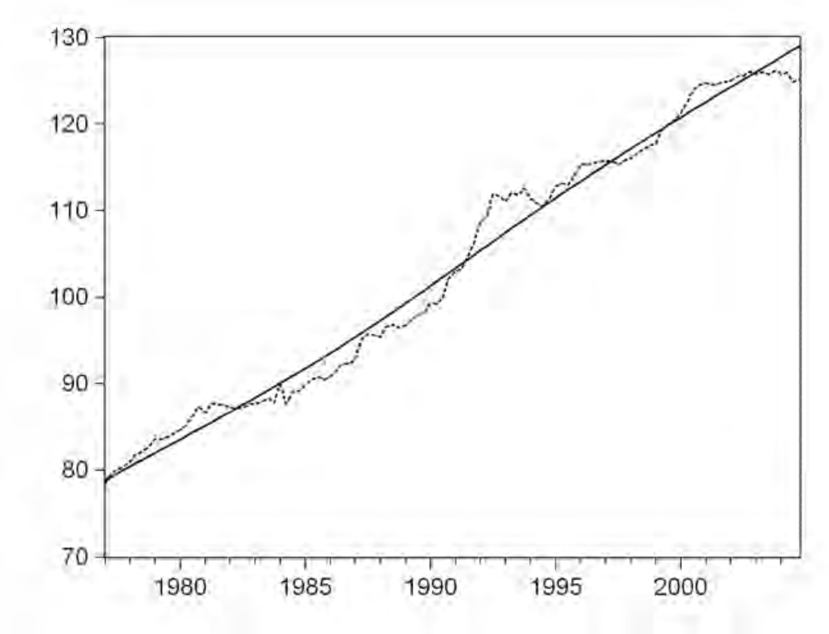
Note: The job-finding rate is calculated as entries into employment (data-source: IABS) referring to unemployment. Corrected vacancies are data of the Federal Employment Agency. Seasonal adjusted quarterly data, log of deviation from HP filtered trend with smoothing parameter 10^5.

Figure 6: Quarterly Separation Rate for West-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.

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



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

0.020 in the US.

We use real average output per working hour to measure labor productivity. Thus, we deviate from Shimer who uses the productivity per worker. We consider this measure unsuitable for the analysis of German data. Germany has seen considerable changes in the working time (e.g., more part time work, across-the-board reductions in working time, etc.). Especially part-time employment has grown considerably in Western Germany (see Klinger and Wolf, 2008). To rule out that changes in working time drive the volatilities,[8] we measure productivity as output per working hour. The standard deviation from the trend is 0.013 (see Figure 8).

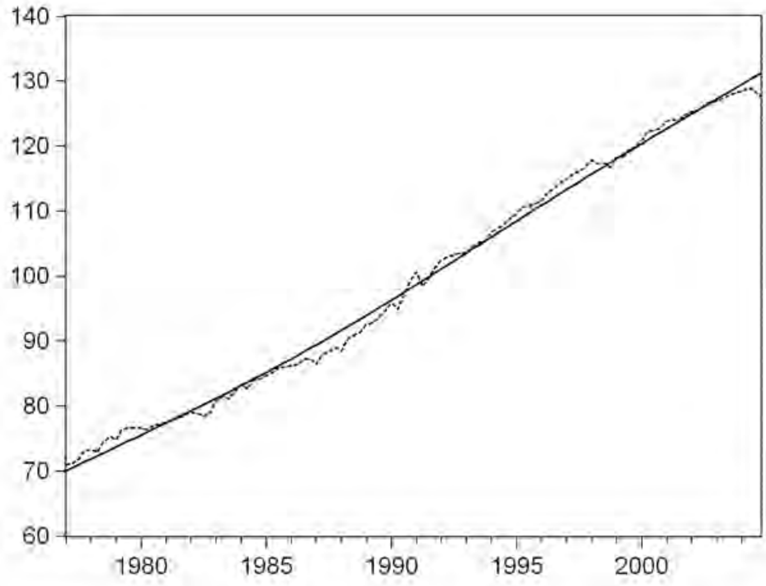
For robustness reasons, we also compute the volatility of output per worker. Note that the correlations with the labor market variables, such as the job-finding rate, the vacancies and the market tightness, are a lot lower. Therefore, the output per worker seems less suitable as a potential driving force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

3 Two Labor Market Models in Perspective

In this section, we compare two different theoretical labor market models and their ability to generate sufficiently high labor market volatilities of labor market variables, as they can be

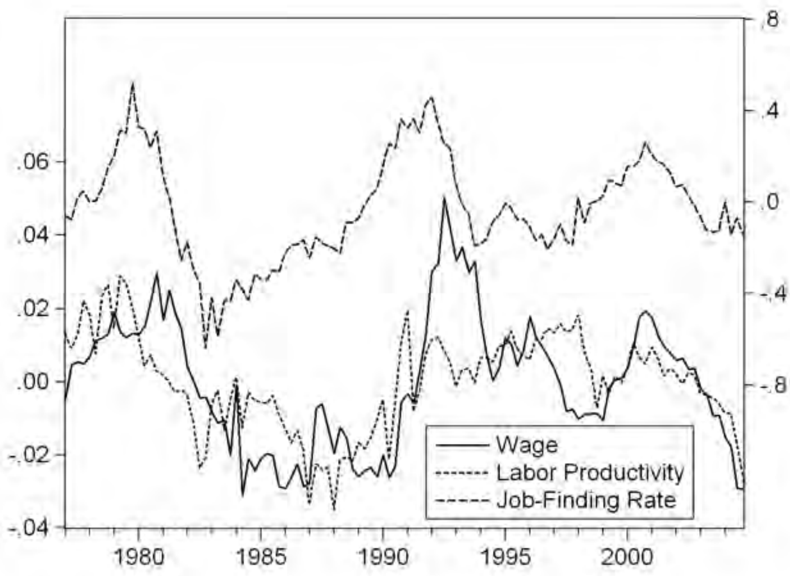
[8] Otherwise, an across-the-board reduction of the working time might show up as productivity decrease (as the production per worker falls).

Figure 8: Quarterly Labor Productivity in West-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 West-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.

found in the data. First, we briefly explain the mechanism in the 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.

3.1 The Search and Matching Model

"The central idea of the [search and matching] 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" (Pissarides, 2000, p. 3).

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, $m = f(u, v)$, similar 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 US data).[9] There is an extensive discussion in the literature on calibration strategies that bring the model closer to the data. Two main strategies 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 the 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 the profits, inducing a volatile reaction in vacancy posting.

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

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

[9] 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.

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

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. The 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 the empirical part, 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 by the search and matching model, wages would either have to be a lot more rigid in Germany than in the United States or the profit rate would even have to be smaller than in the small surplus calibration 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.[10] Second, Merkl and Schmitz (2009) show that different degrees of real wage rigidities in the Eurozone do not correlate in statistically significant manner with macroeconomic volatilities. 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 non-market activity to 95.5 percent of the productivity for the United States. They defend this number with a high valuation of leisure, where unemployment benefits only contribute a small part 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 non-market 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.[11] Vacancies are

[10] 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.

[11] 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 the model with endogenous firing.

not modeled, because in this model, unemployment exists not 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 shocks 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. In the next step, we show analytically that the intuition also holds under different 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,[12] 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 whenever the expected discounted profits of a particular worker exceed the hiring costs, i.e., $E_t(\pi_t) > h$. All other workers who are underneath this threshold are not hired. The next period, 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 will be the hiring rate (i.e., also less productive workers will be hired). The exact hiring rate is determined by the distribution of the operating costs.

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

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:

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

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 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 the 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 will be the job-finding rate 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 knows that a worker has a longer job tenure, it will obtain a larger share of the higher future productivities (the same intuition would hold under an autocorrelated stochastic productivity shock). Therefore, the firm will also hire workers, which are hit by larger current idiosyncratic productivity shocks (as the higher productivities increase the present value).

This effect provides an intuitive answer 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 US 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 the employment volatility. However, Hall (2006) shows that the voluntary quit rate was larger than the involuntary separation rate from 2000 to 2004. The voluntary quit rate in the United States was even larger than the overall separation rate in Germany. Therefore, it is highly plausible to assume that US firms face higher exogenous separations than German firms.[13]

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 with two different wage setting mechanisms. First, we assume that the wage for the entire economy is set by bargaining between the median insider and the firm. Second, we assume that the entrants are paid their average expected productivity and that firms are not allowed to pay wages below a certain threshold, e.g., due to a minimum wage legislation. In this case, we obtain a wage distribution.

Let's assume first, that there is bargaining between the median insider and the firm. Firms face the following present value under bargaining agreement

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

and fallback option

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

i.e., we assume that there is no production in case of disagreement. However, future profits are not affected in case of disagreement.

The median insider faces the following present value under bargaining agreement

[13] There is a second potential explanation: The sensitivity on the job-finding rate with respect to productivity depends also on the dispersion of the operating costs/the idiosyncratic productivity. The larger the number of workers that are in the close environment of the hiring threshold (i.e., this would translate into a smaller z under the employed simple unit distribution), the more sensitive will be 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.

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

and under disagreement

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

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

When we maximize the Nash product, we obtain the wage:

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

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 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[14], there remains a positive reaction of the job-finding rate. As before, in principle the job-finding rate can be very sensitive to changes in a (for a small z).

To see whether the intuition also 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 which agree on long-term contracts with their new employees. Firms will overbid the wage offers $w_i \in (w_{min}, \infty)$ until the zero profit condition holds (i.e., the 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:

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

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

When we plug in the threshold in $\eta = F(e)$ 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 in the same way: If the wage in the exogenous wage model would be the same level as w_{min}, the hiring 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 $a - \varepsilon_i - w$, where in the case of a wage distribution with a lower bound w_{min} the workers receive the rent $a - \varepsilon_i - w_{min}$.

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

4 Inspecting the Mechanism Numerically

4.1 Calibration

To illustrate the intuition further, we use the wage bargaining version of the heterogenous productivity model and calibrate it to German data. For simplicity, we constrain 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 for the labor good, leading to similar effects as our productivity shock in the partial equilibrium framework.

As usual, we assume an annual real interest rate of 4 percent,[15] i.e, the quarterly discount factor, δ, is $1/1.01^{1/4}$. 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.[16] The hiring costs, h, are set to 1. The unemployment benefits, b, are

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

[16] 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

Table 3: Simulation Calibrated for Germany

	Unemployment	Job-Finding	Wage	Productivity
	u	η	w	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.

set to 0.73.[17] When we regress the cyclical component of wages on the cyclical component of productivity (for the time span from 1977 to 2004), we obtain a coefficient of 0.82 for the chosen observation period. Therefore, we choose a bargaining parameter, β, of 0.82 for the median insider. In line with our dataset, the exogenous separation rate, ϕ, is set to 0.04. Finally, the distributional parameter, z, is chosen such that we obtain the average job-finding rate (0.46) in our sample. The standard deviation and the autocorrelation of the aggregate productivity shock are chosen to match the respective values in the data.

4.2 Simulation Results

We simulate the reaction of our model in response to random productivity shocks for 500 quarters and discard the first 388 quarters to obtain the same sample length as in our empirical exercise. This exercise is repeated 500 times (standard errors across model simulations are in brackets). We use 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 the empirical unemployment volatility and of the job-finding rate volatility. This is remarkable, as all the model performance is due to a single shock, namely the aggregate productivity shock. A decomposition of the contribution of different shocks on aggregate volatility is an interesting topic for future research, but goes beyond the scope of this paper.

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

costs show that these numbers for the training costs should rather be considered as a 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 evidence for Germany, we rely on US numbers.

[17] This is the average of the net replacement rate 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). Numbers before 2001 are not available for the net replacement rates.

Table 4: Simulation Calibrated for High Flow Economy

	Unemployment u	Job-Finding η	Wage w	Productivity 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.

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 modify the calibration in the following two ways. First, we increase the exogenous firing rate to 0.1. Second, we halve the value of unemployment benefits to 0.365. Therefore, we obtain a steady state job finding rate of 0.63.[18] All these numbers are in line with US evidence. For comparability reasons, we keep 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 increase the firing rate and reduce the hiring costs to obtain US style labor market flow numbers. This would deliver a reduction in the volatility of similar magnitude.

Table 4 shows that the volatilities of 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 right qualitative statement (as shown in the analytical part). But it also captures the relative magnitudes about right, by just taking the appropriate job separation rates into account.

5 Conclusions

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

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

[18] 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 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).

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

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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