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**Title** The Composition of Wage Differentials between  
Migrants and Natives

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# The Composition of Wage Differentials between Migrants and Natives \*

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## Abstract

We consider the role of unobservables, such as differences in search frictions, reservation wages, and productivities for the explanation of wage differentials between migrants and natives. We disentangle these by estimating an empirical general equilibrium search model with on-the-job search due to Bontemps, Robin, and van den Berg (1999) on segments of the labour market defined by occupation, age, and nationality using a large scale German administrative dataset.

The native-migrant wage differential is then decomposed into several parts, and we focus especially on the component that we label “migrant effect”, being the difference in wage offers between natives and migrants in the same occupation-age segment in firms of the same productivity. This decomposition of wage differentials also allows us to quantify the marginal and joint roles of the distinct unobservables by counterfactually assigning to one group structural parameter values of the reference group. The “migrant effects” are particularly pronounced among the unskilled and young, but the differences diminish with age.

**Keywords:** immigrants, decomposition of wage differentials, job search, turnover

**JEL Codes:** J31, J61, J63

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# 1 Introduction

The empirical literature on the labour market experience of immigrants often focuses on differences in observable characteristics between migrants and natives to explain wage differentials. Less explored is the role of unobservables, such as differences in search frictions, reservation wages, and productivities. Yet, it is precisely these factors that modern search theory emphasises to be important for wage dispersion. We examine and disentangle the role of these various unobservables in explaining migrant-native wage differentials by adapting to the migrant context the empirical general equilibrium search model with on-the-job search due to Bontemps, Robin, and van den Berg (1999). The estimation of this structural model on segments of the labour market defined by occupation, age, and nationality enables us to decompose the native-migrant wage differential into several parts. In particular, we focus on the component that we label “migrant effect”, being the difference in wage offers between natives and migrants in firms of the same productivity. This decomposition of wage differentials also allows us to quantify the marginal and joint roles of the various unobservables by counterfactually assigning to one group structural parameter values of the reference group.

The structural model is estimated on a large German administrative panel. Germany is a particularly interesting and relevant case since it hosts the largest numbers of foreign nationals in Europe, and immigration is known to be predominantly low-skilled. According to Eurostat, 7.13 million foreign nationals resided in Germany in 2010, about 8.7% of the total population. Using the 2% subsample of the German employment register allows us to stratify the analysis by nationality, occupation and age. The resulting subsamples are sufficiently large to permit precise estimation of the model’s structural parameters. Moreover, since this is administrative data, the usual concerns about the quality of survey data in a migrant context (sample size, measurement accuracy, and use of retrospective information) are absent. Using the same data set but pursuing different concerns, D’Amuri, Ottaviano, and Peri (2010) estimate the wage and employment effects of recent immigration in Western Germany (and find that the substantial immigration of the 1990s had very little adverse effects on native wages and on their employment levels), while Dustmann, Glitz and Vögel (2010) explore how migrants’ wages and unemployment fluctuate over the economic cycle in comparison to the experiences of German native workers.

We briefly describe some aspects of our applications of the structural model. In order to control for heterogeneity in observables, we follow common estimation practice in the search-theory literature by partitioning the labour market into many segments. These segments are defined in terms of occupation, age and nationality.<sup>1</sup> Sample sizes are sufficiently large to permit such stratification. Each segment is thus assumed to be potentially a separate labour market, characterised by its own job turnover parameters (the job arrival and separation rates). For empirical evidence of labour market segmentation in Germany see e.g. Constant and Massey (2005). Turning to the unobservables (for the econometrician), firms in each segment differ in terms of productivity, and workers differ in terms of reservation wages. Given the absence of a legal minimum wage in Germany, such reservation wage heterogeneity is particularly plausible in our migration context, since the location decisions of labour migrants in Roy-style models are usually based on comparisons of expected incomes in source and host country, which thus determine reservation wages. Sampling individuals of several nationalities should further contribute to heterogeneity in this dimension.

For each segment, we estimate using maximum likelihood the job turnover parameters,

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<sup>1</sup>The term “nationality” rather than “immigrant status” is used here for greater precision given the coding practices of the German Statistical Office. Most German data sources, including the data used below, record nationality and not country of birth since German nationality is conferred by descent.

the parameters characterising the reservation wage distribution, and the firms' productivity distribution. Given the skill profile of migrants, we consider only the low and medium skill occupations. We find substantial differences in Germany between natives and foreigners. Migrants experience job separations more often than natives but also find jobs more quickly. The job turnover parameters decline in age. Across all segments and nationality, transitions into new jobs happen more quickly than transitions into unemployment. The reservation wage distribution plays a non-trivial role across both groups as there are some workers with high reservation wages who turn down new job offers when wage offers are too low. Migrant workers are on average typically less demanding than natives. Firm productivities are well approximated by Pareto forms and we find only small differences between natives and migrants in the same age-occupation segments. However, migrants receive wage offers that are lower than those for natives who have the same productivity. This migrant effect is the largest for clerks and service workers, and small for skilled workers.

These estimates are used in the implementation of the decomposition of the wage differential. Since the migrant effect compares natives and migrants in firms that have the same productivity, we decompose the mean wage differential into the mean differences of migrant effects and weighted productivity differences. Unlike Bowlus and Eckstein (2002) we do not interpret such differences in terms of discrimination. Our decomposition approach also allows us to quantify the (marginal and joint) roles of the underlying drivers, and we investigate these quantitatively by attributing some structural parameters of the reference group to the other, such as lowering the job separation rate of migrants to that of natives. One feature of outcomes of such counterfactual experiments is that the migrants' wage offer curves do not shift but rather rotate: such parameter improvements yield only negligible improvements for workers in firms of low productivity, but for high productivity levels these become sizeable.

This paper is organised as follows. In Section 2, we set out the model as well as the estimation approach, both drawing heavily on Bontemps et al. (1999). Two validation exercises verify that the estimation of the structural parameters works well. Section 2.2 introduces the migrant effect and the decomposition of the actual wage differential, whilst Section 2.2.1 considers the counterfactual scenarios in the context of the simulated data. These counterfactual scenarios are later examined in Section 5 with the real data. Section 3 describes the data used for the analysis. We also report the results of the descriptive exercise based on reduced-form Weibull durations with unobserved heterogeneity and duration dependence, which confirms the relevance of unobserved heterogeneity. The estimation results are presented in Section 4, and the resulting decompositions in Section 5. Section 6 concludes. The Appendix provides a detailed description of the variables used in the empirical analysis.

## 2 The Analytical Framework

The search model with wage-posting and on-the-job search has been described and discussed extensively before in the literature. Therefore, only its most salient features will be outlined. We use the extension of the Burdett and Mortenson (1998) model, and the subsequent empirical generalisation and implementation of van den Berg and Ridder (1998), due to Bontemps et al. (1999) which extends the basic setting by introducing productivity heterogeneity among firms and heterogeneity among workers in terms of the unobserved opportunity cost of employment. The former extension has been shown to improve the fit of the model to wage data, the latter has been shown to improve the fit to the unemployment duration data.

In the migration context, heterogeneity in the opportunity costs of employment is particularly attractive in the absence of a legal minimum wage in Germany since the location decisions of labour migrants in Roy-style models and thus reservation wages are usually based on comparisons of expected incomes in source and host country. Sampling individuals of several nationalities should further contribute to such heterogeneity.

The labour market is partitioned into many segments, defined in our empirical implementation by age, occupation and nationality. Each segment is considered as a labour market for which the following model and estimation approach applies. The structural parameters are of course allowed to vary across segments, but for notational simplicity we suppress a segment index. This segmentation assumption precludes individuals moving from one segment to another, which is consistent with the evidence of occupational immobility in Germany presented below; the assumption also implies that firms in different segments do not compete. If the labour market is integrated over some stipulated segments, then the estimates of the structural parameters should be the same statistically; the segments can then be added to improve estimation efficiency. Below we report evidence that the labour market in Germany is indeed segmented since the estimated structural parameters differ across occupation-age-nationality groups. We proceed to outline the model for one labour market segment.

## 2.1 The Model of a Labour Market Segment

The labour market segment is populated by a fixed continuum of workers with measure  $M$ , and a fixed continuum of firms with measure normalised to one. Firms differ in terms of (the marginal) productivity (of labour)  $p$  with distribution  $\Gamma$ . Unemployed workers differ in terms of their reservation wages  $b$  with distribution  $H$ .

At any point in time, a worker is either unemployed or employed, and searches for jobs both off and on the job. Individuals draw offers by sampling firms using a uniform sampling scheme. Jobs are terminated at the exogenous rate  $\delta$ , and job offers arrive at the common rate  $\lambda$  irrespective of the worker's state. This is a restrictive assumption but necessary for identification. Job offers are, of course, unobservable to the econometrician. The job offer distribution is denoted by  $F$ , whereas the observable wage or earnings distribution (i.e. of accepted wages) is denoted by  $G$ .  $F$  is related to  $G$  through an equilibrium condition implied by the theoretical structure. Firms post wages and there is no bargaining.<sup>2</sup>

Workers are risk neutral and maximise their expected steady state discounted future income. Their optimal strategy has the reservation wage property: an employed individual moves to a new employer if the offered wage exceeds the current wage (so the model does not allow for wage cuts); an unemployed individual accepts a new job if the offer exceeds  $b$ , and otherwise rejects the offer and remains unemployed. On-the-job search therefore generates further ex-post heterogeneity in reservation wages.

In steady-state equilibrium, the flows of workers into and out of the unemployment pool are equal, which determines the unemployment rate  $u$ . Consider the stock of employed workers who earn a wage less than or equal to  $w$ . The flow into this stock consists of unemployed individuals who receive wage offers above their reservation wage. Two sources constitute the outflow, namely: (i) exogenous job separations at rate  $\delta$  and subsequent transits into unemployment, and (ii) wage upgrading as employed workers move to poaching firms. Equating inflows and outflows relates the wage offer distribution  $F$  to the realised wage distribution  $G$ . To be precise, it can be shown that the unemployment rate  $u$  and the

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<sup>2</sup>For an analysis of wage determination in the presence of heterogeneity, search on-the-job, and strategic wage bargaining, see Cahuc et al. (2006). They find no significant bargaining power for intermediate and low skilled workers in France.

actual wage distribution  $G$  satisfy

$$u = \left[ \frac{1}{1+k} H(\underline{w}) + \int_{\underline{w}}^{\bar{w}} \frac{1}{1+k(1-F(x))} dH(x) \right] + [1 - H(\bar{w})] \quad (1)$$

$$G(w) = \frac{H(w) - [1+k(1-F(w))] \left[ \frac{1}{1+k} H(\underline{w}) + \int_{\underline{w}}^{\bar{w}} \frac{1}{1+k(1-F(x))} dH(x) \right]}{[1+k(1-F(w))](1-u)} \quad (2)$$

where  $k = \lambda/\delta$ , and  $[\underline{w}, \bar{w}]$  is the support of the wage offer distribution  $F$ .

Risk neutral firms have constant-returns-to-scale technologies, and post wages that maximise steady state profit flows, the profit per worker being  $p - w$ . Firms do not observe the reservation wage of a potential employee. In equilibrium, firms offer wages to workers that are smaller than their productivity level, so firms have some monopsony power. Bontemps et al. (1999) show that in equilibrium there exists an increasing function  $K$  which maps the productivity distribution into the wage offer distribution, so that the wage offer satisfies  $w = K(p)$  with

$$K(p) = p - \left[ \frac{p - \underline{w}}{(1+k)^2} H(\underline{w}) + \int_{\underline{p}}^p \frac{H(K(x))}{1+k[1-\Gamma(x)]} dx \right] \frac{[1+k[1-\Gamma(p)]]}{H(K(p))} \quad (3)$$

and  $F(w) = \Gamma(K^{-1}(w))$ . Hence given the frictional parameter  $k$ , the reservation wage distribution  $H$  and the productivity distribution  $\Gamma$ , equation (3) yields the wage offer distribution  $F$ , which then via (1) yields the equilibrium unemployment rate and through (2) the actual wage distribution  $G$ .

Our dataset does not include measures of firm productivity but, of course, extensive wage data. Using expressions of the key quantities in terms of the actual wage density  $g$ , the productivity distribution  $\Gamma$  becomes estimable. In particular, it can be shown that

$$(1-u) = \frac{k}{(1+k) \int_{\underline{w}}^{\bar{w}} \frac{g(t)}{H(t)} dt}, \quad (4)$$

$$\frac{1}{[1+k\bar{F}(w)]} = (1-u) \int_{\underline{w}}^w \frac{g(t)}{H(t)} dt + \frac{1}{[1+k]} \quad (5)$$

where, for notational convenience  $\bar{F}(\cdot) = [1 - F(\cdot)]$ , and equation (4) follows from (5) with  $w = \bar{w}$ . The equilibrium productivity levels follow as

$$p = K^{-1}(w) = w + \frac{H(w)}{2(1-u)g(w)[1+k\bar{F}(w)] + h(w)}. \quad (6)$$

### 2.1.1 Maximum Likelihood Contributions for Labour Market Segments

We use duration data for employed and unemployed workers in each labour market segment to estimate the structural parameters of the model. Assuming that the arrival rates of job offers and separations follow Poisson processes, sojourn times are exponentially distributed. Consequently, the model will be estimated by maximum likelihood. We follow the literature and consider only a single spell, and assume that  $H$  is a normal cdf with location and scale parameters,  $\theta = (\mu, \sigma)$ , to be estimated.

In a preliminary step, we estimate the infimum and the supremum of the wage offer distribution  $F$ ,  $\underline{w}$  and  $\bar{w}$ , by the minimum and the maximum of the observed wages. The density of accepted wages  $g$  is estimated using kernel methods. The estimate of  $g$  (and the

corresponding estimate of  $G$  obtained by numerical integration of  $\widehat{g}$ ) enters all likelihoods as a nuisance parameter.

We proceed to consider in more detail the contributions to the likelihoods. These differ from those in Bontemps et al. (1999) since our data are flow samples and not stock samples. Consider first the likelihood contributions of unemployed agents. In equilibrium, the probability of encountering an unemployed individual is  $u$ , given by (4). The distribution of durations in the flow sample of unemployed workers is exponential and its parameter is given by the exit rate from unemployment. Conditional on the individual's opportunity cost of employment,  $b$ , this rate is  $\lambda\overline{F}(b)$ . Given that  $F(\underline{w}) = 0$ , the exit rate from unemployment is  $\lambda$  for all workers with reservation wages  $b \leq \underline{w}$ . The observed transition from unemployment to the job allows us to record the accepted wage,  $w$ , which is a realisation of the wage offer distribution truncated at  $b : f(w)/\overline{F}(b)$ . We assume that all individuals included in our sample would accept at least one wage offer  $w \in [\underline{w}, \overline{w}]$ . This implies that the sup of  $H$  is lower than the sup of  $F$ ,  $\overline{b} \leq \overline{w}$ , so this specification does not take into account cases of permanently unemployed individuals.<sup>3</sup> In case the transition to the job is not observed in the sample, spells are then right censored<sup>4</sup>, i.e. it is only known that the true duration exceeds the observation period  $t$ . The likelihood contribution of a censored spell is the probability of this event. The likelihood contributions of unemployed  $L_u$  is thus

$$L_u(\lambda, \delta, \theta) = \lambda^{(1-d_r)} \exp(-\lambda t) \frac{H(\underline{w})}{1+k} [f(\underline{w})]^{(1-d_r)} + \int_{\underline{w}}^{\overline{w}} \left\{ [\lambda\overline{F}(b)]^{(1-d_r)} \exp[-\lambda\overline{F}(b)t] \left[ \frac{f(w)}{\overline{F}(b)} \right]^{(1-d_r)} \frac{h(b)}{[1+k\overline{F}(b)]} \right\} db, \quad (7)$$

where  $d_r$  is a dummy variable equal to one if the spell is right-censored and zero otherwise,  $v$  is a dummy variable equal to one if the destination of an employment spell is unemployment and zero if the destination is another job. The first summand in expression (7) corresponds to unemployed individuals that accept all job offers: their reservation wage satisfies  $b \leq \underline{w}$ . The second summand corresponds to unemployed individuals that accept some job offers and reject others: their reservation wage satisfies  $\underline{w} < b \leq \overline{w}$ .

We turn to the likelihood contributions of employed workers, denoted by  $L_e$ . The probability of sampling an employed individual receiving a wage  $w$  is  $(1-u)g(w)$ . Conditional on being employed with wage  $w$ , the job duration has an exponential distribution with parameter  $[\delta + \lambda\overline{F}(w)]$ , which is equal to the sum of the job destruction rate,  $\delta$ , and the exit rate to higher paying jobs,  $\lambda\overline{F}(w)$ . Exits to unemployment occur with probability  $\delta / [\delta + \lambda\overline{F}(w)]$  and exits to higher paying jobs occur with probability  $\lambda\overline{F}(w) / [\delta + \lambda\overline{F}(w)]$ . If an employment spell is censored, the corresponding likelihood contribution expresses the probability of sampling an employed individual with wage  $w$  and *true* spell duration that exceeds the observed employment duration. We have

$$L_e(\lambda, \delta, \theta) = (1-u)g(w) \exp\{-[\delta + \lambda\overline{F}(w)]t\} \times \left\{ \delta^v [\lambda\overline{F}(w)]^{(1-v)} \right\}^{(1-d_r)}, \quad (8)$$

where  $(1-u)$  is given by equation (4).

<sup>3</sup>This assumption is not restrictive as indicated by the description of our sample in the following section. Two points deserve emphasis: first, we only consider low-wage workers, who are not likely to have such extreme reservation wages; second, wages from the right tail of the wage offer distribution are drawn by employed individuals moving to higher paying jobs.

<sup>4</sup>Only cases of right-censored spells are observed in our sample. The number of right-censored employment and unemployment spells by segment are reported in Table 5 below.

### 2.1.2 A Validation Exercise

Given the complexity of both the model and the estimating equations, it is of interest at this stage to test their performance on a single labour market segment. At the same time, to help fix ideas, we also introduce the wage offer function which will be used extensively below.

The data generating process uses the parametrisations discussed above: arrival rates of job offers and separations follow Poisson processes, and the reservation wage distribution is normal. The particular calibration, given in Table 1, uses values similar to those encountered in the empirical application below. We also need to stipulate either a realised wage distribution  $G$ , or a productivity distribution  $\Gamma$ . Since we observe wages but not productivities in our data, we specify a productivity distribution here in order to verify that the model-implied wage distributions “look realistic” (i.e. share the principal features of real wage distributions). Since the empirical results reported below suggest that productivities are Pareto-like, we assume this explicitly here:  $\Gamma(p) = 1 - (30/p)^{2.1}$ . We also compute the model-implied unemployment rate  $u$ . Using this Data Generating Process (DGP), we draw 400 samples of 2000 observations each and estimate the model by maximum likelihood.

Table 1 reports the results. All structural parameters are estimated well as the true values are included in the 95 percent bootstrap confidence intervals. The means of the job turnover parameters are particularly well estimated. The mean of the reservation wage distribution  $H$  is somewhat below the true value; this underestimate is perhaps not too surprising since the model effectively only considers the right tail of  $H$  (i.e. reservation wages  $b$  that satisfy  $b > \underline{w}$ ). The predicted unemployment rate is also very close to the theoretical value.

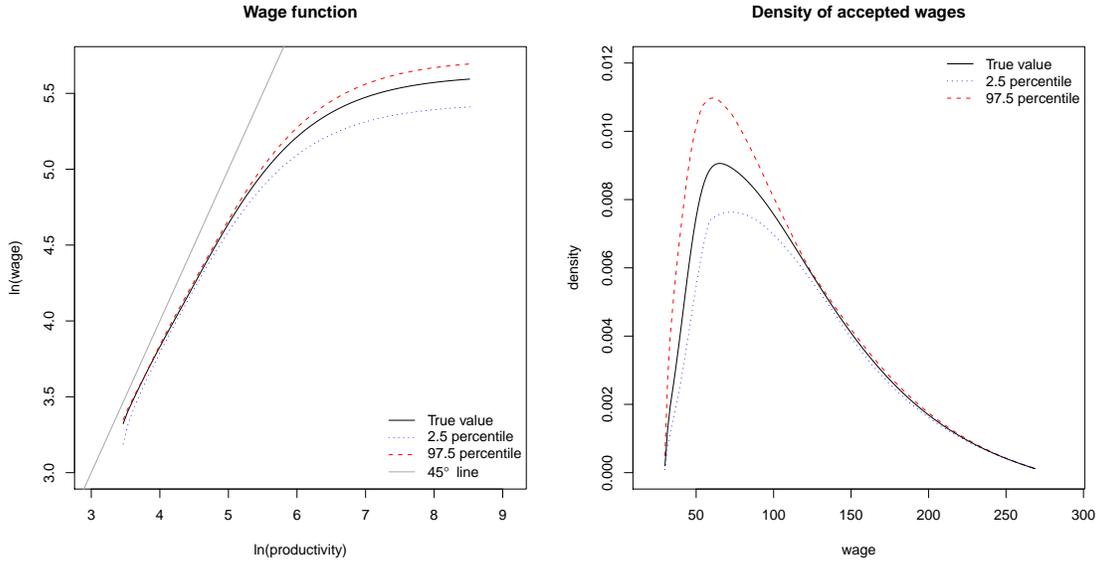
Table 1: Validation experiment

	$\mu$	$\sigma$	$\lambda$	$\delta$	$u$
True Value	35	10	.1	.005	.096
Mean	31.37	10.51	.0917	.00502	.0943
Median	31.32	10.34	.0858	.00498	.0880
2.5 percentile	24.70	7.20	.0669	.00478	.0825
97.5 percentile	39.00	14.61	.1291	.00542	.1495

Figure 1 depicts the implied wage offers as a function of productivities, as well as the density of realised wages.<sup>5</sup> The skewed density of realised wages does have a shape often encountered in empirical work (see also Figure 4 below). Turning to the wage offer function, this lies below the 45 degree line. In equilibrium, firms offer wages to workers that are smaller than their productivity level. This distance is thus a measure of the firms’ monopsony power.

<sup>5</sup>The computation of the wage offer curves for the validation exercise based on a given productivity distribution  $\Gamma$  is more involved than in our empirical analysis below. In the latter case, given the estimates of the structural parameters and the wage density,  $F(w)$  follows straightforwardly from equation (5) and the productivity values follow from (6). In the former case,  $F(w) = \Gamma(K^{-1}(w))$ , and  $K(p)$  in (3), defined implicitly, is estimated progressively: starting from  $p$ ,  $p$  is incremented by a small step  $\varepsilon_p$ , and  $K(p + \varepsilon_p)$  is found through a local search based on (3), whence  $p + 2\varepsilon_p$  is considered. The confidence bands are computed pointwise, and simply determined by the relevant tail quantiles of the bootstrap distribution. It is also of interest to note that the shapes of the wage offer curves in Figures 1 and 2 are similar to those encountered in the empirical analysis, Figures 5-7.

Figure 1: Wage offer function, and the density of accepted wages.



## 2.2 Migrants, Natives, Wage Differentials and the Migrant Effect

For our analysis of migrant-native wage differentials, we consider now two labour market segments, one occupied by natives and the other by immigrants. Workers in either segment exhibit the same observable characteristics (in our empirical application below we consider the same skill and age group). Comparing the wage offer curves for migrants (F) and natives (N), we define the “migrant effect” to be the difference in wage offers for individuals from firms with the same productivities,  $w_N(p) - w_F(p)$ , with segment specific wage offers given by (3).

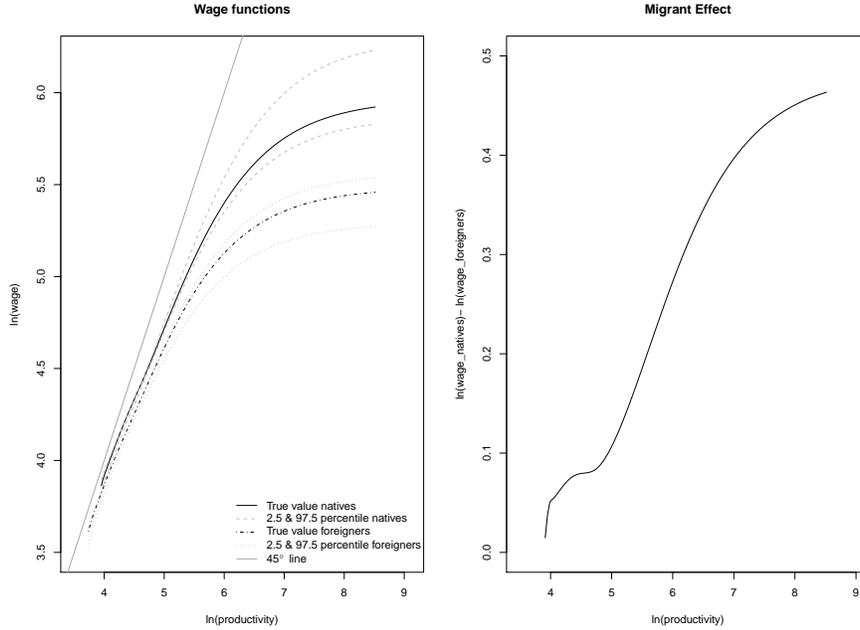
This migrant effect is illustrated in Figure 2, which is based on the calibration of the segments reported in Table 2 (which is in line with the empirical results below), and the parametrisations of the preceding validation exercise. In particular, we assume that the job turnover parameters of migrants are higher than those of natives,  $\delta_F > \delta_N$  and  $\lambda_F > \lambda_N$ , while natives have higher mean reservation wages,  $\mu_F > \mu_N$ . We also assume that the productivity distribution in the segment for natives first order stochastically dominates that of migrants:  $\Gamma_F(p) = 1 - (\underline{p}_F/p)^\alpha$  and  $\Gamma_N(p) = 1 - (\underline{p}_N/p)^\alpha$  with  $\alpha = 2.1$ ,  $\underline{p}_F = 40$ , and  $\underline{p}_N = 50$ .<sup>6</sup>

Table 2: Natives and immigrants: DGP and parameter estimates.

	$\mu_N$	$\mu_F$	$\sigma_N$	$\sigma_F$	$\lambda_N$	$\lambda_F$	$\delta_N$	$\delta_F$	$u_N$	$u_F$
True Value	60	45	10	10	.07	.13	.005	.016	.1214	.1838
Mean	56.23	40.88	8.61	10.18	.0887	.1181	.0050	.0173	.1145	.1822
Median	56.33	40.96	8.43	10.17	.0835	.1136	.0050	.0173	.1142	.1819
2.5 perc.	53.46	36.62	5.63	6.86	.0566	.0939	.0047	.0164	.1053	.1711
97.5 perc.	59.88	45.21	12.38	13.62	.1403	.1671	.0053	.0181	.1246	.1935

<sup>6</sup>For the sake of completeness, the table also reports the estimates of the structural parameters based on the simulated data. The same qualitative conclusions obtain as in the preceding validation exercise. We also observe that with this parametrisation the unemployment rate of migrants exceeds that of natives.

Figure 2: Wage offer curves for natives and migrants, and the “migrant effect”.



Comparing the labour market segments defined by skill and age between natives and immigrants, the differences in wage offers

$$w_N(p|p_N, \alpha_N, \mu_N, \sigma_N, \lambda_N, \delta_N) - w_F(p|p_F, \alpha_F, \mu_F, \sigma_F, \lambda_F, \delta_F) \quad (9)$$

derive from three sources: differences in (i) the job turnover parameters, (ii) the reservation wage distribution, and (iii) firm productivities. On inspecting (3) it is clear that the wage differential between migrants and natives is thus a complicated function of the differences between these three sources. Using the wage offer curve to define the migrant effect is particularly appealing as it is straightforward to control for differences in firm productivity levels. Comparing natives and immigrants for a given productivity  $p$  requires, of course, restricting attention to the interval where the supports of the productivity distributions overlap. Denote this intersection by  $A$ . The concept of the migrant effect suggests to decompose the aggregate wage differential<sup>7</sup> between migrants and natives into the aggregate migrant effect and a weighted difference between firm productivities:

$$\begin{aligned} \int_A w_N(p) d\Gamma_N(p) - \int_A w_F(p) d\Gamma_F(p) &= \int_A [w_N(p) - w_F(p)] d\Gamma_N(p) \\ &+ \int_A w_F(p) d[\Gamma_N(p) - \Gamma_F(p)]. \end{aligned} \quad (10)$$

However, a closer inspection of the migrant effect shows that apart from the differences in the reservation wage distribution and labour turnover parameters, the difference in the productivity distributions also plays a role although we compare wage offers for the same productivity levels. It is for this reason that we consider a second decomposition of wage differentials based on counterfactuals.

<sup>7</sup>For a decomposition of wage differentials in a reduced form setting, see Dustmann and Theodoropoulos (2010). Note that their decomposition considers, as we do, the wage offer function, but their empirical approach does not recover it from the data.

Table 3: Counterfactual decompositions of the wage differential.

	Ref. group	Scenario	Wage differential	Migrant effect
Actual wages				
(1)			32.022	6.825
Counterfactuals				
(2)	F	$(\mu_N, \sigma_N) = (\mu_F, \sigma_F)$	27.436	2.239
(3)	N	$(\mu_F, \sigma_F) = (\mu_N, \sigma_N)$	30.096	3.747
(4)	N	$\delta_F = \delta_N$	28.973	1.954
(5)	N	$\lambda_F = \lambda_N$	34.029	10.032
(6)	N	(3) and (4)	27.423	-0.524
(7)	N	(3) and (5)	31.694	6.300
(8)	N	(4) and (5)	30.459	4.328
(9)	N	(3) and (4) and (5)	28.758	1.610
(10)	N	$(\underline{p}_F, \alpha_F) = (\underline{p}_N, \alpha_N)$		4.904
(11)	N	(10) and (3)		1.932
(12)	N	(10) and (4)		0.750
(13)	N	(10) and (5)		7.814
(14)	N	(10) and (3) and (4)		-1.842
(15)	N	(10) and (3) and (5)		4.400
(16)	N	(10) and (4) and (5)		2.741

Notes: Based on the DGP given in Table 2. Rows 10+: the wage differential equals the migrant effect because the productivity distributions are the same.

### 2.2.1 Counterfactual Wage Decompositions

We ask: what would be the migrant effect and the wage differential if one group is imputed counterfactually parameter values of the other group? For instance, choosing migrants as the reference group and considering the reservation wage distribution parameters  $(\mu, \sigma)$ , we have the counterfactual wage decomposition

$$\begin{aligned}
 & \int_A [w_N(p|\underline{p}_N, \alpha_N, \mu_F, \sigma_F, \lambda_N, \delta_N) - w_N(p|\underline{p}_F, \alpha_F, \mu_F, \sigma_F, \lambda_F, \delta_F)] d\Gamma_N(p|\underline{p}_N, \alpha_N) \\
 = & \int_A w(p|\underline{p}_N, \alpha_N, \mu_F, \sigma_F, \lambda_N, \delta_N) d\Gamma_N(p|\underline{p}_N, \alpha_N) \\
 - & \int_A w(p|\underline{p}_F, \alpha_F, \mu_F, \sigma_F, \lambda_F, \delta_F) d\Gamma_F(p|\underline{p}_F, \alpha_F) \\
 - & \int_A w(p|\underline{p}_F, \alpha_F, \mu_F, \sigma_F, \lambda_F, \delta_F) d[\Gamma_N(p|\underline{p}_N, \alpha_N) - \Gamma_F(p|\underline{p}_F, \alpha_F)].
 \end{aligned}$$

This approach allows us to examine both marginal effects as well as joint effects since (3) shows that the interaction of the parameters is non-trivial. Table 3 collects the decomposition results for the simulated data using the DGP of Table 2. Row 1 of the table is the factual decomposition based on (10), all subsequent rows consider counterfactual scenarios. Rows 2 to 5 and 10 examine marginal effects, the other rows consider joint effects. Starting in row 10, the productivity distributions are equalised.

The actual migrant effect (row 1, 6.8) is substantial, about 21% of the wage differential. Accounting for differences in the productivity distributions (rows 10+) has only a small negative impact on the migrant effect. Row 7 suggests that the main driver of the migrant effect is the difference in the job separation rate (6.3), and this impact is further amplified by its interaction with the effect of the reservation wage distribution (row 5, 10.0). This joint effect is, however, slightly smaller than the sum of the marginal effects (10.6, as row 8 isolates the role of the reservation wage distribution, and row 7 that of the separation rate).

### 3 The Data

The empirical analysis is based on the 2% subsample of the German employment register provided by the Institute of Employment Research, known as IABS.<sup>8</sup> This large administrative dataset for Germany, covering the period 1975-2004 consists of mandatory notifications made by employers to social security agencies. These notifications are made on behalf of workers, employees, and trainees who pay social security contributions. This means that self-employed individuals, civil servants, and workers in marginal employment are not included. Notifications are made at the beginning and at the end of an employment or unemployment spell. Information on individuals not experiencing transitions during a calendar year is updated by means of an annual report. Hence, we are able to use a flow and not a stock sample in our empirical analysis.

Apart from wages, transfer payments, and spell markers, the dataset contains some standard demographic measures, including nationality, as well as occupation and firm markers. The education variable is not used since its problems are well-known (see Fitzenberger et al. (2006) for a detailed discussion). Wage records in the IABS are top coded at the social security contribution ceiling. However, this ceiling is not binding for our population of interest, namely individuals (natives and foreigners) in low and middle skill occupations. We use real wages in 1995 prices. The occupational information is provided in extensive (three digit codes) but non-standard form. We therefore map this coding into 10 major groups based on the International Standard Classification of Occupations (ISCO-88). The Data Appendix provides some details. Since immigration is known to be predominantly low skilled, we select from these 10 groups 3 low and middle skilled occupations, namely (1) unskilled blue-collar workers, (2) clerks and low-service workers, and (3) skilled blue-collar workers. Table 4 below shows that these three groups capture the majority of foreign workers in our sample.

The data allows us to distinguish between three labour market states: employed, recipient of transfer payments (i.e. unemployment benefits, unemployment assistance and income maintenance during participation in training programs) and out of sample. Unfortunately, none of the two last categories corresponds exactly to the economic concept of unemployment. This issue is discussed in several studies, see e.g. Fitzenberger and Wilke (2010). For example, participants in a training program are transfer payment recipients despite being in employment (they are considered unemployed from an administrative point of view), while individuals that are registered unemployed but are no longer entitled to receive benefits appear to be out of the labour force. Therefore, the dataset provides a representative sample of those employed and covered by the social security system, but somewhat misrepresents

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<sup>8</sup>For a detailed description of the dataset, see Bender, Haas, and Kloose (2000). The data have also been used recently by Dustmann, Ludsteck and Schönberg (2009) who investigate wage inequality in Germany in the 1980s and 1990s (though they do not study immigrants). Adopting a migration focus, Bender and Seifert (1996) examine whether young migrants who run through the German apprenticeship system have similar labour market outcomes (captured by their transition rates) as natives. Based on a wage curve approach, Brücker and Jahn (2008) examine the labour market effects of migration in Germany.

those in the state of unemployment. For our purposes, all individuals who are out of sample between two different spells are classified as unemployed, so only two labour market states are considered: unemployment and employment. The definition of unemployment used in our analysis is therefore somewhat broad: we assume that unemployment is proxied by non-employment, strictly speaking non-employment is an upper-bound for unemployment.

Nationality is included as a binary variable indicating whether an individual is German or a foreign national. German nationality is usually conferred by descent, and not by place of birth. The data set does not report place of birth. Given this coding practice, some young foreign nationals might be born and raised in Germany. At the same time, ethnic Germans who immigrated from the former Soviet Union after the fall of the Berlin Wall will be classified as German, although they usually speak little German and have low skills. However, Dustmann et al. (2010) have argued that the former issue is ignorable, and we address the second by repeating the estimation using the subsample of individuals that were present in the data before the fall of the Berlin Wall, see the analysis in Section 4.5.

### 3.1 The Sample

The data used in our empirical analysis is restricted to male full-time workers aged 25 to 55 years old residing in West-Germany (East Germany is excluded because of the peculiar transition processes taking place in the wake of unification). This sample is grouped into cells by occupation, nationality, and age. We define three age groups (25-30, 30-40, and 40-55) to proxy for potential experience. The aim of the grouping is to arrive at cells in which individuals are fairly homogeneous, and which are sufficiently large for the subsequent econometric investigation.

Our observation window is 1995-2000, a period of fairly stable growth and unemployment, as shown in Figure 3. Focussing on this stable period reduces the scope for biases arising from asymmetric responses of natives and foreigners to the business cycle. We consider the first transition between labour market states for individuals: our analysis thus uses transition data, and we have a flow sample.

Figure 3: GDP growth and unemployment rates.

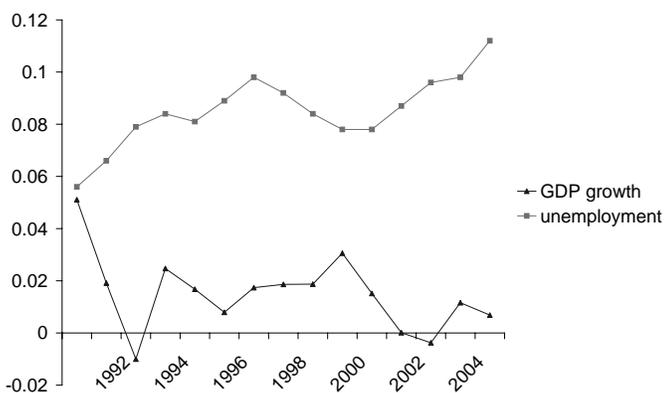


Table 4 cross-tabulates occupation by nationality and confirms that foreigners in our sample are predominantly low skilled: 94% of the population of foreigners are included in this group, while the corresponding number for natives is approximately 86%. The remainder occupational category is the highly skilled, which we have excluded because the excessive top-coding of earnings. Occupational mobility is small, as most workers remain in the same class.

Table 4: Natives and foreigners by occupation

Occupation	Natives				Foreigners			
	N	Col%	Row%	Stayers	N	Col%	Row%	Stayers
1 Unskilled Workers	21,119	19	74.10	90.6	7,382	30.2	25.90	89.4
2 Clerks & Service Workers	32,436	29.2	86.10	94.6	5,235	21.4	13.90	90.6
3 Craft & Trades Workers	42,101	37.9	80.3	93.1	10,364	42.4	19.8	90.9

Notes: “Col”(umn) percentages condition on nationality, while “Row” percentages condition on the occupational group. “Stayers” refers to the share of workers who stay in this occupational group throughout the observation window.

Table 5 describes the labour market outcomes as well as the labour market transitions for all nationality-age-occupation cells. For both natives and foreigners, we observe many more transitions from employment than from unemployment. However, for natives, the majority of transitions from employment are to another job, whereas for the majority of foreigners the destination is unemployment. Hence, in terms of the structural parameters, we expect higher separation rates for foreigners,  $\delta_F > \delta_N$ . The duration data for the unemployed, examined briefly in the next subsection, suggests that foreigners exit more quickly, so that we expect  $\lambda_F > \lambda_N$  at least for this group. As regards wage outcomes (measured by daily gross wages in 1995 DM), natives receive substantially higher mean wages than foreigners across all occupation groups, the relative difference ranging between factors of 1.06 to 1.57. The three occupational groups can be partially ordered in terms of mean wages: mean wages for the skilled exceed those for the unskilled for all age groups and across nationalities. Foreign clerks and low-service workers assume an intermediate position, but mean wages of natives in this group can exceed those for skilled workers. Rather than only restricting attention to the mean wage, Figure 4 depicts the kernel estimates of the realised wage densities (the solid lines refer to natives). The most pronounced distributional difference exist for the semi-skilled workers (clerks and service workers), and the differences persist across age groups. By contrast, for all other occupations, the differences decrease in age, which can be interpreted as evidence of assimilation. The density estimates also exhibit “blips” in the far left tails of the wage densities. This bimodality leads to problems in the estimation of the model, manifesting themselves by the occurrence of spikes in the estimated productivity density. We overcome this issue by truncating the wage distribution at the blip in the left tail (resulting in cell-specific losses ranging from 1.3 % to 12.7%, a mean loss of about 6.2% of a sample).

### 3.1.1 Reduced Form Estimates: The Importance of Unobservable Heterogeneity

Before embarking on the estimation of the model, we first explore descriptively whether there is scope for unobserved heterogeneity to play a role in explaining unemployment durations. To this end we estimate standard reduced-form hazard models for the unemployed, controlling incrementally for unobserved heterogeneity using the usual gamma frailty and duration dependence (see e.g. van den Berg (2001)). The structural model emphasises the joint contribution of the unobservable productivity distribution and the reservation wage distribution, whereas the reduced form cannot, of course, distinguish between these.

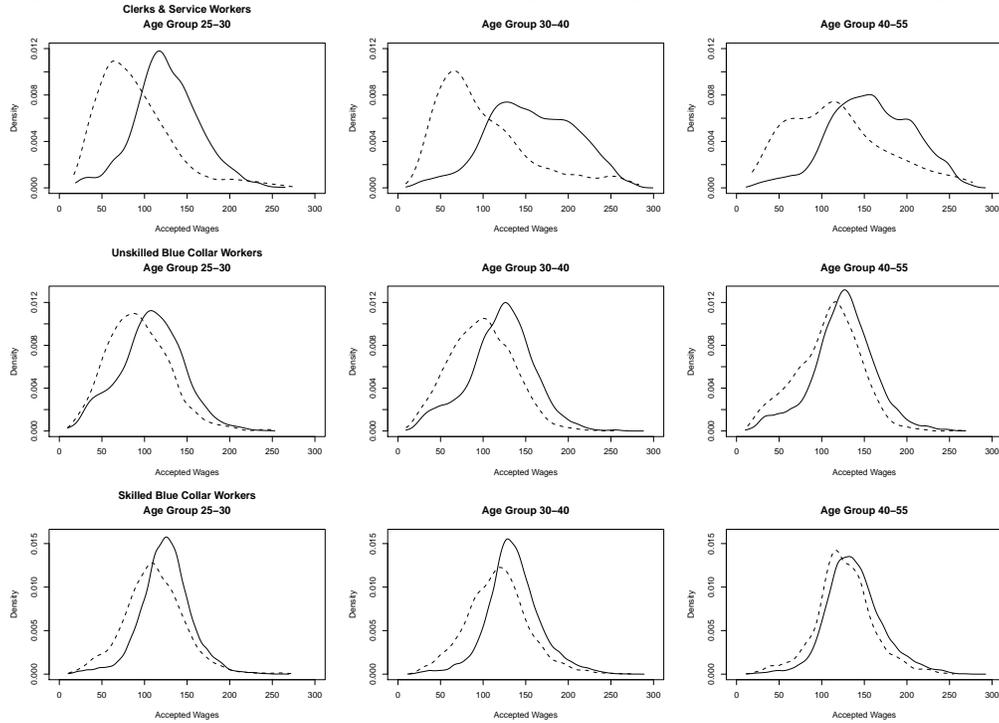
Table 6 reports the results of the exponential and the Weibull models for parsimonious specifications that control for nationality, age and occupations. The foreigner dummy is positive throughout, so that their job offer arrival rates exceed those of natives. The reduced

Table 5: Descriptives for the transition data.

<i>Age</i>		<i>Natives</i>			<i>Foreigners</i>		
		<i>Services</i>	<i>Unskilled</i>	<i>Skilled</i>	<i>Services</i>	<i>Unskilled</i>	<i>Skilled</i>
<b>25-30</b>	N	8060	5097	11939	1887	2347	3023
	<i>Transitions</i>						
	from E	6088	3085	8450	1438	1670	2155
	from U	1972	2012	3489	449	677	868
	U→E	1879	1932	3275	431	637	795
	E→U	2132	1764	4418	718	997	1225
	E→E	3432	1037	3562	373	351	550
	<i>E_censored</i>	524	284	468	347	322	380
	<i>U_censored</i>	93	80	214	18	40	73
	<i>Wages</i>						
	mean	122.36	107.77	124.74	88.94	92.54	111.07
sd	41.86	37.68	29.94	44.15	36.09	35.21	
N	12800	7748	15381	2074	2752	3681	
<b>30-40</b>	<i>Transitions</i>						
	from E	10723	5506	12448	1637	2067	2830
	from U	2077	2242	2933	437	685	851
	U→E	1853	2055	2601	393	619	749
	E→U	2988	2644	5284	735	1128	1451
	E→E	6717	2400	6157	453	477	795
	<i>E_censored</i>	1018	461	1007	449	462	584
	<i>U_censored</i>	224	187	332	44	66	102
	<i>Wages</i>						
	mean	156.35	120.94	135.79	99.38	97.99	116.65
	sd	51.22	38.24	32.04	55.02	36.61	36.22
N	11576	8274	14781	1274	2283	3660	
<b>40-55</b>	<i>Transitions</i>						
	from E	9825	6147	12315	1007	1687	2918
	from U	1751	2127	2466	267	596	742
	U→E	1554	2013	2130	244	540	582
	E→U	4538	4467	8973	505	1101	2019
	E→E	6671	3206	6848	329	513	1024
	<i>E_censored</i>	2703	1726	3306	312	476	683
	<i>U_censored</i>	1434	1358	3273	104	308	696
	<i>Wages</i>						
	mean	158.17	125.05	138.29	112.74	107.49	126.20
	sd	48.09	36.71	33.29	56.81	36.89	33.50

Notes: Wage dating: for transitions from employment (E→ {U,E}), these are the last earned wages in this state, for transition out of unemployment (U→ E) these are the first wages earned in the new job. “Censoring” refers to a drop out from the administrative register.

Figure 4: Estimates of the density of accepted wages by labour market segments.



Notes: Natives (solid lines) v. foreigners (dashed lines).

form clearly picks up the important role of unobserved heterogeneity. At the same time, it reveals this approach to be problematic since the estimated unobserved heterogeneity confounds the duration dependence and the migrant dummy.

We now proceed to examine the duration data in the light of the structural model, by focussing on the different sources of unobserved heterogeneity whilst controlling for confounding factors by stratifying the sample into occupation-age-nationality cells.

## 4 Estimation Results

We proceed to estimate the structural parameters of the model, i.e. the arrival rate of job offers,  $\lambda$ , the match destruction rate,  $\delta$ , and the parameters of the distribution of workers' reservation values,  $(\mu, \sigma)$ , as well as the productivity density of firms in each segment. We consider each occupation group in turn, and we segment for each occupation the labour market further by age and nationality. The migrant effect and the wage decompositions are then examined in Section 5 below.

### 4.1 Unskilled Blue Collar Workers

Table 7 reports the results. Across all three age groups, the labour turnover parameters of migrants exceed those of natives,  $\hat{\delta}_F > \hat{\delta}_N$  and  $\hat{\lambda}_F > \hat{\lambda}_N$ . Migrants experience job separations more often, but this is partially compensated by them also finding new jobs more quickly. Across age groups and nationality, transitions into new jobs happen more quickly than transitions into unemployment,  $\hat{\lambda} > \hat{\delta}$ . Typically foreigners have lower reservation wages on average,  $\hat{\mu}_F \leq \hat{\mu}_N$ , but these are also more dispersed. The non-trivial reservation wage distribution for both groups implies that not all new job offers are accepted: there

Table 6: Reduced-form unemployment duration models

		(1)	(2)	(3)	(4)
		Exponential	Exponential <sup>§</sup>	Weibull	Weibull <sup>§</sup>
Foreigner		0.0742*** (0.0203)	0.0329 (0.0272)	0.0721** (0.0254)	0.0362 (0.0273)
Age					
	30-40	-0.465*** (0.0189)	-0.359*** (0.0269)	-0.447*** (0.0236)	-0.364*** (0.0270)
	40-55	-1.566*** (0.0197)	-1.744*** (0.0257)	-1.778*** (0.0256)	-1.753*** (0.0263)
Occupation					
	Services	0.130*** (0.0206)	0.0662* (0.0281)	0.128*** (0.0257)	0.0700* (0.0282)
	skilled	0.0206 (0.0188)	-0.0474 (0.0253)	-0.00723 (0.0236)	-0.0459 (0.0254)
constant		-6.949*** (0.0180)	-6.445*** (0.0275)	-6.921*** (0.0225)	-6.478*** (0.0324)
Unobserved			0.779***		0.710***
Heterogeneity			(0.0242)		(0.0423)
Duration				-0.223***	-0.0230
Dependence				(0.00654)	(0.0119)

Notes. Standard errors in parentheses, \*( $p < 0.05$ ), \*\*( $p < 0.01$ ), \*\*\*( $p < 0.001$ ). Reference groups: age 25-30, the unskilled, native.

<sup>§</sup>Frailty is Gamma distributed.

Table 7: Structural parameter estimates: Unskilled blue collar workers

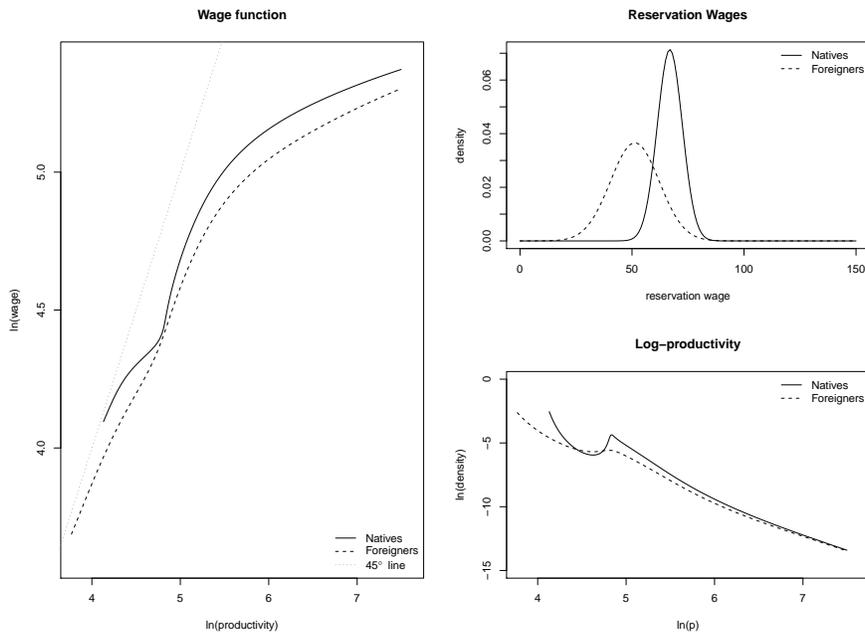
Age	Nationality	$\mu$	$\sigma$	$\lambda$	$\delta$
<b>25-30</b>	<i>Natives</i>	66.88 [62.54-69.75]	5.59 [4.13-6.44]	0.0649 [0.0538-0.0712]	0.0247 [0.0205-0.0273]
	<i>Foreigners</i>	51.26 [46.72-58.50]	10.91 [9.53-13.29]	0.1215 [0.0984-0.1372]	0.0370 [0.0291-0.0433]
<b>30-40</b>	<i>Natives</i>	48.87 [44.29-50.62]	8.55 [7.04-9.18]	0.0272 [0.0218-0.0306]	0.0097 [0.0085-0.0113]
	<i>Foreigners</i>	48.89 [44.25-51.76]	14.49 [11.38-16.21]	0.0584 [0.0491-0.0629]	0.0182 [0.0102-0.0263]
<b>40-55</b>	<i>Natives</i>	49.48 [47.63-50.54]	8.57 [7.24-9.66]	0.01498 [0.0117-0.0173]	0.0044 [0.0037-0.048]
	<i>Foreigners</i>	43.65 [40.81-45.47]	10.61 [8.73-11.48]	0.0232 [0.0198-0.0254]	0.0073 [0.0055-0.087]

Notes: Period: 1995-2000. In brackets: the 2.5% and 97.5% percentiles of the bootstrap distribution.

are some workers with high reservation wages who would and do turn down new job offers with insufficiently high wages. We also observe that for both groups, the job turnover parameters fall in age. The young appear to be excessively demanding or optimistic, as higher age groups have lower reservation wages.

In Figure 5 we consider some implications of the estimated model for the young. Panel B depicts the reservation density. Panel A plots the wage offer functions, whilst panel C plots the estimated productivity densities. These are obtained as follows. Given the parameter estimates and kernel estimate of the realised wage density, the unemployment rate  $u$  is estimated using equation (4), and the wage offer distribution  $F$  follows from equation (5); the productivity distribution is then estimable from equation (6). It is evident, that the productivity densities for both groups are well approximated by a Pareto density. The slopes for sufficiently high productivities are very similar. For a better quantitative understanding, recall from Table 5 the mean accepted wages. For natives, the log mean wage is 4.7, and considering wages within one standard deviation of the mean gives the range from 4.2 to 5.0. Panel A reveals the presence of a migrant effect, as migrants with the same productivity as natives receive lower wage offers.

Figure 5: Unskilled blue collar workers aged 25-30.



## 4.2 Clerks and Low-Service Workers

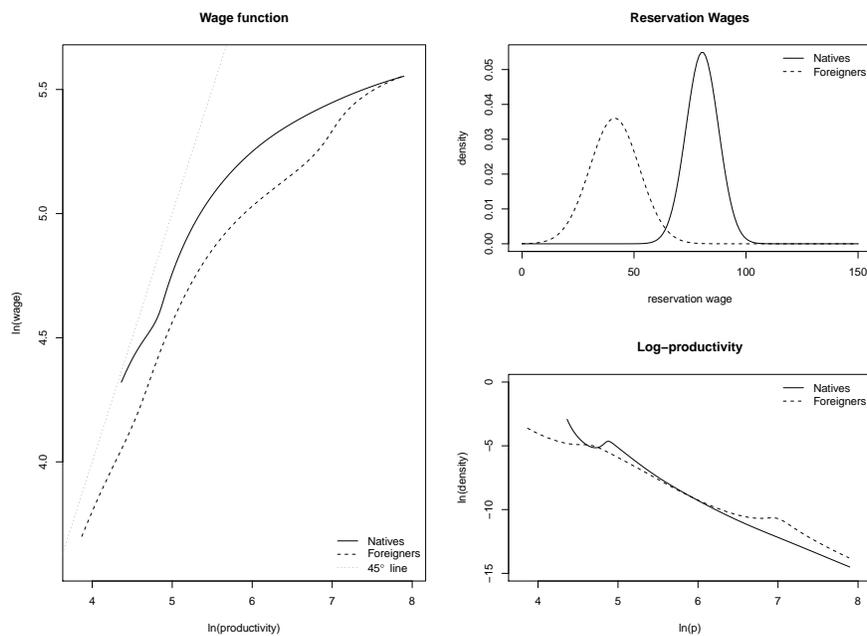
Turning to the results for clerks and low-service workers, reported in Table 8, these exhibit patterns similar to those for the unskilled. In particular, both job turnover parameters are larger for migrants than for natives, and these decline in age. The reservation wage distribution for both nationality groups plays a non-trivial role, and migrants typically have lower means, while young natives are particularly demanding. Figure 6 suggests that productivities are again well approximated by a Pareto form, and the maximal migrant effect is larger than for the unskilled. These results are also consistent with the evidence of Table 5, which revealed that discrepancy between mean accepted wages across all cells was the largest for the young in this segment, the factor being 1.57, and the distributional differences observed in row 1 of Figure 4.

Table 8: Structural parameter estimates: Clerks & service workers

Age	Nationality	$\mu$	$\sigma$	$\lambda$	$\delta$
<b>25-30</b>	<i>Natives</i>	80.49 [78.61-83.80]	7.25 [5.14-8.49]	0.0648 [0.0524-0.0739]	0.0181 [0.0127-0.0213]
	<i>Foreigners</i>	41.32 [34.26-46.04]	11.07 [8.85-13.92]	0.0643 [0.0397-0.0811]	0.0266 [0.0144-0.0391]
<b>30-40</b>	<i>Natives</i>	50.00 [47.13-52.94]	10.51 [5.14-10.09]	0.0300 [0.0211-0.0461]	0.0075 [0.0067-0.0091]
	<i>Foreigners</i>	21.28 [15.33-26.72]	22.96 [18.47-25.56]	0.0403 [0.0275-0.0629]	0.0156 [0.0098-0.0237]
<b>40-55</b>	<i>Natives</i>	48.24 [45.31-52.40]	9.79 [7.04-12.82]	0.0156 [0.0107-0.0194]	0.0035 [0.0028-0.0039]
	<i>Foreigners</i>	48.67 [42.75-53.84]	5.17 [4.42-8.03]	0.0630 [0.0526-0.0698]	0.0076 [0.0062-0.0085]

Notes: As for Table 7.

Figure 6: Clerks and service workers aged 25-30.



### 4.3 Skilled Blue-Collar Workers

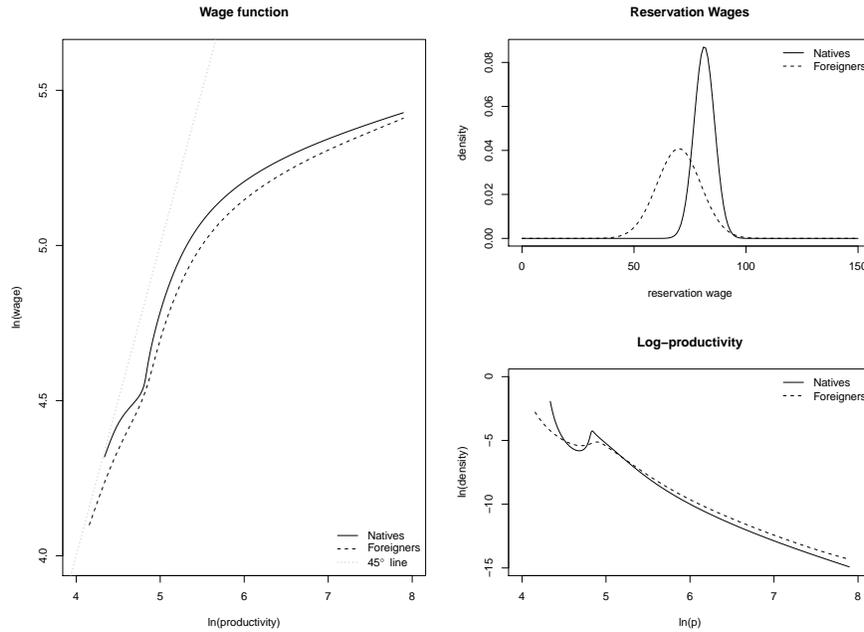
Table 9: Structural parameter estimates: Skilled blue collar workers

Age	Nationality	$\mu$	$\sigma$	$\lambda$	$\delta$
<b>25-30</b>	<i>Natives</i>	81.39 [79.42-82.77]	4.57 [4.14-6.03]	0.0704 [0.0591-0.0788]	0.0157 [0.0114-0.0186]
	<i>Foreigners</i>	70.01 [66.75-72.93]	9.77 [7.63-11.29]	0.0786 [0.0618-0.0905]	0.0243 [0.0193-0.0287]
<b>30-40</b>	<i>Natives</i>	50.51 [49.63-52.08]	10.46 [9.68-10.95]	0.0262 [0.0233-0.0281]	0.0071 [0.0065-0.0074]
	<i>Foreigners</i>	70.05 [67.53-71.65]	8.02 [6.94-9.23]	0.0621 [0.0539-0.0673]	0.0123 [0.0092-0.0206]
<b>40-55</b>	<i>Natives</i>	49.44 [48.12-51.23]	9.42 [8.36-9.98]	0.0143 [0.0112-0.0192]	0.0037 [0.0031-0.0042]
	<i>Foreigners</i>	74.70 [71.18-78.62]	8.53 [6.81-9.63]	0.0555 [0.0436-0.0598]	0.0050 [0.0043-0.0055]

Notes: As for Table 7.

For the skilled blue-collar workers, the by now familiar pattern emerges too, as evident from Table 9: the turnover parameters are higher for migrants, and decline in age. The reservation distribution is non-trivial, and young natives are particularly demanding. Focussing on the young in Figure 7, productivities are Pareto like and similar between the two groups. The migrant effect, captured in Panel A, is modest.

Figure 7: Skilled blue collar workers aged 25-30.



## 4.4 General Discussion

Comparing the results across occupations, we observe similar patterns. Migrants experience job separations more often than natives but also find jobs more quickly. The job turnover parameters decline in age. Across all segments and nationality, transitions into new jobs happen more quickly than transitions into unemployment. The reservation wage distribution plays a non-trivial role across both groups as there are some workers with high reservation wages who turn down new job offers when wage offers are too low.<sup>9</sup> Migrant workers are on average typically less demanding than natives. Firm productivities are well approximated by Pareto forms,<sup>10</sup> and we find little differences between natives and migrants in the same age-occupation segments. However, migrants receive wage offers that are lower than for natives who have the same productivity. This migrant effect is the largest for clerks and service workers, and small for skilled workers.

## 4.5 Robustness Checks: Ethnic German Immigrants

The inflow of foreign-born ethnic Germans in the late 1980's and early 1990's changed the composition of the group of natives. While qualifying for a German passport by descent, many did not speak German and were more similar to the group of foreign nationals considered above. However, these ethnic German immigrants are not directly identifiable in the data and thus latent in the group of natives. This arguable misclassification could lead to biases in our estimates for native workers. To check the robustness of our results to such changes in the population of German citizens, we estimate the model using the subsample of native workers that are also present in the data set before 1988, the year before the inflow of ethnic Germans occurred. Table 10 reports our estimates. The estimates are fairly similar in the full sample and the subsample, which suggests that the presence of ethnic Germans has little effect on the estimates of the structural parameters for natives.

## 5 Migrant Effects and Wage Decompositions

We proceed to examine actual and counterfactual decompositions of the wage differential by considering the scenarios of Section 2.2.1. The discussion there has highlighted the importance of the productivity distribution, and we operationalise the decomposition as follows. Our estimation has yielded, given the (estimate of the) actual wage distribution  $G$ , the estimated wage offer functions  $w_i^e(p|\hat{\lambda}, \hat{\delta}, \hat{\mu}, \hat{\sigma})$ . Given the Pareto-like productivity distributions, we calibrate wage offer functions  $w_i(p|\hat{\lambda}, \hat{\delta}, \hat{\mu}, \hat{\sigma}, \underline{p}, \alpha)$  based on Pareto productivity distributions by minimising the integrated absolute deviations between  $w_i^e(p|\cdot)$  and  $w_i(p|\cdot, \underline{p}, \alpha)$ . Table 11 reports the calibrated parameters of the Pareto productivity distribution (which are in line with the results reported in footnote 10).

Figure 8 illustrates, for young unskilled workers, this calibration, and also illustrates the counterfactual experiment of improving the job turnover situation of foreigners by lowering

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<sup>9</sup>These results differ from estimates for Netherlands (van den Berg and Ridder(1998)) and France (Bontemps et al. (1999)) since both countries have a binding legal minimum wage. Similar to these studies, however, we observe that job separation parameter  $\delta$  is approximately one order of magnitude smaller than the estimated job offer arrival rate  $\lambda$ .

<sup>10</sup> The approximate linearity in the productivity plots suggests a simple (graphical) estimator of the shape parameter of the Pareto distributions: use OLS to estimate the regression of log density on log productivity (and add 1). A second estimator refines this by using the productivity densities as weights, and yields similar results. A third marginal refinement considers only observations to the right of the left-tail kink. For foreigners, this yields the estimates -1.26 (clerks), -1.99 (unskilled), -2.17 (skilled), and for natives -2.31 (clerks), -2.36 (unskilled) and -2.49 (skilled). Similar values have been used in the validation exercises of Section 2.

Table 10: Native workers: full and restricted sample results.

Age	group	$\mu$	$\sigma$	$\lambda$	$\delta$
A. Unskilled Blue-Collar Workers					
<b>25-40</b>	<i>pre-1988</i>	57.92 [56.34-59.13]	2.00 [*-*	0.0287 [0.0138-0.0382]	0.0102 [0.0075-0.0173]
	<i>All</i>	65.41 [62.83-67.22]	7.07 [5.31-8.64]	0.0598 [0.0460-0.0682]	0.0226 [0.0194-0.0269]
<b>40-55</b>	<i>pre-1988</i>	48.72 [45.96-51.88]	8.62 [6.84-9.69]	0.0139 [0.0092-0.0218]	0.0041 [0.0029-0.0055]
	<i>All</i>	49.48 [47.63-50.54]	8.57 [7.24-9.66]	0.0150 [0.0117-0.0173]	0.0044 [0.0037-0.048]
B. Clerks and Service Workers					
<b>25-40</b>	<i>pre-1988</i>	77.26 [73.31-82.62]	7.76 [5.34-10.12]	0.0405 [0.0316-0.0641]	0.0098 [0.0074-0.0139]
	<i>All</i>	81.69 [79.11-82.94]	5.88 [4.37-7.62]	0.0771 [0.0595-0.0874]	0.0159 [0.0112-0.0193]
<b>40-55</b>	<i>pre-1988</i>	48.67 [43.88-51.74]	9.79 [6.74-12.49]	0.0149 [0.0097-0.0182]	0.0033 [0.0026-0.0041]
	<i>All</i>	48.24 [45.31-52.40]	9.79 [7.04-12.82]	0.0156 [0.0107-0.0194]	0.0035 [0.0028-0.0039]
C. Skilled Blue-Collar Workers					
<b>25-40</b>	<i>pre-1988</i>	80.59 [77.42-82.79]	5.2 [4.14-6.03]	0.0432 [0.0311-0.0688]	0.0090 [0.0071-0.0106]
	<i>All</i>	80.78 [78.51-81.94]	4.65 [4.11-6.20]	0.070 [0.0552-0.0781]	0.0151 [0.0110-0.0184]
<b>40-55</b>	<i>pre-1988</i>	49.31 [48.12-51.23]	9.42 [7.61-11.07]	0.0131 [0.0104-0.0188]	0.0033 [0.0028-0.0039]
	<i>All</i>	49.44 [48.12-51.23]	9.42 [8.36-9.98]	0.0143 [0.0112-0.0192]	0.0037 [0.0031-0.0042]

their job separation rate to  $\delta_F \equiv \delta_N$ . The first two panels of the figure show the close match between  $w^e(p)$  (which we have seen before in Figure 5) and  $w(p)$ . Panel three depicts the calibrated wage offers  $w_N(p)$  (solid line) and  $w_F(p)$  (dashed line), as well as the counterfactual  $w_F(p|., \hat{\delta}_N)$  (dotted line). The reduction in the separation rate for foreigners from  $\hat{\delta}_F$  to  $\hat{\delta}_N$  ‘rotates’ the wage offer curve up: for lower productivities, the improvement is negligible, but for high productivities foreigners receive wage offers equal to or better than those for natives. Considering the actual and counterfactual wage decomposition based on equation (10), recall that the migrant effect is weighted by the (calibrated Pareto) productivity density  $d\Gamma_N$ , so weights are linearly declining. The actual migrant effect is 8.49, and the counterfactual scenario reduces this to 4.7. The increase in wage offers for foreigners yields the improvement in the density of accepted wages depicted in the fourth panel of the figure.

Table 12 reports the results for all the counterfactual experiments, for all skill and age groups. Recall that throughout setting counterfactually  $\delta = \delta_N$  represents an improvement and  $\lambda = \lambda_N$  a deterioration for foreigners. We briefly comment on a few results.

Consider first the young unskilled. The difference in productivities in the two sectors plays a role as the migrant effect decreases from 8.48 (row 1) to 2.43 (row 10) after their equalisation; the productivity difference interacts positively with the reservation wage distribution (row 8) and the job arrival rate (row 6). For instance, comparing row 6 to row 14, the migrant effect falls from 10.6 to 4.25. Considering the other two age groups, it is evident that the magnitude of the effects decreases in age. In fact, in the age group 40-55, there is little difference between natives and foreigners.

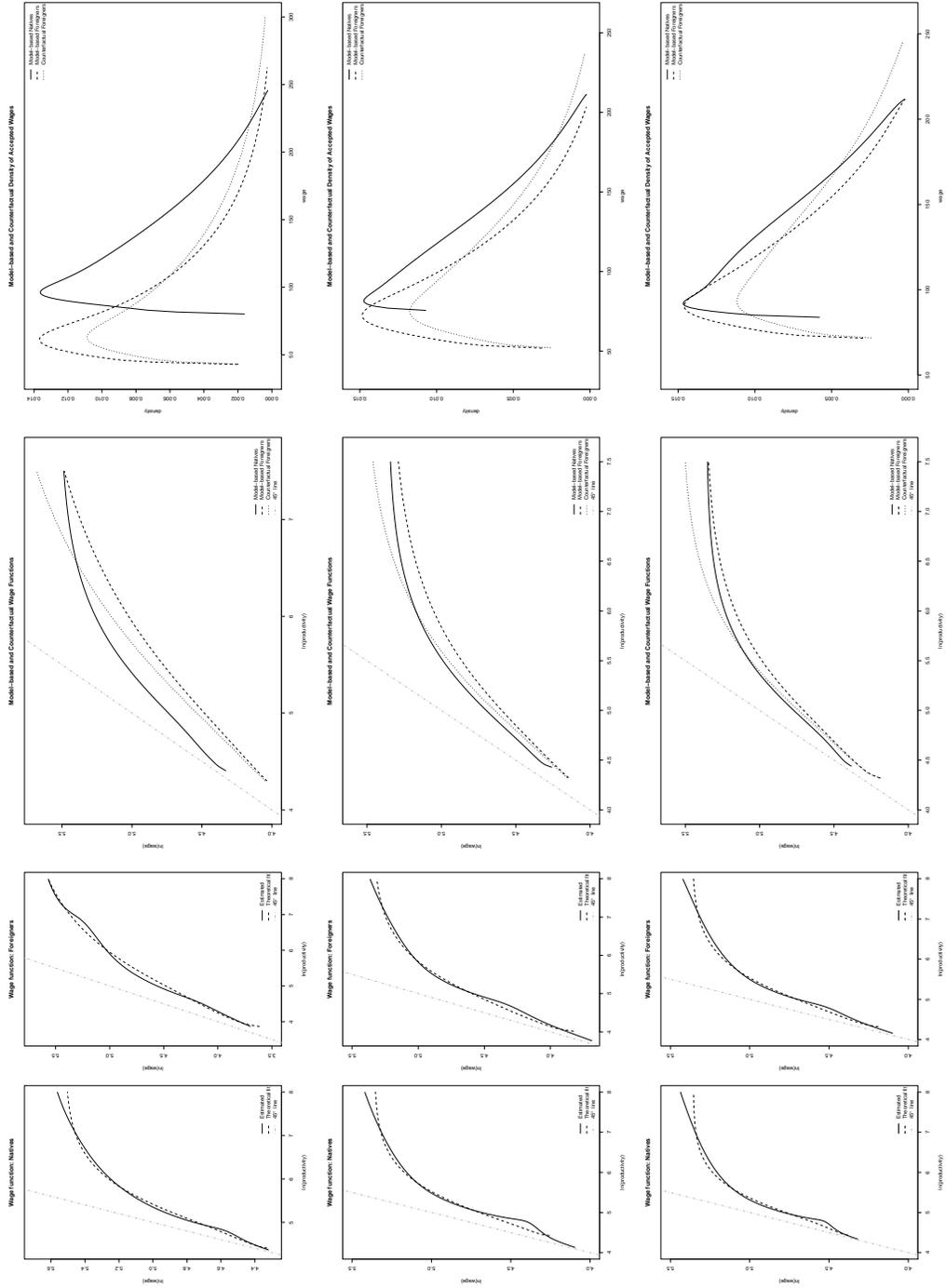
As regards the young skilled, relative to the young unskilled, the effects are smaller in magnitude, which is to be expected given the similarities depicted in Figure 7. The productivity difference plays a much smaller role (row 1 v. row 10). For the other age groups the relative situation of foreigners improves with age, and the actual mean migrant effect in fact becomes negative, and gets amplified by the counterfactual improvements in productivity (row 10) and job separation rates (row 4). An important driver for the differences in wage offers are differences in the reservation wage distribution; equalising these reduces or nulls the magnitude of the migrant effect (rows 3, 2, and 11).

Finally, turning to the young clerks and low service workers, as expected from Figure 6, the largest difference between foreigners and natives occur for this group. Differences in productivities play an important role, but substantial migrant effects persist even after their equalisation (row 10). Equalising both productivity and reservation wage distribution almost nils the migrant effect (row 11). Considering the other age groups, migrant effects are persistent, and the role of differences in the reservation wage distribution diminishes significantly (row 3). Equalising the productivities significantly reduces the migrant effect for the old (row 10), and it falls from 22.89 to 2.49 for the middle age group if the job separation rates are also equalised (row 12).

Table 11: Calibrated Pareto distribution parameters.

Age Group	Nationality	Unskilled		Skilled		Clerks	
		$\underline{p}$	$\alpha$	$\underline{p}$	$\alpha$	$\underline{p}$	$\alpha$
25-30	Natives	83.838	2.652	84.848	3.177	81.818	2.530
	Foreigners	55.556	2.146	75.253	2.591	47.778	1.506
30-40	Natives	104.211	3.221	99.495	3.197	121.316	3.258
	Foreigners	68.182	2.449	69.192	2.652	56.316	1.489
40-55	Natives	98.485	3.157	99.495	3.157	121.316	3.458
	Foreigners	86.869	3.035	59.091	2.874	40.526	1.805

Figure 8: Calibration, migrant effects, and wage densities for young workers.



Notes. Row 1: unskilled blue collar workers. Row 2: clerks and lower service workers. Row 3: skilled blue collar workers.

Table 12: Wage differential decomposition and average migrant effects.

Scenario	Young				30-40				40-55									
	Unskilled Diff Mig Ef	Skilled Diff Mig Ef	Clerks Diff Mig Ef	Unskilled Diff Mig Ef	Skilled Diff Mig Ef	Clerks Diff Mig Ef	Unskilled Diff Mig Ef	Skilled Diff Mig Ef	Clerks Diff Mig Ef	Unskilled Diff Mig Ef	Skilled Diff Mig Ef	Clerks Diff Mig Ef						
(1)	58.3	8.48	28.2	6.18	60.9	22.91	65.5	1.71	61.6	-2.51	82.4	22.89	31.2	-0.32	78.7	-6.42	102.3	11.38
	Actual																	
(2)	54.0	4.23	25.3	3.31	49.4	11.45	67.7	3.94	67.6	3.53	76.8	17.30	29.9	-1.66	87.0	1.94	99.8	8.81
(3)	57.0	5.07	26.1	3.08	54.5	7.20	65.7	2.56	62.5	0.05	81.5	19.58	30.7	-1.19	79.3	-3.60	102.3	10.84
(4)	56.3	4.74	25.9	3.84	57.6	18.92	62.3	-5.17	59.5	-6.78	75.0	11.27	28.0	-4.93	78.1	-8.60	99.8	1.45
(5)	61.4	14.56	28.8	6.81	60.8	22.83	69.6	11.28	65.1	5.22	85.4	28.21	34.7	4.58	81.5	4.83	107.2	34.59
(6)	59.4	10.63	26.5	4.41	57.6	18.84	66.2	3.32	62.8	0.19	77.9	15.58	30.9	-0.86	80.8	2.32	104.5	21.26
(7)	55.2	1.89	24.0	1.07	52.2	5.05	62.5	-4.60	60.2	-4.81	74.5	9.20	27.5	-5.67	78.7	-6.15	99.7	1.13
(8)	59.6	9.95	26.7	3.62	54.5	7.15	70.1	12.79	66.7	9.57	84.3	24.13	34.0	3.53	82.9	11.39	107.0	32.78
(9)	57.9	6.84	24.6	1.57	52.2	5.01	66.5	4.26	63.9	3.25	77.3	13.11	30.3	-1.71	82.0	7.66	104.4	20.36
(10)		2.43		4.55		15.05		-3.47		-8.10		11.17		1.82		-14.10		-2.62
(11)		-1.63		1.50		2.44		-1.31		-2.38		5.05		0.47		-6.82		-4.99
(12)		-0.58		2.33		11.53		-8.48		-11.15		2.49		-2.21		-15.28		-6.98
(13)		7.83		5.16		14.97		4.44		-1.81		15.52		6.17		-6.25		11.96
(14)		4.25		2.87		11.46		-2.23		-6.04		5.59		1.34		-8.36		2.57
(15)		-4.35		-0.49		0.05		-6.55		-5.82		-2.84		-3.46		-8.16		-9.21
(16)		3.13		2.04		2.39		7.07		5.02		8.95		4.67		2.65		8.93

Notes: 'Diff' refers to the wage differential and 'Mig Ef.' to the migrant effect. Rows 10+: the wage differential equals the migrant effect because the productivity distributions are the same.

## 6 Conclusion

The use of the structural empirical general equilibrium search model with on-the-job search has enabled us to disentangle the role of various unobservables for the explanation wage differentials between migrants and natives. In particular, we have examined differences in search frictions, reservation wages, and productivities in segments of the labour market defined by occupation, age, and nationality using a large scale German administrative dataset. The resulting decompositions of the actual and counterfactual wage differential quantify the marginal and joint roles of the various factors.

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## A Data Appendix

Our sample only includes full-time working men aged 25-55 years old residing in West Germany. In what follows, we describe how we construct the key variables used in our empirical analysis.

### A.1 Variable Description

**Age** The age variable is constructed using information on the date of birth and the year in which the spell took place. Date of birth is not available for individuals who were under 16 years old at their first observed spell or over 65 years old at their last observed spell. In such cases, we assume that workers were 15 years old at their first spell and 67 years old at their last spell.

**Labour Market Status** The information provided in the data set are sufficient to distinguish between three labour market states: employed, recipient of transfer payments, and out of sample. In our analysis, we employ the broad definition of unemployment, as proposed by Fitzenberger and Wilke (2010), and assume that unemployment is proxied by non-employment. Using this definition of unemployment, we only consider two labour market states (employment and unemployment) since being out of sample is equivalent to being unemployed. However, this strategy may lead to the mis-classification of non-participants as unemployed: for example, an individual that had an employment spell in her late teens, subsequently went to university, and reappeared in the sample in her late twenties would be classified as unemployed despite the fact that she was not in the labour market. To correct for this problem, individuals that are out of sample are only classified as unemployed if their out of sample duration does not exceed the average duration of transfer payment recipients' spells.

**Spells** Due to the annual reporting system, all spells have a maximum duration of one year. We merge all consecutive annual spells during which the individual does not experience a change in her labour market status, i.e. she either remains unemployed or employed with the same employer. We use firm-identifiers included in the dataset to determine when a worker changes employers. The new merged spells record the start date, the end date, the duration of the spell, the employment status, the average wage under the same employer, and the transition experienced by the individual (job-to-unemployment, job-to-job, unemployment-to-job).

**Wages** The dataset reports gross daily wages and does not provide information on hours worked. We therefore exclude part-time employees, trainees, interns, and at-home workers from the sample since the wage information is not comparable for these groups. Wages are truncated at the social security contributions threshold (DM10) and censored at the social security contributions ceiling (DM300). For workers with wages below the social security contribution threshold, we use wages of adjacent employment spells. Wage censoring is not pronounced as the social security contributions ceiling is not binding in our sample as we focus on low-wage workers who are not likely to earn wages in excess of this upper bound.

Since the focus of our analysis is the transitions experienced by workers in the early 1990s, all wages are reported in DM and adjusted to real 1995 prices using the German Consumer Price Index. For all individuals who experience wage variation during employment spells, we compute the average per period wage of each worker under the same employer.

**Occupation** The dataset includes extensive information on occupations (three-digit codes), which is used to classify individuals to 10 major groups based on the International Standard Classification of Occupations (ISCO-88). Exploiting the description of occupations in our dataset and the detailed index of occupational titles of the ISCO-88, we are able to map the code list from the Federal Employment Service of Germany included in the IABS into the following ISCO-88 major groups:

1. Legislators, Senior Officials, and Managers
2. Professionals
3. Technicians and Associate Professionals
4. Clerks
5. Service Workers and Shop & Market Sales Workers
6. Skilled Agricultural and Fishery Workers
7. Craft and Related Trades Workers
8. Plant and Machine Operators and Assemblers
9. Elementary Occupations
10. Armed Forces

We restrict attention to low- and middle-skill occupations, where the concentration of foreigners is higher. Specifically, we consider three occupational groups that are defined as follows:

- unskilled blue-collar workers, which includes individuals classified in the ISCO-88 major groups 8 and 9;
- skilled blue-collar workers, which includes individuals classified in the ISCO-88 major group 7;
- clerks & low-service workers, which includes individuals classified in the ISCO-88 major groups 4 and 5.

**Education** Information on education reported in the IABS is not exploited since it is known to be problematic: the education variable “bildung” contains missing values corresponding to 17 percent of individuals and for some individuals is inconsistent over time; foreigners are disproportionately affected by missing information and inconsistencies with respect to educational levels.<sup>11</sup> An additional concern is that education acquired in foreign countries may not have the same value in the labor market as education and experience obtained in Germany. Given that the classification of educational levels in the IABS reflects the official recognition of educational degrees acquired abroad, which is rather restrictive in Germany, the correlation between educational degree and occupational status is similar for foreigners and natives.<sup>12</sup>

Therefore, we are convinced that the stratification of the sample by age and occupation captures skill in a more consistent way than the discarded education variable.

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<sup>11</sup>See Fitzenberger et al (2006) for a detailed discussion of the problems associated with the education variable in the IABS and the recommended imputation procedures to improve its accuracy.

<sup>12</sup>Brücker and Jahn (2008) find that in the highest education group they consider (individuals with a university degree) the share of immigrants in high-level occupations is only slightly below that of natives. D’Amuri et al. (2010), in their analysis of wage elasticities, provide further evidence to support this relationship between educational level and occupational status: they find no differences, whether classifying the labor force by educational or occupational level.

More importantly, dividing the sample by occupation and age provides a more homogeneous grouping of individuals than the stratification of the sample by industry used in Bontemps et al. (1999). Each industry can be considered a microcosm of the aggregate market: observed variation in the labour market outcomes of workers within industries is by and large the result of underlying heterogeneity (in skill, experience, and so on). Within the age-occupation cells we consider, workers are relatively homogeneous; this facilitates our empirical exercise as it reduces the sources of variability that may influence individual labour market outcomes.