I Z A Institute of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 11314

Value Added, Wages, and Labor Market Flows at the Establishment Level

Christian Merkl
Heiko Stüber

FEBRUARY 2018

IZA Institute of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 11314

Value Added, Wages, and Labor Market Flows at the Establishment Level

Christian Merkl
Friedrich-Alexander-University Erlangen-Nuremberg (FAU) and IZA

Heiko Stüber
Friedrich-Alexander-University Erlangen-Nuremberg (FAU), IZA and IAB

FEBRUARY 2018

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Value Added, Wages, and Labor Market Flows at the Establishment Level*

In this paper, we analyze the connection between value added, wages, and labor market flows at the establishment level. We develop a simple model to illustrate the expected comovement of these variables. For the empirical analysis, we link the new German Administrative Wage and Labor Market Flow Panel (AWFP) dataset to the IAB Establishment Panel. We show that establishments' hires rates have a positive and separations rates a negative comovement with establishment-specific value added, whereby hires react by more than separations. In addition, we provide evidence that establishments' partial equilibrium reaction is an important driver for aggregate labor market dynamics.

JEL Classification: E24, E32, J64

Keywords: labor market flows, value added, wages, administrative data, establishments

Corresponding author:
Heiko Stüber
Friedrich-Alexander-Universität Erlangen-Nürnberg
Lange Gasse 20
90403 Nürnberg
Germany
E-mail: Heiko.Stueber@fau.de

* We would like to thank an anonymous referee and Johann Ludsteck for helpful suggestions and discussions. The authors gratefully acknowledge support from the German Research Foundation (DFG) under priority program "The German Labor Market in a Globalized World" (SPP 1764) and the Hans-Frisch-Stiftung for financial support.

1 Introduction

We are the first to link the new Administrative Wage and Labor Market Flow Panel (AWFP, henceforth) for Germany (Seth and Stüber 2017) to the IAB Establishment Panel (Ellguth et al. 2014). The linkage provides a unique combination of establishments' revenues, inputs, wages, and labor market flows, which can be used for a variety of research questions.

We analyze the quantitative comovement of establishments' value added and wages with hires and separation rates in Germany. Our paper proposes a simple labor market flow model to illustrate the expected comovement of these variables. We look at the linked data through the lens of a model with idiosyncratic heterogeneity and find that the patterns in the data are well in line with the model's predictions. Our empirical results offer an important reference point for the quantitative reaction of labor market flow models to idiosyncratic and aggregate shocks (e.g. Mortensen and Pissarides 1994).

In addition, we provide novel results on establishments' differential reaction to value added changes depending on their characteristics. In line with economic theory, establishments with larger explicit or implicit firing costs (e.g. due to size or the existence of a works council) show a smaller (absolute) reaction of separations to value added changes. In turn, they also show a smaller reaction of hires to value added changes.

To illustrate the dynamics in the AWFP, Figure 1 shows the aggregated worker flows, namely the Hodrick Prescott filtered (smoothing parameter $\lambda = 6.25$) hires and separation rates, and GDP (multiplied by 10) at the national level (for the definitions see data section).

The hires rate is strongly proyclical (correlation with GDP: 0.73), while the separation rate is moderately countercyclical (correlation with GDP: -0.15). Visual inspection also shows that the hires and separation rates are roughly 10 times more volatile than GDP, which confirms prior findings by Gartner et al. (2012).

The rest of the paper proceeds as follows. Section 2 shows a simple model. Section 3 presents the dataset and Section 4 provides empirical results.

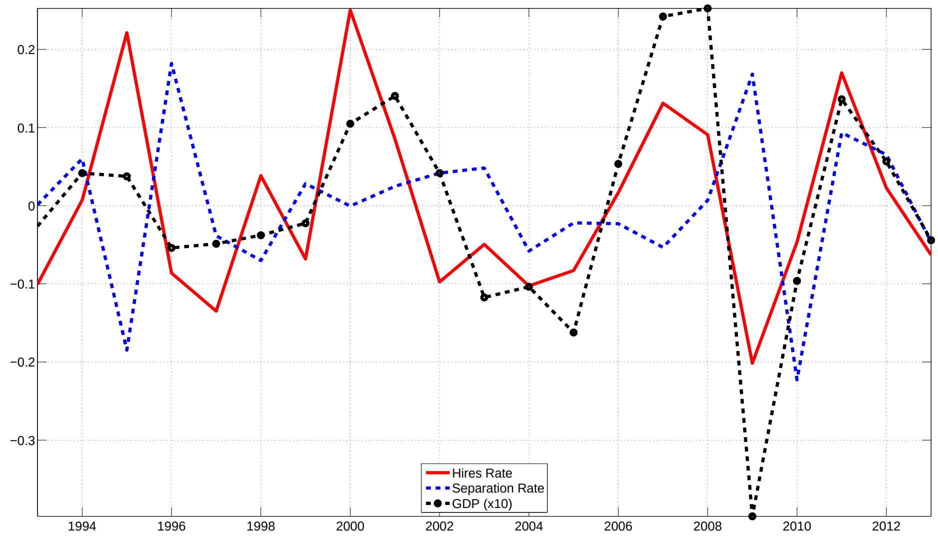

Figure 1: Cyclical components of the hiring rate, separation rate and GDP. The latter is multiplied by 10 for illustration purposes.

2 A Simple Model

Assume firm i faces two stochastic variables. Value added a_{it} is subject to aggregate and establishment-specific shocks. Following Chugh and Merkl (2016), the firm interviews an exogenous number of applicants each period. Each applicant j draws a match-specific idiosyncratic training cost shock ε_{ijt}, which is assumed to be *iid* and from a stable density function $f(\varepsilon)$. The firm's present value for a given applicant j is

$$a_{it} - \varepsilon_{ijt} - w(a_{it}, \varepsilon_{ijt}) + E_t \delta (1 - \phi) FV_{t+1}, \tag{1}$$

where $w(a_{it}, \varepsilon_{ijt})$ are wages (which may be a function of value added and idiosyncratic training costs), E_t is the rational expectations operator, δ is the discount factor, ϕ is the exogenous separation rate, and FV_{t+1} is the future value of a worker.

We assume that worker-firm pairs are only hit by idiosyncratic training cost shocks during the first employment period. Thus, the future value of a worker-firm pair is

$$FV_{t+1} = a_{it+1} - w(a_{it+1}) + \delta (1 - \phi) FV_{t+2}. \tag{2}$$

The firm chooses an optimal cutoff point for training costs at which it is indifferent between hiring and not hiring, i.e. it will only select the most suitable workers (selection model):

$$\tilde{\varepsilon}_{it} = a_{it} - w\left(a_{it}, \tilde{\varepsilon}_{it}\right) + E_t \delta \left(1 - \phi_t\right) FV_{t+1}. \tag{3}$$

The firm-specific probability of selecting a worker from a pool of applicants is

$$\eta_{it} = \int_{-\infty}^{\tilde{\varepsilon}_{it}} f\left(\varepsilon\right) d\varepsilon. \tag{4}$$

We rewrite the model in terms of the steady state and derive several results for the firm's partial equilibrium reaction (see Appendix A.1). The firm's reaction to one-period idiosyncratic value added, a_i, and wage changes are:

$$\frac{\partial \eta_i}{\partial a_i} > 0 \text{ and} \tag{5}$$

$$\frac{\partial \eta_i}{\partial w\left(a_i, \tilde{\varepsilon}_i\right)} < 0. \tag{6}$$

Equations (5) and (6) show that firms can be expected to increase their hires rates[1] in response to positive value added (negative wage) changes. A higher value added makes it worthwhile to select workers with higher training costs ε_i. These two model based implications will be tested in the data.

Now assume that firms are hit by a an aggregate productivity shock. What is the partial equilibrium reaction to this shock? We approximate the aggregate shock by a permanent productivity shift $\bar{a}$ (as in the existing literature, e.g. Hornstein et al. 2005). It can be shown that

$$\frac{\partial \ln \eta_i}{\partial \ln \bar{a}} = \frac{1}{1 - \delta\left(1 - \phi\right)} \frac{\partial \ln \eta_i}{\partial \ln a_i}. \tag{7}$$

Given that $\phi < 1$, equation (7) shows that the reaction to aggregate shocks can be expected to be several times larger than the reaction to idiosyncratic shocks.[2]

[1]Note that hires rate and selection rate are used interchangeably here, although the former refers to the number of new hires divided by the number of employees and the latter to the number of hires divided by the number of applicants. However, for a given steady state firm size, the qualitative movements of these two rates is the same (see Appendix A.1).

[2]The driving force is the assumption that aggregate shocks show more persistence than idiosyncratic shocks. In the end, this is an empirical question. Aggregate productivity shocks are known to be

In principle, we could derive an endogenous separation decision by adding idiosyncratic cost shocks for incumbent worker-firm pairs. This would yield very similar results and simply flip the signs in equations (5) and (6). However, we abstain from this theoretical exercise for space reasons.

Appendix A.1 shows that a standard search and matching model would yield similar results as the selection model. However, the selection model has the advantage that the unit of observation is the firm and not the respective submarket.

3 Data Set

The AWFP aggregates German administrative wages, labor market flows, and stock information at the establishment level. The underlying administrative microeconomic data source is mainly the Employment History (BeH) of the IAB. Before aggregating the data to the establishment level, several data corrections were conducted at the microeconomic data level. See Appendix A.2 and the AWFP data report (Seth and Stüber 2017) for further details.

For coherency, we focus on wages and flows for full-time workers.[3] Following Davis et al. (2006), we define the hires rate (hr_{it}) as new full-time hires in an establishment i divided by the average number of full-time workers in period t and $t-1$. The separation rate (sr_{it}) is defined equivalently. The wage variable we use is the mean real wage per full-time worker at establishment i in period t (w_{it}).[4]

The AWFP only contains administrative information on establishments' labor market flows and wages, but no information on establishments' revenues or intermediary inputs. Therefore, we linked the AWFP to the IAB Establishment Panel (based on establishment identifiers), which is an annual survey among up to 16,000 establishments starting in 1993 (Ellguth et al. 2014).[5] We use the information on establishments' real annual revenues and deduct the share of inputs to construct the real value added

persistent. By contrast, when we estimate the coefficient for the lagged dependent hires rate based on equation (8), we obtain statistically insignificant results. This is a sign that establishment-specific revenues are not persistent at the annual frequency.

[3] More precisely, we focus on "regular workers" (see Appendix A.2).

[4] Strictly speaking, w_{it} are the average overall real earnings per full-time worker. In line with search and matching models where employment is adjusted along the extensive margin, we refer to this variable as the wage (per full-time worker).

[5] An AWFP extension for the IAB Establishment Panel will be provided by the Research Data Centre (FDZ) at the IAB by the end of 2018 (see Stüber and Seth 2017).

per full-time worker (va_{it}). Correspondingly, we define the wage information and labor market flows at the annual level. This leaves use with an overall sample size of 105,903 observations for the years 1993–2013. For more information, see Appendix A.2.

4 Empirical Results

In line with our theoretical framework, we estimate the following equations

$$hr_{it} = \beta_0 + \beta_1 \ln w_{it} + \beta_2 \ln va_{it} + \beta_3 X_{it} + \alpha_i + \sum_{t=1}^{N} \gamma_t + \mu_{it} \text{ and} \tag{8}$$

$$sr_{it} = \beta_0 + \beta_1 \ln w_{it} + \beta_2 \ln va_{it} + \beta_3 X_{it} + \alpha_i + \sum_{t=1}^{N} \gamma_t + \mu_{it}, \tag{9}$$

where α_i are establishment fixed effects and γ_t are time fixed effects. X_{it} is a set of establishment-specific covariates, namely the share of full-time workers, the number of full-time workers, and the share of low- and high-skilled workers. They are meant to control for time-variant structural changes at the establishment level.

Note that our regressions measure the comovement between the hires/separation rate and wages/value added per full-time worker and cannot make a causal statement in the statistical sense. However, the transmission channel in labor market flow models is clear cut. Revenue changes and shocks to wage formation affect the flow rates and not vice versa.

Tables 1 and 2 show the estimation results for the entire sample and different subgroups (establishments within/outside collective bargaining, with/without works council, different size classes and for West and East Germany). The estimated coefficients for value added and wages show the expected signs and are statistically significant for most subgroups. They have to be interpreted as the semi-elasticity of the hires and separation rates with respect to idiosyncratic changes, as systematic time-invariant establishment-specific effects and aggregate effects are controlled for by establishment fixed-effects and by time dummies.

Let us emphasize that the quantitative results for the semi-elasticity of wages is more difficult to interpret than the one for value added. First, wages may be moved directly due to wage shocks (e.g. a higher bargaining power for workers) or indirectly due to value added changes. Second, under the existence of implicit long-run contracts, in response to value added changes, the movement of current wages may be much smaller than the movement of the discounted present value of wage costs.[6] From a theoretical perspective the latter is relevant for the hiring behavior, while the former enters the regression. This may lead to an upward bias of the estimated wage coefficient (in absolute terms).

Interestingly, in absolute terms the semi-elasticities of the hires rate with respect to value added are several times larger than for the separation rate. This indicates that the major adjustment at the establishment level takes place via the hiring margin.

Establishments' semi-elasticities of the separation rate with respect to value added are larger (in absolute terms) for smaller establishments than for larger establishments (Table 2). In Germany, smaller establishments typically face smaller firing restrictions (establishment below certain thresholds are for example exempted from employment protection). In addition, establishments' reaction to a drop of value added is larger without works council than with works council. In Germany, works council have to approve certain decisions at the establishment level such as firing. Thus, they may lead to higher implicit firing costs.

Interestingly, higher explicit or implicit firing costs do not only reduce the (absolute) semi-elasticity of the separation rate, but also the semi-elasticity of the hires rate (Table 1). Larger establishments and those with works council exhibit much smaller numbers than their peers.

Table 2 shows that the estimated semi-elasticity of the separation rate with respect to wages is positive and statistically significant.[7] Interestingly, this result is driven by East German establishments. Surprisingly, establishments without bargaining regimes show the quantitatively largest reaction of the separation rate to log-value added changes. Note, however, that these results are again driven by East German establishments.[8]

[6]The comovement between current wages and current value added is very small. Across all subgroups, we find a stable estimated coefficient of about 0.02 in fixed effects log-log-estimations.

[7]Carlsson and Westermark (2016) argue that this may be considered as a sign for inefficient separations. See their paper for details.

[8]Estimations for subsamples of different bargaining regimes in East and West Germany are available on request.

Table 1: Hires Rate Reaction for different Subgroups.

Establishments:	Coefficients		Number of	R^2		
	$ln(w_{it})$	$ln(va_{it})$	observations	within	between	overall
all	-0.231 ***	0.082 ***	105,903	0.042	0.051	0.035
	(0.018)	(0.003)				
with centralized bargaining	-0.198 ***	0.063 ***	41,710	0.040	0.040	0.032
	(0.029)	(0.004)				
with firm level bargaining	-0.272 ***	0.029 ***	7,699	0.059	0.028	0.019
	(0.081)	(0.009)				
centrally oriented	-0.261 ***	0.079 ***	22,510	0.049	0.025	0.020
	(0.036)	(0.008)				
no bargaining regimes	-0.233 ***	0.118 ***	23,907	0.059	0.021	0.019
	(0.033)	(0.008)				
without a works council	-0.236 ***	0.102 ***	71,736	0.050	0.030	0.026
	(0.020)	(0.004)				
with a works council	-0.249 ***	0.032 ***	28,078	0.047	0.033	0.031
	(0.030)	(0.004)				
size: ≤ 10	-0.223 ***	0.163 ***	44,551	0.079	0.004	0.017
	(0.022)	(0.006)				
size: $11 - 100$	-0.213 ***	0.033 ***	41,651	0.055	0.017	0.021
	(0.021)	(0.003)				
size: $101 - 500$	-0.150 ***	0.029 ***	15,143	0.065	0.048	0.045
	(0.035)	(0.004)				
size: ≥ 500	-0.085 *	0.023 ***	4,558	0.070	0.023	0.015
	(0.043)	(0.009)				
located in West Germany	-0.230 ***	0.074 ***	60,344	0.044	0.059	0.044
	(0.024)	(0.004)				
located in East Germany	-0.232 ***	0.094 ***	45,559	0.048	0.026	0.018
	(0.026)	(0.005)				

Note: *** Denotes significance at 1% level, ** at 5% and * at 10 %. w_{it}: mean real wage per full-time worker at establishment i in period t. va_{it}: real value added per full-time worker at establishment i in period t. Robust std. errors in brackets.

Table 2: Separation Rate Reaction for different Subgroups.

Establishments:	Coefficients		Number of	R^2		
	$ln(w_{it})$	$ln(va_{it})$	observations	within	between	overall
all	0.037 ***	-0.036 ***	105,903	0.056	0.019	0.024
	(0.013)	(0.002)				
with centralized bargaining	-0.018	-0.026 ***	41,710	0.063	0.025	0.032
	(0.026)	(0.003)				
with firm level bargaining	0.087	-0.014	7,699	0.033	0.004	0.005
	(0.097)	(0.012)				
centrally oriented	0.057 **	-0.044 ***	22,510	0.078	0.020	0.026
	(0.029)	(0.005)				
no bargaining regimes	0.047 *	-0.054 ***	23,907	0.072	0.021	0.024
	(0.025)	(0.005)				
without a works council	0.024 *	-0.048 ***	71,736	0.063	0.012	0.022
	(0.014)	(0.003)				
with a works council	0.027	-0.011 ***	28,078	0.058	0.023	0.023
	(0.052)	(0.004)				
size: ≤ 10	0.010	-0.101 ***	44,551	0.155	0.000	0.012
	(0.015)	(0.004)				
size: $11 - 100$	0.007	-0.032 ***	41,651	0.098	0.006	0.021
	(0.017)	(0.002)				
size: $101 - 500$	0.025	-0.018 ***	15,143	0.097	0.010	0.024
	(0.028)	(0.003)				
size: ≥ 500	-0.018	-0.011 ***	4,558	0.110	0.025	0.029
	(0.042)	(0.004)				
located in West Germany	0.013	-0.029 ***	60,344	0.054	0.016	0.022
	(0.016)	(0.003)				
located in East Germany	0.057 ***	-0.047 ***	45,559	0.067	0.023	0.028
	(0.022)	(0.003)				

Note: *** Denotes significance at 1% level, ** at 5% and * at 10 %. w_{it}: mean real wage per full-time worker at establishment i in period t. va_{it}: real value added per full-time worker at establishment i in period t. Robust std. errors in brackets.

For better interpretation, we transform the semi-elasticity of the hires rate with respect to value added into an elasticity for the median establishment. The elasticity for the median establishment (with a hires rate of 0.091) is 0.90. Using model equation (7), we calculate a partial equilibrium (PE) elasticity of the hires rate with respect to a permanent aggregate productivity shift of 6.6.[9] As a benchmark, we regress the aggregated cyclical component of the hires rate on the cyclical component of GDP (as depicted in Figure 1) and obtain an estimated coefficient of 6.2, which is very similar to the calculated PE elasticity. This provides suggestive evidence that the PE reaction of establishments is an important driver for aggregate labor market dynamics. By contrast, if the two numbers were far apart, this would be a sign for potentially important general equilibrium effects.

5 Conclusion

In this paper, we have analyzed the connection between value added, wages, and labor market flows at the establishment level. We have developed a simple model to illustrate the expected comovement of these variables. For the empirical analysis, we have linked the new AWFP dataset to the IAB Establishment Panel. The comovements in the data are well in line with our model.

We have shown that more value added at the establishment level is associated with a larger (smaller) hires (separation) rate. Higher wages are associated with a smaller hires rate.

This paper is the starting point of a larger research agenda, where the interaction of wage formation and labor market flow dynamics is used as laboratory for testing the qualitative and quantitative validity of various labor market flow models.

[9] The median firm's separation rate is 10 percent and we assume $\delta = 0.96$.

6 References

Carlsson, Mikael and Andreas Westermark (2016), Endogenous Separations, Wage Rigidities and Employment Volatility. Sveriges Riksbank Working Paper Series, 326.

Chugh, Sanjay and Christian Merkl (2016). Efficiency and Labor Market Dynamics in a Model of Labor Selection. International Economic Review, 57(4), 1371–1404.

Davis, Steven J., Jason Faberman, and John Haltiwanger (2006), The Flow Approach to Labor Markets: New Data Sources and Micro-Macro Links, Journal of Economic Perspectives, 20(3), 3–26.

Ellguth, Peter, Susanne Kohaut, and Iris Möller (2014). The IAB Establishment Panel – Methodological Essentials and Data Quality. Journal of Labor Market Research, 47(1-2), 27–41.

Elsby, Michael W.L. and Ryan Michaels (2013), Marginal Jobs, Heterogeneous Firms, and Unemployment. American Economic Journal: Macroeconomics, 5(1), 1–48.

Gartner, Hermann, Christian Merkl, and Thomas Rothe (2012). Sclerosis and Large Volatilities: Two Sides of the Same Coin. Economics Letters, 117(1), 106–109.

Hornstein, Andreas, Per Krusell, and Giovanni Violante (2005). Unemployment and Vacancy Fluctuations in the Matching Model: Inspecting the Mechanism. Federal Reserve Bank of Richmond Quarterly, 91(3), 19–51.

Mortensen, Dale T. and Christopher A. Pissarides (1994). Job Creation and Job Destruction in the Theory of Unemployment. Review of Economic Studies, 61 (3), 397–415.

Seth, Stefan and Heiko Stüber (2017). Administrative Wage and Labor Market Flow Panel (AWFP) 1975-2014. FAU Discussion Papers, 1/2017.

Schmucker, Alexandra, Stefan Seth, Johannes Ludsteck, Johanna Eberle, and Andreas Genzer (2016). Establishment History Panel 1975-2014. FDZ-Datenreport, 3/2016.

Stüber, Heiko and Stefan Seth (2017). The Public Release Data of the Administrative Wage and Labor Market Flow Panel. Journal of Economics and Statistics, ahead of print (DOI: `https://doi.org/10.1515/jbnst-2017-1002`).

A Appendices

A.1 Theory Derivations

A.1.1 Simple Model

Assume firm i is subject to two types of idiosyncratic shocks. Value added a_{it} is subject to aggregate and establishment-specific shocks. Following the selection model by Chugh and Merkl (2016), the firm interviews an exogenous number of workers each period.[10] Each applicant j draws an idiosyncratic training cost shock ε_{ijt}, which is assumed to be iid and from a stable density function $f(\varepsilon)$:

$$a_{it} - \varepsilon_{ijt} - w\left(a_{it}, \varepsilon_{ijt}\right) + E_t \delta \left(1 - \phi\right) FV_{t+1}, \tag{10}$$

where E_t is the expectations operator, ϕ is the separation rate and, FV_t is the future value of a worker, which is defined to be

$$FV_{t+1} = a_{it+1} - w\left(a_{it+1}\right) + \delta \left(1 - \phi\right) FV_{t+2}. \tag{11}$$

Note that we abstain from endogenous separation and assume that existing worker-firm pairs are not subject to idiosyncratic training costs shocks, i.e. ε_{it} is not contained in FV_{t+1}.

The firm chooses an optimal cutoff point for training costs:

$$\tilde{\varepsilon}_{it} = a_{it} - w\left(a_{it}, \tilde{\varepsilon}_{it}\right) + E_t \delta \left(1 - \phi\right) FV_{t+1}. \tag{12}$$

The probability of selecting a worker from a pool of applicants is

$$\eta_{it} = \int_{-\infty}^{\tilde{\varepsilon}_{it}} f\left(\varepsilon\right) d\varepsilon. \tag{13}$$

To organize thoughts, we rewrite this model in terms of the steady state:

[10] In a richer model, the number of applicants may be driven by the number of vacancies and market tightness.

$$\tilde{\varepsilon}_i = a_i - w(a_i, \tilde{\varepsilon}_i) + \delta(1-\phi) FV \tag{14}$$

$$= a_i - w(a_i, \tilde{\varepsilon}_i) + \delta(1-\phi) \frac{a - w}{1 - \delta(1-\phi)}. \tag{15}$$

A one period shock to value added (without persistence) changes the cutoff point as follows:

$$\frac{\partial \tilde{\varepsilon}_i}{\partial a_i} = \left(1 - \frac{\partial w(a_i, \tilde{\varepsilon}_i)}{\partial a_i}\right). \tag{16}$$

A one period shock to wages (without persistence) changes the cutoff point as follows:

$$\frac{\partial \tilde{\varepsilon}_i}{\partial w(a_i, \tilde{\varepsilon}_i)} = -1. \tag{17}$$

The firm's steady state reaction to unpersistent idiosyncratic value added and wage changes is:

$$\frac{\partial \eta_i}{\partial a_i} = \frac{\partial \tilde{\varepsilon}_i}{\partial a_i} f(\tilde{\varepsilon}) = \left(1 - \frac{\partial w(a_i, \tilde{\varepsilon}_i)}{\partial a_i}\right) f(\tilde{\varepsilon}) \text{ and} \tag{18}$$

$$\frac{\partial \eta_i}{\partial w_i} = -f(\tilde{\varepsilon}). \tag{19}$$

How does the firm react to permanent shifts of productivity (which are meant to approximate persistent aggregate shocks)? To see this, let's rewrite the cutoff point and denote $\bar{a}$ as permanent productivity shifts:

$$\tilde{\varepsilon}_i = \bar{a} - w(\bar{a}, \tilde{\varepsilon}_i) + \delta(1-\phi) \frac{\bar{a} - w(\bar{a})}{\delta(1-\phi)}. \tag{20}$$

The first derivative with respect to $\bar{a}$ is

$$\frac{\partial\tilde{\varepsilon}_i}{\partial\bar{a}} = \left(1 - \frac{\partial w\left(\bar{a},\tilde{\varepsilon}_i\right)}{\partial\bar{a}}\right) + \delta\left(1-\phi\right)\frac{\left(1 - \frac{\partial w(\bar{a})}{\partial\bar{a}}\right)}{1-\delta\left(1-\phi\right)}. \tag{21}$$

Assuming that $\frac{\partial w(\bar{a},\tilde{\varepsilon}_i)}{\partial\bar{a}} = \frac{\partial w(\bar{a})}{\partial\bar{a}}$, we obtain:

$$\frac{\partial\tilde{\varepsilon}_i}{\partial\bar{a}} = \frac{\left(1 - \frac{\partial w(\bar{a},\tilde{\varepsilon}_i)}{\partial\bar{a}}\right)}{1-\delta\left(1-\phi\right)}. \tag{22}$$

Thus, the reaction to aggregate shocks is

$$\frac{\partial\eta_i}{\partial\bar{a}} = \frac{\partial\tilde{\varepsilon}_i}{\partial\bar{a}}f\left(\tilde{\varepsilon}\right) = \frac{\left(1 - \frac{\partial w(\bar{a},\tilde{\varepsilon}_i)}{\partial\bar{a}}\right)}{1-\delta\left(1-\phi\right)}f\left(\tilde{\varepsilon}\right) = \frac{1}{1-\delta\left(1-\phi\right)}\frac{\partial\eta_i}{\partial a_i}. \tag{23}$$

Note that we have analyzed the steady state reaction of the selection rate η_i, which is defined to be matches divided by the number of applicants. By contrast, in the data, we observe the hires rate, which is matches divided by the number of workers at an establishment. However, in our simple selection model, the number of applicants is exogenous. In steady state, for a given number of employees and applicants, the driving factor is the number of matches. Thus, all theoretical statements from above are both true for the selection rate and the hires rate.

Also note that our simple model is of pure partial equilibrium nature and thus we have not aggregated across all firms (which would simply mean aggregating over all a_{it}, where we have remained agnostic about the underlying distribution). This corresponds to our empirical strategy where we control for aggregate effects by time dummies and systematic time-invariant differences across firms by fixed effects.

A.1.2 Connection to Search and Matching Model

Alternatively to using idiosyncratic training costs, we could write a standard search and matching model, where the firm faces the following present value:

$$a_{it} - w(a_{it}) + E_t \delta (1 - \phi) FV_{t+1}, \tag{24}$$

where a_{it} is the stochastic value added in a particular submarket. This would yield the following job-creation condition:

$$\frac{\kappa}{q(\theta_{it})} = a_{it} - w(a_{it}) + E_t \delta (1 - \phi) \frac{\kappa}{q(\theta_{it+1})}, \tag{25}$$

where κ are vacancy posting costs.

Imposing the steady state and after some algrebra, we obtain:

$$p_i = \left(\frac{a_i - w(a_i)}{1 - \delta (1 - \phi)} \right)^{\frac{1-\xi}{\xi}}, \tag{26}$$

where p is the probability of finding a job and ξ is the elasticity of a Cobb-Douglas constant returns matching function with respect to unemployment.

Similar to the selection model above, it can be shown that p reacts more to (transitory) idiosyncratic shocks than to (permanent) aggregate shocks. However, the standard search and matching model would derive the reaction in a homogenous sub-market, i.e. the index i refers to a market and not a particular firm. Given that our empirical unit of empirical analysis is the establishment, our proposed model is better suited. Using a search and matching model, which is in line with our empirical needs, would require a model such as proposed by Elsby and Michaels (2013). This would complicate the derivations of analytical results substantially.

A.2 Data Description

The Administrative Wage and Labor Market Flow Panel (AWFP) for Germany was developed within the framework of the priority program 1764, sponsored by the German Research Foundation (DFG). The AWFP aggregates German administrative wages, labor market flows, and stock information at the establishment level of the years 1975–2014. Seth and Stüber (2017) document the dataset.

The underlying administrative micro data sources of the AWFP are the Employment History (BeH) and the Benefit Recipient History (LEH) of the Institute for Employment Research (IAB). Before aggregating the data to the establishment level, several data corrections were applied. For example: imputation of earnings above the upper earnings limit for social security contributions, correction and imputation of information on education and training, and imputation of details regarding full-time and part-time employment in 2011 and 2012. The data corrections of the AWFP are identical to the ones used generating the Establishment Historic Panel 1975-2014 and are described in detail in Section 3.1 of the corresponding FDZ data report (see Schmucker et al. 2016).

The AWFP consists of all German establishment of the years 1975 to 2014 that have at least one "regular worker". A "regular worker" is defined as a full-time worker subject to social security contributions (without any special characteristics); this means that the following workers do not count as regular worker: (marginal) part-time workers, (student) apprentices, workers in partial retirement etc. (see Seth and Stüber 2017).

All stocks and flows are calculated at the end of the period (in our case the end of the year).[11] If not stated otherwise, only regular workers are counted as employees. We define the stocks and flows as:

- End-of-period stock: Stock of employees of an establishment in some period p equals the number of regular workers employed on the last day of the period.
- End-of-period inflow: Inflows of employees of an establishment for period p equals the number of regular workers who are employed on the last day of period p but not on the last day of the preceding period, $p-1$.
- End-of-period outflow: Outflows of employees of an establishment for period p equals the number of regular workers who are employed on the last day of preceding period $(p-1)$ but not last day of period p.

We use the following stock and flow information on the establishment level from the AWFP on a yearly frequency:

- Imputed mean wage of regular workers. We use the CPI to calculate real mean wages.
- Establishment's industry classification.

[11] AWFP data is also available on a quarterly frequency.

- The stock of regular workers without formal vocational training (low-skilled workers), the stock of regular workers with formal vocational training (medium-skilled workers) and the stock of regular workers with a university degree (high-skilled workers). These stocks are used to calculate the shares of low- and high-skilled workers.

- The stock of all workers and the stock of regular workers to calculate the share of regular workers in the establishments.

Following Davis et al. (2006), we define the hires rate (hr_{it}) as new hires in an establishment divided by the average number of regular workers in period t and $t-1$. The separation rate (sr_{it}) and the wage per regular worker (w_{it}) are defined equivalently.

We use these establishment information from the AWFP for the years 1993 to 2013 and link it to the IAB Establishment Panel (an annual survey among up to 16,000 establishments, starting in 1993). For a detailed description of the panel see, e.g., Ellguth et al. (2014).

We use three peaces of information from the IAB Establishment Panel: (1) establishments' annual revenues, where we deduct the share of inputs to construct the value added per full-time worker (va_{it}). Since annual revenues are a retrospective information, we have information available until 2013. We use the CPI to calculate real value added. (2) Information whether a works council exists in the establishment and (3) information on the wage bargaining within the establishment (centralized/firm level/centrally oriented/none).

For our analysis, we drop some outliers. Observations with wage and/or value added below the 1^{st} percentile and above the 99^{th} percentile. After merging the AWFP data with the IAB Establishment Panel, we are left with an overall sample size of 105,903 observations for the years 1993–2013.

An AWFP extension for the IAB Establishment Panel will be provided by the Research Data Centre (FDZ) at the IAB by the end of 2018 (see Stüber and Seth 2017).