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Labor Selection over the Business Cycle: An Empirical Assessment

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Abstract

This paper is the first to analyze how much the probability of selecting a worker from a pool of applicants fluctuates over the business cycle. We use the German Job Vacancy Survey to construct the selection rate on the regional, industry, and national level and show that it is negatively correlated with unemployment. In addition, panel estimations reveal a positive comovement between the selection rate and market tightness, which is in line with the theoretical prediction from labor selection models.

JEL classification: E24, E32, J64
Keywords: Labor Selection, Job-finding Rate, Labor Market Dynamics, Business Cycle

1 Introduction

The job-finding rate is an important driver of unemployment dynamics (see Shimer (2012) for the United States and Bachmann (2005) for Germany). It is standard practice to model the business cycle dynamics of the job-finding rate with a matching function, which assumes that new contacts between unemployed workers and firms are a stable function of vacancies and unemployment. However, it is well known that job creation consists of various margins. Davis et al. (2013), for instance, investigate the patterns of hiring intensities. Based on firm survey data for the United States, Barron et al. (1985, p.50) find evidence that "...most employment is the outcome of an employer selecting from a pool of job applicants." Baydur (2016), Brown et al. (2015), and Chugh and Merkl (2016) show that selection models, which make use of this mechanism, can replicate various important cross-sectional or time series dimensions of US data.

However, so far there is no direct evidence how much the selection rate actually varies over the business cycle. To fill this gap, we calculate the selection rate for different points in time based on the German Job Vacancy Survey. We use information on the last hire and the number of suitable applicants for this position. We aggregate firms' probability of selecting a worker to a panel dimension both on the regional and industry level. The data is available on an annual basis from 1991 to 2013.

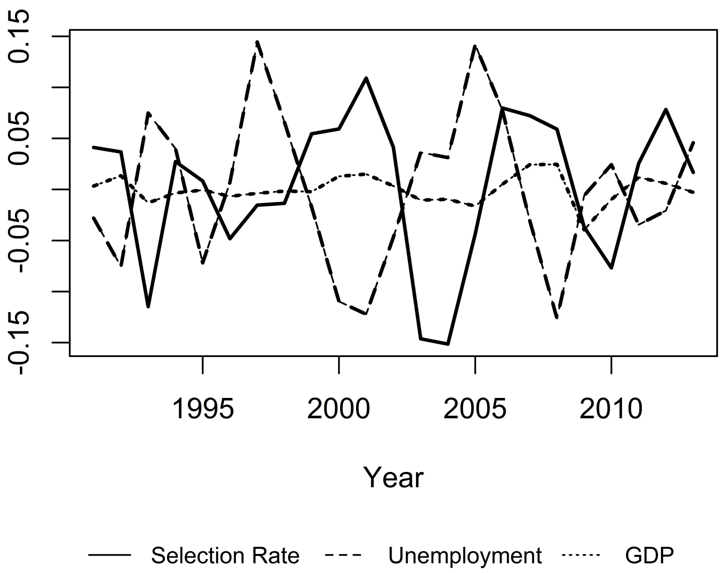
This paper is the first to show empirically that labor selection fluctuates strongly over the business cycle. The selection rate is positively correlated with GDP and negatively correlated with unemployment. In addition, the data confirms a key prediction of selection models, namely, a log-linear Cobb-Douglas relationship between the selection rate and market tightness (Kohlbrecher et al., 2014). Of course, these findings may also be driven by other model classes. Given that we provide access to our aggregated panel data, the empirical validity of different models can be tested in future research.

2 Business Cycle Dynamics of Labor Selection

We are the first to use and aggregate firms' selection rate in the German "Job Vacancy Survey" (IAB-Stellenerhebung) provided by the Institute for Employment Research. In this representative survey, firms are asked about their last realized hire within the previous 12 months. Information on the number of suitable applicants is available on an annual basis from 1991 onwards. The selection rate is defined as the inverse of the number of suitable applicants.

Figure 1 shows the aggregate time series behavior of the selection rate,

Figure 1: Selection Rate, Unemployment and GDP for West Germany in log deviations of HP-filtered series ($\lambda = 6.25$)



unemployment, and GDP for West Germany.[1] Table 1 confirms that the aggregated labor selection rate for West Germany is strongly procyclical. The labor selection rate is very volatile. Its standard deviation is about 5 times larger than the standard deviation of GDP. Furthermore, labor selection correlates positively with GDP and negatively with unemployment.

3 Theoretical Background

In the canonical search and matching model, the transmission of aggregate shocks works through vacancy creation and the matching function. In a boom, firms have an incentive to post more vacancies. This depresses the probability of filling these vacancies ($q_t = C_t/V_t$, where C_t and V_t are the number of contacts and vacancies respectively). The matching function assigns workers to firms and all workers are selected.[2] A strongly procyclical

[1] For detailed information on the data set, see Appendix.

[2] A different interpretation would be that a constant fraction is selected. However, this fraction is usually set to 1.

Table 1: Summary Statistics, HP-filtered West German Data, 1991-2013

		Selection Rate	Unemployment	GDP
Standard Deviation		0.072	0.075	0.014
Correlation Matrix	Selection Rate	1	-	-
	Unemployment	-0.514	1	-
	GDP	0.672	-0.574	1

Notes: All statistics are reported as log deviations from an HP-trend for West Germany with smoothing parameter $\lambda = 6.25$.

selection rate is not accounted for in standard search and matching models. Given the strong procyclicality of the labor selection rate documented in Figure 1, the standard search and matching model misses an important margin.

We provide a model based view on this additional margin. In a labor selection model, firms only choose a fraction of heterogeneous applicants according to their idiosyncratic characteristics, which we model via a match-specific productivity realization, ε_{it}.[3] Only workers with idiosyncratic productivity realizations above the cutoff productivity, $\tilde{\varepsilon}_{it}$, are selected. Assuming that the distribution of idiosyncratic productivity realizations is given by the probability density function $f(\varepsilon)$, the match-specific probability to select a worker is given by the integral from the cutoff point to the upper support of the density function $\eta\left(\tilde{\varepsilon}_{it}\right) = \int_{\tilde{\varepsilon}_{it}}^{\infty} f\left(\varepsilon\right) d\varepsilon$. Under homogeneous firms, this match-specific selection rate corresponds to the aggregate selection rate $\eta\left(\tilde{\varepsilon}_{it}\right) = \eta\left(\tilde{\varepsilon}_{t}\right)$.

Kohlbrecher et al. (2014) show that the aggregate selection rate exhibits a procyclical comovement with market tightness when the model is closed with a free entry condition for vacancies. In order to illustrate this effect, consider a positive aggregate productivity shock. Now, firms are willing to select workers with lower idiosyncratic productivity. This causes the selection rate to rise. In addition, the positive productivity shock increases the ex-ante expected profit under free entry of vacancies. Therefore, vacancy posting and market tightness increase. This leads to a positive comovement of the selection rate and market tightness. In the steady state of a pure selection model,[4] this comovement can be expressed in terms of the elasticity of the selection rate with respect to market tightness (see Appendix for details),

[3] Note that this mechanism is similar to endogenous separations in search and matching models. However, the potential role for job creation has not been emphasized much in the literature.

[4] A pure selection model assumes a constant contact rate (for each unemployed worker). However, the implications with different constant contact rates would be analogous.

which takes the following form:

$$\frac{\partial \ln \eta}{\partial \ln \theta} = \frac{f(\tilde{\varepsilon})}{\eta} \left(\frac{\int_{\tilde{\varepsilon}}^{\infty} \varepsilon f(\varepsilon)\, d\varepsilon}{\eta} - \tilde{\varepsilon} \right). \tag{1}$$

In addition, Kohlbrecher et al. (2014) show that the comovement between the selection rate and market tightness is observationally equivalent to a Cobb-Douglas matching function with constant returns to scale. For standard distributions, equation (1) delivers a coefficient in between 0 and 1 (see Appendix for details). This prediction can be tested by regressing the log of the selection rate on the log of market tightness, similar to a standard matching function estimation.

4 Selection Based Matching Function

In order to test the predictions of a labor selection model (Kohlbrecher et al., 2014), we aggregate the answers from the "Job Vacancy Survey" to the West German federal state and industry level. This provides us with additional observations. The market tightness, θ_{jt}, is constructed as vacancies from the Job Vacancy Survey over unemployment from the "Integrated Labour Market Biographies (IEB)". We use the following econometric model:

$$\ln \eta_{jt} = \beta_o + \beta_j + \beta_1 \ln \theta_{jt} + \beta_2 D_{00} + \beta_3 D_{05} + \psi_{jt}, \tag{2}$$

where j denotes the cross-sectional units, β_j are cross-sectional fixed effects, D_{00} as well as D_{05} are dummies for the year 2000 and 2005 respectively (due to structural breaks, see Appendix), and ψ_{jt} is the error term.

Table 2 shows the results on the aggregate level for West Germany as well as on the federal state and industry level. The weight on market tightness is 0.271 at the aggregate level, 0.153 at the federal states level, and 0.091 at the industry level.[5]

These estimations confirm the predictions from the selection model that there is a strong positive comovement between the selection rate and market tightness. Interestingly, the estimated coefficients are in line with estimated matching function coefficients for Germany as a whole (see Kohlbrecher et al., 2014, Klinger and Rothe, 2012 or Burda and Wyplosz, 1994). This shows that labor selection plays a major role for the dynamics of the job-finding rate.

[5] It is a common result that the coefficient in matching function estimations declines with the degree of disaggregation (compare e.g. Bauer, 2013).

Table 2: Selection function estimates for West Germany, for West German federal states and industries, 1991 to 2013

	Dependent variable:		
	log(selection rate)		
	OLS	*Panel Fixed Effects*	
	West Germany	Federal States	Industry
log(theta)	0.271***	0.153***	0.091***
	(0.093)	(0.030)	(0.014)
dummy05	0.116***	0.150***	0.121***
	(0.036)	(0.014)	(0.011)
dummy00	−0.075*	−0.072***	−0.049***
	(0.045)	(0.021)	(0.011)
Constant	−0.458***		
	(0.108)		
Observations	23	115	345
R^2	0.703	0.272	0.202
Adjusted R^2	0.656	0.253	0.192

Notes: *p<0.1; **p<0.05; ***p<0.01, robust standard errors in parenthesis.

5 Conclusion

By using data on the number of suitable applicants for the last hire of the IAB's Job Vacancy Survey, we calculate a selection rate. We find that the selection rate is negatively correlated with unemployment and positively correlated with market tightness. These facts confirm the model based predictions of a labor selection model. Traditional search models would also be in line with the procyclicality of the labor selection rate, although they usually lack a free entry condition. We put the aggregated data of the Job Vacancy Survey into the public domain. Thus, the accordance of different models with the observed time series patterns on different aggregation levels can be tested in future research.

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A Appendix

A.1 Theory

A.1.1 Baseline Selection Model

We use the simple selection model as in Kohlbrecher et al. (2014). There is a measure one of workers in the economy that can be either employed or unemployed. Unemployed workers search for jobs and get in contact with a firm with a constant probability $c \leq 1$.[6] When firms and workers meet, they draw from an idiosyncratic productivity distribution. Some contacts are more productive than others. Only workers above a certain cutoff productivity will be selected. Every period, a fraction ϕ of existing worker-firm pairs separates. As is standard in search and matching models, we assume that firms have to post vacancies at a cost if they want to attract a share of the economy wide applicants.

Selection Decision: When workers and firms get in contact, they draw a match-specific realization ε_{it} from an idiosyncratic productivity distribution with density $f(\varepsilon)$ and cumulative density $F(\varepsilon)$. This distribution is iid across workers and time. Because of the *iid* assumption and identical firms we drop the index i in the following. For notational simplicity, we assume that matches only differ in the first period of production and are identical afterwards. Kohlbrecher et al. (2014) show that results are identical if one assumes that productivity differences are permanent or, as in endogenous separation models, redrawn in every period.
The expected discounted profit of hiring an unemployed worker, $\pi_t^E(\varepsilon_t)$, is equal to the current aggregate productivity plus the idiosyncratic productivity shock, ε_t, minus the current wage, $w_t^E(\varepsilon_t)$, plus the expected discounted future profits for incumbent worker-firm pairs, π_{t+1}^I:

$$\pi_t^E(\varepsilon_t) = a_t + \varepsilon_t - w_t^E(\varepsilon_t) + \delta(1-\phi) E_t\left(\pi_{t+1}^I\right), \tag{3}$$

with

$$\pi_t^I = a_t - w_t^I + \delta(1-\phi) E_t(\pi_{t+1}^I), \tag{4}$$

where δ is the discount factor and ϕ is the exogenous separation probability.

The firm hires the worker as long as the expected profit is greater or equal to zero. The cutoff productivity is therefore:

$$\tilde{\varepsilon}_t = w_t^E(\tilde{\varepsilon}_t) - a_t - \delta(1-\phi) E_t\left(\pi_{t+1}^I\right). \tag{5}$$

[6] This is a simplifying assumption that helps to disentangle the effects of selection and contacts on the elasticity of the job-finding rate with respect to market tightness. Kohlbrecher et al. (2014) also study the more general case, where contacts are driven by a standard matching function.

This determines the selection rate:

$$\eta_t = \int_{\tilde{\varepsilon}_t}^{\infty} f(\varepsilon)\, d\varepsilon. \tag{6}$$

Vacancies: We make the standard assumption that firms have to pay a fixed vacancy posting cost κ to enter the market. The value of a vacancy Ψ is

$$\Psi_t = -\kappa + q_t \eta_t E_t \left[\pi_t^E | \varepsilon_t \geq \tilde{\varepsilon}_t\right] + (1 - q_t \eta_t)\, \Psi_{t+1}, \tag{7}$$

where $q_t = c/\theta_t$ is the probability that a vacancy leads to a contact (i.e. worker's contact rate divided by market tightness).

We assume free entry of vacancies such that the value of a vacancy will be zero in equilibrium. Thus:

$$\frac{\kappa}{q_t \eta_t} = E_t \left[\pi_t^E | \varepsilon_t \geq \tilde{\varepsilon}_t\right], \tag{8}$$

or

$$\frac{\kappa}{q_t \eta_t} = a_t + \frac{\int_{\tilde{\varepsilon}_t}^{\infty} \left(\varepsilon - w_t^E(\varepsilon)\right) f(\varepsilon)\, d\varepsilon}{\eta_t} + \delta (1 - \phi)\, E_t \left(\pi_{t+1}^I\right). \tag{9}$$

Wage: Our model can nest a variety of wage formation mechanisms. We assume that the wage takes the general form:

$$w^E(\varepsilon_t) = w_t^I + \alpha \varepsilon_t \tag{10}$$

with

$$w_t^I = \omega(a_t, \eta_t, \theta_t, x), \tag{11}$$

and

$$0 \leq \alpha < 1. \tag{12}$$

Here, w_t^I denotes the wage net of idiosyncratic productivity. It can depend on all endogenous variables, such as productivity, market tightness, the selection rate, as well as exogenous variables and parameters, represented by the vector x. This specification nests the popular Nash bargaining wage.

Employment: As our labor force is normalized to 1, the employment stock is equal to the employment rate, n. The law of motion for employment reads:

$$n_{t+1} = (1 - \phi - c\eta_t)\, n_t + c\eta_t. \tag{13}$$

The number of searching workers is equal to the number of unemployed workers at the beginning of period t, i.e.

$$u_t = 1 - n_t. \tag{14}$$

A.1.2 Model Predictions

Steady State Equations: In order to derive analytical results, we use the steady state version of the selection model with free entry of vacancies. The following three equations are relevant for our derivations below, namely the cutoff point, the selection rate and market tightness:

$$\tilde{\varepsilon} = \frac{w^I - a}{(1 - \delta(1 - \phi))(1 - \alpha)}, \tag{15}$$

$$\eta = \int_{\tilde{\varepsilon}}^{\infty} f(\varepsilon)\, d\varepsilon, \tag{16}$$

$$\theta = (1 - \alpha)\frac{c\eta}{\kappa}\left(\frac{\int_{\tilde{\varepsilon}}^{\infty} \varepsilon f(\varepsilon)\, d\varepsilon}{\eta} - \tilde{\varepsilon}\right). \tag{17}$$

Comovement between Selection Rate and Market Tightness: From these equations, we can derive the elasticity of the selection rate with respect to market tightness, by first obtaining the elasticity of the selection rate and market tightness with respect to productivity.

$$\frac{\partial \ln \eta}{\partial \ln a} = \frac{-f(\tilde{\varepsilon})\frac{\partial \tilde{\varepsilon}}{\partial a} a}{\eta}, \tag{18}$$

which is clearly positive due to $\frac{\partial \tilde{\varepsilon}}{\partial a} < 0$, and

$$\frac{\partial \ln \theta}{\partial \ln a} = \frac{-\frac{\partial \tilde{\varepsilon}}{\partial a} a}{\frac{\int_{\tilde{\varepsilon}}^{\infty} \varepsilon f(\varepsilon) d\varepsilon}{\eta} - \tilde{\varepsilon}}. \tag{19}$$

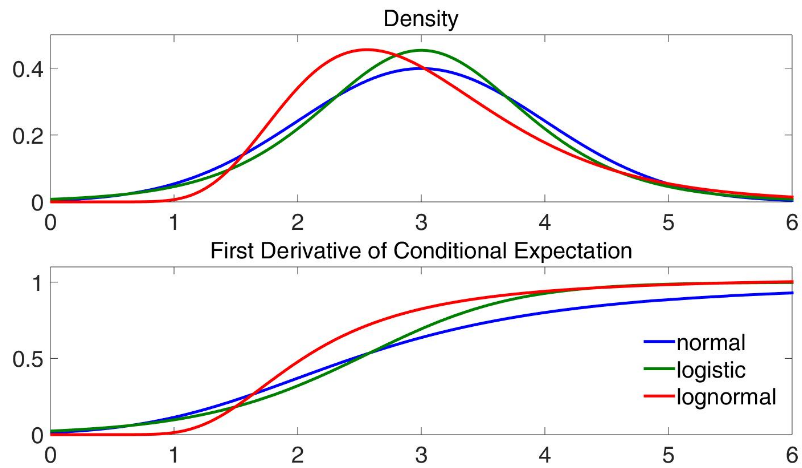
These two equations correspond to the intuition provided in the main part. Under a positive aggregate productivity shock, firms are willing to select workers with lower idiosyncratic productivity. This causes the selection rate to rise. In addition, the positive aggregate productivity shock increases the ex-ante expected profit under free entry of vacancies. Therefore, vacancy posting and market tightness increase.

This leads to a positive comovement of the selection rate and market tightness, which can be shown by combining (18) and (19). The result gives the elasticity of the selection rate with respect to market tightness:

$$
\begin{aligned}
\frac{\partial \ln \eta}{\partial \ln \theta} &= \left(\frac{-f\left(\tilde{\varepsilon}\right)\frac{\partial \tilde{\varepsilon}}{\partial a}a}{\eta}\right) \Big/ \left(\frac{-\frac{\partial \tilde{\varepsilon}}{\partial a}a}{\frac{\int_{\tilde{\varepsilon}}^{\infty}\varepsilon f(\varepsilon)d\varepsilon}{\eta} - \tilde{\varepsilon}}\right) \\
&= \frac{f\left(\tilde{\varepsilon}\right)}{\eta}\left(\frac{\int_{\tilde{\varepsilon}}^{\infty}\varepsilon f\left(\varepsilon\right)d\varepsilon}{\eta} - \tilde{\varepsilon}\right) \\
&= \frac{\partial \frac{\int_{\tilde{\varepsilon}}^{\infty}\varepsilon f(\varepsilon)d\varepsilon}{\eta}}{\partial \tilde{\varepsilon}} > 0.
\end{aligned}
$$

Figure 2 illustrates this analytical result for different distributions and different cutoff points. The upper panel shows the densities of a normal, a logistic and a lognormal distribution. The lower panel shows the results for $\partial \frac{\int_{\tilde{\varepsilon}}^{\infty}\varepsilon f(\varepsilon)d\varepsilon}{\eta} / \partial \tilde{\varepsilon}$at different cutoff points for these distributions. Interestingly, the lower panel shows numbers in between 0 and 1.

Figure 2: Predicted matching coefficients for standard distributions



Notes: Density function and first derivative of conditional expectation for different standard distributions namely, normal, logistic, and lognormal). For comparability reasons, the variance is normalized to 1 and the mean is set to 3 (the lognormal distribution requires a positive mean).

A.2 Data

We use annual data on the number of suitable applicants for the most recent hire in the last 12 months and the number of total vacancies of the IAB Job Vacancy Survey. Information on the IAB Job Vacancy Survey can be found in Moczall et al. (2015). In addition, data on unemployment was taken from register data of the federal labour office, the "Integrated Labour Market Biographies (IEB)" (vom Berge et al., 2013).[7]

The Job Vacancy survey was first carried out in 1989 in West Germany and was extended to East Germany in 1992. It is conducted via a written questionnaire every fourth quarter of the year. Yearly, a stratified random sample of establishments is drawn according to industries, regions as well as size classes. The number of establishments participating ranges from 4.000 in the first years to about 14.000 in the recent years. The data set includes weights to extrapolate the data for the whole economy. Weights for the most recent case of hiring ensure representativeness for all hires.

In 2005, the extrapolation procedure has been revised and adapted backwards until 2000, which causes a break in the data. We control for that by including a shift dummy from the year 2000 onwards (D_{00}). In addition, the German labor market experienced severe reforms in 2005, hence, we include another shift dummy starting in 2005 (D_{05}).

We restrict the analysis to West Germany because of the special conditions in East Germany during the transformation period in the 1990s. Furthermore, the question on the number of suitable applicants was not posed in 1990, therefore, we restrict our sample range from 1991 to 2013. Since the sample range is quite short to conduct time series analysis, we calculate the time series at the federal state and industry level. We aggregate the inverse of the number of suitable applicants by taking mean values. Following Klinger and Rothe (2012, p.17), we add the city states (Bremen and Hamburg) to the neighboring state to avoid spatial correlation. The Job Vacancy Survey contains too few observations for small federal states in order to be representative. Therefore, we restrict our sample to federal states with at least 6 million inhabitants.[8]

[7] Status quo of the data as of January 2016.

[8] As of December 2014. Hence, we include Baden-Wuerttemberg, Bavaria, North-Rhine Westphalia, Lower Saxony plus Bremen and Hessen.