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Exploiting Regional Heterogeneity to Test Wage Setting Theories – Firm Size Wage Effects in Urban and Rural Regions

Preliminary and incomplete – do not quote

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Abstract

We exploit regional differences in labour market density to conduct a simple empirical test of dynamic monopoly and selection wage theories. According to selection wage theories employers offer above-average wages in order to attract more applicants. This allows them to be choosier and to select only the most productive workers. This mechanism is more effective in densely populated regions and can therefore be expected to be more important there. Observationally similar predictions arise in models of dynamic monopsony. The empirical implication, that firm-size wage effects should be more pronounced in urban labour markets, is tested empirically based on the German employment register data. Our results confirm that prediction.

Keywords: firm size wage effects, urban wage premium, wage differentials, selection wages, dynamic monopsony, compensating differentials

JEL classifications: J31, R12

1 Introduction

Firm size wage effects are one of the most robust stylized facts of empirical labour market research. Typically wages of workers in large firms exceed those of observationally identical workers in small firms by than 20 percent. They remain significant

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and greater than 10 percent even after controlling for unobserved worker characteristics (fixed individual effects). Despite the robustness of these findings (see e.g. Oi and Idson, 1999 or Manning, 2005, section 4.2, for an overview), the reasons for these large differentials remain a controversial issue.

Basically, the explanations offered by the literature can be sorted into four drawers: Compensating wage differentials, efficiency wages, (dynamic) monopsony, and rent sharing. Whereas rent sharing explanations seem to be ruled out by the observation that employer-size effects are smaller in unionized firms,¹ it remains difficult to evaluate the relative importance of monopsony, efficiency wage effects and compensating differentials from an empirical point of view because it is difficult to formulate predictions of these theories that can be tested empirically.

To understand this, consider compensating differentials. Here it is assumed that working in large establishments is more monotonous and regulated and therefore yields less direct satisfaction. This greater disutility of work has to be compensated by paying a wage premium. Though this view conflicts with the fact that large employers typically provide several amenities and more attractive working conditions than small employers as for example workplace security, fringe benefits and formal rights of co-determination, other aspects of satisfaction that may overcompensate these amenities remain difficult to grasp empirically, if they exist at all.

Similar problems arise with efficiency wage theories. They assume that the productivity of workers depends on the wage paid. Productivity is increased either through labor turnover (as in Schlicht, 1978 and Salop, 1979), or selection, where selection comes in two varieties: Self selection of the applicants (Weiss, 1980) and firm selection (Schlicht, 2008, 2005) where a higher wage offer attracts more applicants and permits firms to be more selective and to hire only the most productive applicants. Empirical testing is complicated by the difficulty to separate the productivity effects of wages from those of other worker characteristics as for example education and firm tenure. It can be shown, however, that both selection wage models as well as monopsony models induce differences in firm-size wage effects between dense and sparse labour markets. This can be exploited in order to obtain (admittedly still indirect) evidence on these theories and competing theories that do not suggest such an effect.

In selection wage models differences in the firm size effects between urban and rural areas arise due to different effectiveness of the selection wage mechanism. The argument is based on two ingredients. First, we know from both theoretical and empirical research on the organization of firms (see e.g. Williamson, 1985) that the costs of organizing and monitoring workers increase in the firm size. Therefore hiring responsible and independently working employees is important especially for large firms. Second, the incentive to offer above-average wages in order to increase the applicant

¹If unionization improves workers' capacity to extract rents from successful establishments, employer-size wage effects should be greater in unionized firms, especially with firm level bargaining. See Manning (2005) for details and references to empirical studies.

queue should increase with the density of the labour market because more potential applicants can be reached there at the same time (and are likely to apply). Since large firms have stronger incentives to increase the quality of their work force by using selection wages, the firm-size wage effect should be more pronounced in densely populated (urban) labour markets.

Similar effects are implied by monopsony theories à la Burdett and Mortensen (1998). In the simplest version of the model, where all workers are equally productive, wage differences arise due to imperfect information. Firms are able to set wages below productivity since not all workers are aware of all job offers in the market at once. However, larger firms have to offer higher wages in order to maintain greater employment. Greater firm size effects in urban regions arise here mainly due to higher labor market density.² A firm's workers obtain more alternative wage offers at the same time (and find it cheaper to move to another firm). This makes it more difficult to retain workers and has to be neutralized by higher wages.

We test this joint hypothesis on monopsony and selection wages by running regression models that allow for different firm-size wage effects in urban and rural labour markets. Note that this hypothesis allows us to exclude compensating differential explanations since there is no plausible reason to assume that the disutility of work is correlated more strongly with firm size in urban areas.

Finally, though our study is foremost aimed to test explanations of the firm size wage effect, our results can be interpreted from a more general perspective as evidence against standard models of pure wage competition.

2 Theory

Though the arguments summarized so far appear to be intuitively clear, explaining the theories behind them in more detail will provide two additional benefits. First, this will allow a more thorough assessment of scope and the validity of the empirical tests conducted below. Second, it helps to understand the observational equivalence of the empirical implications of monopsony and selection wage theories.

Selection Wages

Selection wage theories (Schlicht, 2008) are based on three basic observations. First, workers differ with respect to their productivities. Second, the distribution of wages is compressed compared to the distribution of productivities, either as a consequence of collective wage bargaining, or since the employer's wage-setting policy cannot reflect all aspects of worker's productivity.³ And third, workers are imperfectly mobile.

²Other reasons will be discussed below.

³This refers to the phenomenon of wage compression: Only a small fraction of productivity differences is reflected in wage differentials within a firm, see Frazis and Loewenstein (2006) for empirical

Since the heterogeneity of the productivities is not fully reflected in wages, employers have an incentive to increase the average productivity of their work force by raising wages. Imperfectly mobility makes this strategy feasible. (Otherwise the most productive workers would be poached quickly by competitors. There would be perfect productivity sorting and wage compression would disappear.) Firm size effects arise in this modelling framework if the demand for productive traits, especially for responsibility and independent or unsupervised working, is greater in large firms. This idea is developed in Schwimmer (2006). The author emphasizes that the realization of economies of scale in large firms is accompanied by increasing costs of coordination which can be kept within limits by hiring highly capable, independently working employees.⁴

Dynamic Monopsony

It is somewhat sloppy but illuminating to consider models of dynamic monopsony as special cases of selection wage theories. We develop the similarities based on Manning's (2005) review of Burdett and Mortensen (1998). In the simplest modelling framework all workers have identical productivities. Both employed as well as unemployed workers obtain wage offers and may move freely and costlessly to another employer once they accept her wage offer. Their mobility is, however, restricted indirectly since they do not know all wages but receive them at a finite rate λ . This enables the employers to set wages below productivity. Though profits must be equal across employers, there exists an equilibrium (in mixed strategies) where employers offer different wages. Individual employers may find it worthwhile to offer higher wages in order to increase the number of employees. Of course, the implied marginal decrease of the profit per worker must be neutralized exactly by the induced increase in the number of workers.

The model can be put into space by analyzing the wage effects of space-related parameters, the average firm size and the arrival rate of job offers λ . It is demonstrated formally in an appendix that the firm size wage effect is increasing in both parameters (for sensible parameter values). Since both parameters are greater in urban areas, the model predicts greater firm size wage effects there. The intuition for these results is simple and emphasizes the similarities with the selection wage theories. Greater average firm size inflates the firm size effects by making the market more monopsonistic⁵,

findings and Harris et al. (1975) for theoretical foundations.

⁴See Williamson (1967) for an alternative model where firm size is determined by a manager's *span of control* and *control loss* due to transmission of information across hierarchy levels. Firm size wage effects arise here through the number of hierarchy levels in the firm. Calvo and Wellisz (1978) develop an incentive shirking model where the probability to detect shirking employees depends on the share of monitoring managers at the respective hierarchy level.

⁵Note that a more monopsonistic market structure also decreases the overall wage level. This effect may, however, be shadowed and overcompensated by the competition effect of the market density.

and higher job offer arrival rates increase worker churning and has to be compensated by higher wages.

Note that the firm size wage effects are induced by technological heterogeneity in the efficiency wage models sketched above (greater firms are more productive but face higher coordination costs) whereas productivity is tied exclusively to workers and therefore does not matter in the simplest version of Burdett and Mortensen’s monopsony model. Though it may be appealing to demonstrate that a non-degenerate wage distribution prevails even if all workers are equally productive, identical production technologies are clearly not an essential ‘feature’ of monopsony. In a simple extension, Burdett and Mortensen (1998) add technology-induced productivity differences related to firms size to the model (see section 4 of their paper). Then, in line with expectations, the more productive firms pay higher wages.

3 Data

Our main data base is the employment register of the German Federal Employment Agency (BEH). It covers all workers liable for social security contributions in Germany. This amounts to about 80 percent of the German workforce. It is particularly well suited for our study since it contains unique identifiers that allow us to assign workers to establishments and to regions at the local administrative unit level (LAU2).

3.1 Selection of the Estimation Sample

To simplify the preprocessing and to keep the estimation sample tractable, we keep only spells crossing the 30.6 of the years 2000 to 2008.⁶ Our further sample selections follow the rules applied customarily in empirical work based on the register data.⁷ Missing information on working hours is tackled by restricting the sample to full time workers and proceeding with deflated⁸ daily wages.⁹ Possible distortions due to early retirement schemes are avoided by dropping persons younger than 20 and older than 55 from the final estimation sample. Of course, these restrictions apply only to the final estimation sample whereas the computation of the establishment level indicators (as the establishment size and the shares of foreigners, part-time workers, females, apprentices etc.) is based on all employees. All employee counts are obtained as the weighted sum of full-time and part-time workers where full-timers obtain a weight of

⁶The data are available until 2010. 2008 is chosen as the end year for this draft version in order to avoid problems due to a change of the industry classification.

⁷See, for example, Fitzenberger (1999)

⁸The German consumer price index is used to deflate wages.

⁹Note, however, that the reporting of wages and of the duration of the employment spells is highly precise.

unity and part-timers with more and less than 50 percent of the standard weekly full time hours obtain weights of 0.6 and 0.3, respectively.

For this early draft, the analysis is simplified further by dropping female workers¹⁰ and eastern German establishments from the estimation sample.

3.2 Demarcating Agglomerated Labour Markets

Following the theoretical considerations sketched in the introduction we try to identify the effect of labour market density on the firm size wage effects. To this aim we have to split the estimation sample according to a sensible agglomeration or density measure. Though the dichotomy urban/rural is customarily used to delineate labour market density, it may not be sufficient for our application since the labour market conditions prevailing in administratively independent small communities in the vicinity of large cities (satellite towns) may effectively mimic those of the city. Consequently labour market regions may differ often from administrative units.

Table 1: Partition of the labour market regions according to labour market density (number of employees per km²).

| Nr. of Employees per km ² | Category | Label used in the Text | Base Sample | | | Estimation Sample (Western German Men) | | |
|--------------------------------------|----------|------------------------|-------------------------|-----------------------|------------------|---|-----------------------|------------------|
| | | | Nr. of Loc. Authorities | Nr. of Labour Markets | Nr. of Employees | Nr. of Loc. Authorities | Nr. of Labour Markets | Nr. of Employees |
| ≤ 40 | 1 | Rural | 3,497 | 222 | 3,018,786 | 2,512 | 162 | 1,925,205 |
| (40; 60] | 2 | Rural | 2,155 | 136 | 3,198,764 | 1,652 | 106 | 2,451,025 |
| (60; 100] | 3 | – | 2,166 | 124 | 4,744,793 | – | – | – |
| (100; 200] | 4 | – | 1,411 | 79 | 6,074,525 | – | – | – |
| 200; 500] | 5 | – | 1,138 | 44 | 9,363,282 | – | – | – |
| > 500 | 6 | Urban | 921 | 50 | 4,609,856 | 138 | 18 | 4,031,162 |
| Total | | | 11,288 | 655 | 31,010,004 | 4,302 | 286 | 8,407,392 |

Notes: The partition is computed basing on all German local authorities (including eastern Germany). The numbers of employees are obtained as averages over the years 2000, 2005 and 2010. (The observation numbers in tables 3, 4 and 6 and are greater since the estimation samples includes observations from all years 2000 to 2008.)

To obtain labour market regions that are coherent in an economic sense and to

¹⁰The main reason for this decision is the greater importance of part-time work among women which may induce noteworthy selectivity problems.

partition these regions according to labour market density, we proceed in two steps. In the first step we compute, for each pair (i, j) of the 11,228 (western German) local authorities in our sample, the share of commuters residing in authority i and working in authority j . Authority i is then ‘fused’ with j if at least 20 percent¹¹ of all employees residing in i commute to j . This rule aggregates the 11,228 authorities into 655 local labour market regions. In a second step, we compute – for these 655 regions – a measure of labour market density as the number of employees¹² in the region divided by the community area in km². Finally, the labour market regions are partitioned into 6 categories according to the grid in column 1 of Table 1. The estimation sample contains only full time prime age male employees of western German establishments falling into the categories 1 and 2 (which are combined and will be labelled ‘rural’ henceforth) and category 6 (which will be labelled ‘urban’ henceforth). As a simple check, we re-run our regressions after dropping category 2 (40 to 60 employees per km²) from the estimation sample. As expected, this increased the heterogeneity of firm-size effects across the rural/urban dimension slightly. In order to avoid touching up the results in a direction that supports the hypothesis to be tested, however, category 2 is retained in the estimation sample.

3.3 Further Data Preprocessing

Some minor deficiencies of our data require further preprocessing steps. First, the info on education is missing for roughly 10 percent of the spells of full-time employees. The missing values are imputed in a simple approach loosely following Fitzenberger et al. (2006): Missings are filled by copying the education from preceding or succeeding spells (if they contain valid information on education.) Second, about 10 to 12 percent of all full-time working male employees are censored at the upper social contribution threshold.¹³ To avoid bias due to censoring (which may be severe in our application since the censoring shares are clearly higher for urban labour markets and large establishments), all wages in the estimation sample are imputed using standard Tobit models. (Of course, the specification of the imputation model mimics that of the estimation model.) To retain as much establishment level heterogeneity as possible, the imputation models are run separately for each year and for small packages of establishments.¹⁴ To preserve the wage dispersion in the censored range, an error term

¹¹To check the robustness of our results, we experimented with other commuting thresholds at explorative stages of the project. Setting the threshold to 15 percent generates a different partition of the authorities but almost identical results regarding the firm size effects.

¹²The commuting shares are based on employment-time weighted employee numbers. with employment-time weights as defined above.

¹³See Büttner and Rässler (2008) for further tabulations of the censoring shares.

¹⁴The number of establishments in an imputation package depends of the establishment size. For example, establishment with more than 500 employees are collected into packages with at most 10 establishments (of the same two-digit industry). The package sizes are 20, 50, 100 and 200 for

(drawn from an appropriately truncated normal distribution) is added to the predicted censored wages. See Gartner (2005) for a detailed description of the procedure.

4 Methods

To identify the impact of establishment size and the labour market tightness on wages, we estimate the following simple OLS and fixed effects wage regressions separately for urban and rural regions. Our benchmark model is a OLS regression of the form

$$\ln(w_{i,e,t}) = \sum_s D_{e,t}^s b^s + x_{i,e,t} \beta + z_{e,t} \gamma + \ln(U_{r,t}) \delta + \theta_t + u_{i,e,r,t} \quad (1)$$

where $\ln(w_{i,e,t})$ denotes the Log wage of individual i in establishment e at time (year) t . The firm size wage effects are measured using the size dummies $D_{e,t}^s$. Individual level controls are comprised in $x_{i,e,t}$, establishment level controls in $z_{e,t}$. $\ln(U_{r,t})$ denotes the Log of the regional (district level) unemployment rate, the θ_t represent fixed year effects and $u_{i,e,t}$ a residual term. The indexes i, e, r, t and s refer to individuals, establishments, time, region, and the size categories, respectively. The region index r is omitted from all variables except U and u to keep the notation simple.

Our individual level controls include age, age squared, 13 occupation dummies,¹⁵ a dummy for medium qualification, a dummy for high qualification, establishment tenure (both the main effect and interaction terms with the qualification dummies), and dummies for foreigners and for foreigners from advanced industrial countries. The rich set of establishment level controls includes the establishment level shares of part-timers, of female workers, of apprentices, of foreigners, of foreigners from advanced industrial countries, a dummy for establishment entry after 2000, a dummy for establishment exit before 2008, and two-digit level industry dummies (60 branches). Possible regional heterogeneity is captured by dummies for the federal states.

As is well known from the literature (see e.g. Oi and Idson, 1999 or Manning, 2005) a good deal of the firm-size wage effect may be explained by the heterogeneity of unobservable employee characteristics. A simple but powerful strategy to eliminate this bias is to include fixed person effects. The firm size effects are then identified by employees that move between establishment belonging to different size categories. After inclusion of the fixed worker effects, the model has the form

$$\ln(w_{i,e,t}) = \sum_s D_{e,t}^s b^s + x_{i,e,t} \beta + z_{e,t} \gamma + \ln(U_{r,t}) \delta + \theta_t + \mu_i \epsilon_{i,e,r,t} \quad (2)$$

To avoid collinearity, time-invariant (and almost time-invariant regressors) as e.g. the establishments in the size classes (200; 500], (50; 200], (25; 50] and [1; 25], respectively.

¹⁵The about 330 occupation classes in our data are put into 13 coarse groups using an aggregation scheme proposed by Blossfeld (1985).

skill dummies and the age terms¹⁶ have to be dropped from the fixed effects specifications.

A final minor technical detail regards the computation of standard errors. Our main regressors of interest, the firm size dummies, are aggregated regressors (i.e. take on the same value for all employees of an establishment). If the model contains common shocks that affect all employees in the same establishment identically (formally $\epsilon_{i,e,r,t} \equiv h_e + \eta_{i,e,r,t}$ with common shock h_e), appropriate formulas are required to obtain a consistent estimate of the variance matrix of the regression coefficients. Since our models include an even more aggregated regressor, the district-level unemployment, our covariance estimation accounts for clustering at the district level. This yields also consistent estimates of the establishment level variances too, since establishments are nested within districts.

5 Basic Descriptive Statistics

Table 2: Basic Descriptive Statistics

| Estab. Size | Log Wage | | Age | | Tenure | | Share Highly Qualified Empl. | |
|-------------|----------|-------|-------|-------|--------|-------|------------------------------|-------|
| | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban |
| [1; 10] | 4.09 | 4.15 | 36.78 | 37.56 | 5.01 | 3.99 | 0.03 | 0.07 |
| (10; 25] | 4.23 | 4.37 | 37.87 | 38.25 | 5.93 | 4.60 | 0.03 | 0.09 |
| (25; 50] | 4.28 | 4.43 | 38.53 | 38.68 | 6.31 | 4.78 | 0.03 | 0.10 |
| (50; 100] | 4.32 | 4.48 | 39.02 | 38.94 | 6.69 | 5.03 | 0.04 | 0.12 |
| (100; 200] | 4.37 | 4.53 | 39.15 | 39.22 | 7.23 | 5.29 | 0.05 | 0.13 |
| (200; 500] | 4.44 | 4.61 | 39.31 | 39.60 | 8.12 | 5.87 | 0.06 | 0.16 |
| (500; 1000] | 4.49 | 4.68 | 39.15 | 39.89 | 8.80 | 6.71 | 0.07 | 0.17 |
| > 1000 | 4.57 | 4.75 | 38.97 | 40.14 | 10.25 | 8.11 | 0.08 | 0.20 |

Source: Extract from the employment register, German Federal Employment Agency. Sample: Western German male workers (full-time), 20-55 years.

A first glance at the heterogeneity with respect to firm size and labour market density can be obtained from Table 2. It contains means of (log) wages, age, establishment tenure and the share of highly qualified detailed by establishment size categories. Readers interested in the descriptive statistics for all other regressors and detailed counts of observations and establishments are referred to Tables 3 and 4 in the Appendix.

The means of (log) wages and all other variables increase in the establishment size both for rural and urban regions. Furthermore the means are generally greater for the urban regions with the notable exception of the establishment tenure. Clearly, since

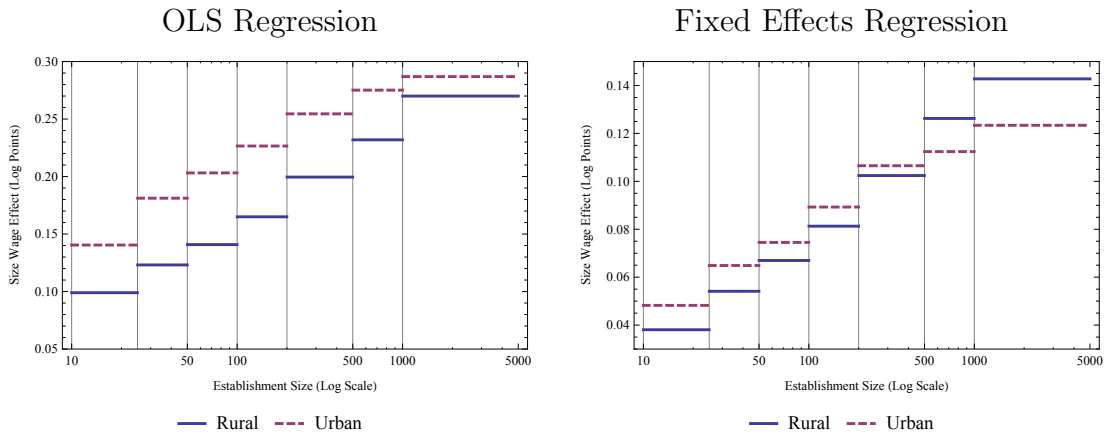
¹⁶They are perfectly collinear with the year dummies.

both wages as well as the other productive characteristics increase in the establishment size, it can be expected that they explain at least part of the size-wage differential. The most important information to be drawn from the table is, however, that the wage difference between the biggest and the smallest establishments is considerably greater for the urban areas. It amounts to $100 \times (4.76 - 4.16) = 60$ log points for the urban areas and exceeds the corresponding rural difference of $100 \times (4.62 - 4.09) = 53$ log points by 7 log points.

6 Regression Results

To obtain pure establishment size effects, we run the specifications 1 and 2 on our final estimation sample (western German full-time male workers, aged 20-55 years, period 2000 to 2008). Since the estimates of the controls are similar to other studies and not directly relevant here, they are shifted to Appendix table 6. Our main results, the estimates of the establishment size dummy coefficients for rural and urban labour markets, are summarized in Figure 1. Readers interested in the exact numerical values of the coefficients (together with their standard errors) are referred to Appendix Table 5. Significance intervals are omitted from the figures since all economically meaningful differences are significant due to the high precision of the estimates.¹⁷

Figure 1: Establishment Size Effects



Notes: The figures depict the coefficients of the establishment size dummies obtained from estimation of equations (1) and (2), respectively.

The left hand side graphic (OLS results) tells us that, after controlling for a rich set of personal and establishment level characteristics, wages in establishments with 10

¹⁷This can be seen from Table 5.

to 25 employees are roughly 10 log points greater than those in the base category (less than 10 employees) for rural labor markets (blue solid line). The corresponding size effect for urban labour markets (dashed line) is roughly 14 log points, and consequently considerably greater. The difference between the urban and rural size effect increases slightly in the size. For example, it amounts to $23 - 16 = 7$ log points for establishments with 100–200 employees. However, it shrinks considerably for establishments with 500 to 1000 employees and vanishes almost for the very large establishments (with more than 1000 employees). We think that the results for the size classes up to 500 employees can be taken as evidence of selection wage effects. For the very large establishments, our results are inconclusive.

The graphic on the right hand side (fixed effects results) adds three pieces of additional information. First, the size effects decrease considerably both for rural and urban regions once we control for unobserved worker productivity using fixed individual effects. (The maximum size effect amounts now to roughly 14 percent.) Second, the size effects are still greater for urban labour markets for the size classes up to 500 employees but the difference¹⁸ between urban and rural markets is considerably smaller now. And third, the relationship between the urban and rural size effects is even reversed for the very large establishments (i.e. the size-wage profiles cross). A possible provisional explanation for the clearly puzzling crossover of the size-wage profiles could be that very large establishments located in rural regions have to compete on supra-regional markets because the surrounding region cannot provide enough labour supply, or that their wages include a premium that gets workers to move to their vicinity or to accept large commuting times.

A comparison of the OLS with the fixed effects estimates suggests that the lion's share of the urban/rural difference between the firm-size effects can be attributed to unobserved worker characteristics. This means (taken the validity of the fixed effects model for granted) that the greater wage differences between large and small firms in urban labour markets are justified by greater differences of unobserved productive characteristics between the workers of large and small employers. It is important to note that this observation does not contradict the selection wage explanation for the firm-size wage differential. It rather suggests that the selection device is successful in attracting prolific workers.

7 Conclusion

In this paper, we exploit differences between urban and rural labour markets in order to conduct an indirect test of monopsony and selection wage models against compensating differentials explanations of the firm size wage effect. If employers offer high wages in

¹⁸Due to the huge size of our data, the differences between the respective urban and rural size effects remain statistically significant. Their economic significance seems to be weak and disputable, however.

order to attract highly prolific workers (selection wages) or to increase the number of workers (monopsony), the incentive to do so should be greater in densely populated labour markets where more potential applicants can be reached.

The hypothesis is tested using an extract from the employment register of the German federal Labour Agency. It is well suited for this application as it contains a huge number of workers and allows us to assign workers to establishments and to regions at the local administrative unit level.

In line with the results known from the literature, our OLS regressions yield a maximum firm size effect of roughly 28 percent.¹⁹ They add the novel information that firm-size wage effects are greater in densely populated urban labour markets. Our fixed effects models reveal that a good deal of the interregional differences in the firm size effect is explained by worker productivity differences. In summary, the OLS results suggest that large employers use the selection wage device more intensively in densely populated regions, and the fixed effects results add the supplementary information that the device is effective in the sense that it allows to recruit workers that are more productive also with respect to personal characteristics which cannot be observed by the researcher.

However, the evidence is not perfectly clear for two reasons. First, the relationship between the urban and rural firm-size profiles is reversed for the very large establishments. This may be explained by the fact that these firms have to operate in supra-regional labour markets due to their sheer size, but this explanation is clearly provisional and deserves further inspection. Second, our results do not allow to separate selection wage theories from theories of monopsonistic competition since both produce observationally identical predictions regarding the firm size effects. A closer look at the theories suggests, however, that this seems of minor importance in practice since they share some important assumptions, at least implicitly. Imperfect mobility of the workers is an essential ingredient of both theories. It is assumed either directly (selection wage theories), or indirectly through imperfect information on job offers and finite separation rates (monopsony). Furthermore, though it is possible to obtain wage differentials even in economies populated with equally productive workers, and this exercise may be theoretically appealing, real-world workers are clearly heterogenous and there is no doubt that large employers exploit these differentials in order to select the best workers. In this sense, monopsonistic market structures and selection wage policies can be thought of as mutually enforcing mechanisms.

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¹⁹‘Maximum effect’ refers to the difference between very large establishments (with more than 1000 employees) and small establishments (at most 10 employees).

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A Firm Size Wage Effects in Dynamic Monopsony Models

We derive here the effects of changes in the average firm size and the arrival rate of job offers on the firm size wage effect in the basic Burdett-Mortensen (1998) framework. The derivation is based on the labour supply function to an individual firm (see equation 2.20 in Manning, 2005)

$$N(w; F) = \frac{\delta \lambda}{M (\delta + \lambda (1 - F(w)))^2} \quad (3)$$

with wage w , job offer arrival rate λ and job destruction rate δ . $M \equiv M_f/M_w$ denotes the relation between the number of firms and M_f the number of workers. The wage offer distribution $F(\cdot)$ which is completely determined by the model assumptions has the form

$$F(w) = \frac{\delta + \lambda}{\lambda} \left\{ 1 - \sqrt{\frac{p-w}{p-b}} \right\}.$$

Here p denotes a worker's (constant) productivity and b denotes the value of leisure b .²⁰ p will be set to unity and b to zero in order to simplify the further analysis (of course, without loss of generality).

²⁰It has the density function $f(w)$ is increasing in w and therefore differs from empirically estimated densities. van den Berg and Ridder (1998) show that this strange feature disappears once workers differ with respect to their productivities. This does not change the qualitative predictions of the model regarding the firm size effects. AbowdEtAl2002

We are interested in the dependence of the derivative $\partial w/\partial n$ on parameters that differ between urban and rural labour markets. Solving the above equation for w and computing the derivative with respect to N yields the firm size wage effect

$$\frac{\partial w}{\partial N} = \frac{\delta \lambda}{M N^2 (\delta + \lambda)^2} \quad (4)$$

and its derivatives

$$\frac{\partial^2 w}{\partial N \partial M} = \frac{-\delta \lambda}{(M N ((\delta + \lambda))^2)} < 0 \quad (5)$$

$$\frac{\partial^2 w}{\partial N \partial \lambda} = \frac{\delta (\delta - \lambda)}{M N^2 (\delta + \lambda)^3}. \quad (6)$$

The right hand side expression $\partial^2 w/(\partial N \partial \lambda)$ in the last equation is negative for the plausible case $\lambda > \delta$.

Since the average firm size is greater in urban regions, M is smaller there. Furthermore, λ should be greater in urban areas (due to the greater density of employees and firms). Thus both, the differences in M and in λ across the region types point to greater firm size wage effects in urban regions. The intuition for these results is simple and emphasizes the similarities with the selection wage theories. Greater average firm size (smaller M_f) inflates the firm size effects by making the market more monopsonistic. Higher job offer arrival rates increase worker churning and has to be compensated by higher wages.

Table 3: Descriptive Statistics (Regression Sample).

| Variable | Rural | | Urban | |
|------------------------------|------------|------------|------------|------------|
| | Mean | S.D. | Mean | S.D. |
| Continuous Variables | | | | |
| Log Wage | 4.316 | 0.379 | 4.531 | 0.494 |
| Log Unempl. Rate | 2.006 | 0.329 | 2.295 | 0.374 |
| Tenure | 6.934 | 7.189 | 5.842 | 6.648 |
| Age | 38.451 | 9.183 | 39.178 | 8.762 |
| (Establishment Level) Shares | | | | |
| Females | 0.238 | 0.208 | 0.264 | 0.204 |
| Apprentices | 0.054 | 0.075 | 0.036 | 0.059 |
| Foreigners | 0.052 | 0.102 | 0.120 | 0.150 |
| Foreigners (Adv.) | 0.007 | 0.031 | 0.012 | 0.034 |
| Part Time Workers (50%) | 0.079 | 0.138 | 0.082 | 0.128 |
| Part Time Workers | 0.118 | 0.215 | 0.085 | 0.196 |
| Medium Qualification | 0.721 | 0.197 | 0.660 | 0.212 |
| High Qualification | 0.045 | 0.087 | 0.139 | 0.184 |
| Dummy Variables | | | | |
| Medium Qualification | 0.772 | 0.420 | 0.643 | 0.479 |
| High Qualification | 0.058 | 0.235 | 0.169 | 0.375 |
| Foreigner | 0.055 | 0.229 | 0.122 | 0.327 |
| Foreigner (Adv.) | 0.007 | 0.084 | 0.012 | 0.109 |
| Entry after 2000 | 0.117 | 0.322 | 0.144 | 0.351 |
| Exit before 2009 | 0.129 | 0.335 | 0.140 | 0.347 |
| Nr. of Observations | 14,657,942 | 14,657,942 | 14,619,549 | 14,619,549 |
| Nr. of Establishments | 350,404 | 350,404 | 259,917 | 259,917 |

Source: Extract from the employment register, German Federal Employment Agency. Sample: Western German male workers (full-time), 20-55 years.

Table 4: Observation Numbers (Final Estimation Sample)

| Estab. Size | Observations | | Establishments | |
|-------------|--------------|-----------|----------------|---------|
| | Rural | Urban | Rural | Urban |
| [1; 10] | 2,619,091 | 1,664,853 | 277,587 | 203,638 |
| (10; 25] | 2,177,290 | 1,439,113 | 44,193 | 31,238 |
| (25; 50] | 1,833,881 | 1,356,748 | 15,616 | 11,967 |
| (50; 100] | 1,854,881 | 1,613,635 | 7,453 | 6,837 |
| (100; 200] | 1,827,306 | 1,708,270 | 3,374 | 3,402 |
| (200; 500] | 2,144,409 | 2,175,843 | 1,711 | 1,952 |
| (500; 1000] | 1,086,285 | 1,470,916 | 345 | 554 |
| > 1000 | 1,114,799 | 3,190,171 | 125 | 329 |

Source: Extract from the employment register, German Federal Employment Agency. Sample: Western German male workers (full-time), 20-55 years.

Table 5: Coefficients of the Establishment Size Dummies

| Establ. Size | OLS | | Fixed Effects | |
|-----------------|------------------|------------------|------------------|------------------|
| | Rural | Urban | Rural | Urban |
| (10;25] | 0.099 (0.003) | 0.140 (0.002) | 0.038 (0.000) | 0.048 (0.001) |
| (25;50] | 0.123 (0.003) | 0.181 (0.002) | 0.054 (0.001) | 0.065 (0.001) |
| (50;100] | 0.141 (0.003) | 0.203 (0.002) | 0.067 (0.001) | 0.075 (0.001) |
| (100;200] | 0.165 (0.003) | 0.227 (0.003) | 0.081 (0.001) | 0.089 (0.001) |
| (200;500] | 0.200 (0.003) | 0.255 (0.002) | 0.102 (0.001) | 0.107 (0.001) |
| (500;1000] | 0.232 (0.003) | 0.275 (0.002) | 0.126 (0.001) | 0.112 (0.001) |
| > 1000 | 0.270 (0.003) | 0.287 (0.003) | 0.143 (0.001) | 0.123 (0.001) |

Source: Extract from the employment register, German Federal Employment Agency. Sample: Western German male workers (full-time), 20-55 years.

Legend: The table contains the regressions coefficients of the establishment size dummies. See Table 6 for coefficients of other control variables.

Notes: Standard errors (in parentheses below coefficients) are robust to clustering at the district level.

Table 6: Regression Coefficients

| | OLS | | | | Fixed Effects | | | |
|------------------------------|------------|------|------------|------|---------------|------|------------|------|
| | Rural | | Urban | | Rural | | Urban | |
| | Coeff. | S.E. | Coeff. | S.E. | Coeff. | S.E. | Coeff. | S.E. |
| Continuous Regressors | | | | | | | | |
| Log Unempl. Rate | -10.56 | 0.16 | -6.50 | 0.14 | -2.49 | 0.06 | -2.12 | 0.09 |
| Tenure | 0.74 | 0.01 | 0.96 | 0.01 | 0.30 | 0.00 | 0.33 | 0.00 |
| Tenure X Med. Qual. | -0.24 | 0.01 | -0.47 | 0.01 | 0.02 | 0.00 | -0.04 | 0.00 |
| Tenure X High Qual. | 0.31 | 0.02 | 0.10 | 0.01 | 0.71 | 0.01 | 0.73 | 0.01 |
| Age | 3.68 | 0.03 | 5.50 | 0.04 | - | - | - | - |
| (Age/10) ² | -3.91 | 0.03 | -5.67 | 0.04 | - | - | - | - |
| (Establishment Level) Shares | | | | | | | | |
| Females | -11.48 | 0.47 | -5.14 | 0.35 | -3.49 | 0.10 | -6.03 | 0.14 |
| Apprentices | 0.92 | 0.67 | 1.95 | 0.62 | 2.42 | 0.13 | 7.16 | 0.23 |
| Foreigners | -13.51 | 0.64 | -22.21 | 0.22 | -4.73 | 0.21 | -6.38 | 0.19 |
| Foreigners (Adv.) | 26.45 | 1.03 | 69.74 | 0.97 | 9.13 | 0.59 | 20.47 | 0.74 |
| Part Time Workers (50%) | 16.54 | 0.42 | 5.06 | 0.26 | 4.59 | 0.11 | 4.59 | 0.15 |
| Part Time Workers | -5.72 | 0.27 | -12.88 | 0.17 | -1.93 | 0.08 | -5.37 | 0.10 |
| Medium Qualification | 7.11 | 0.44 | 18.36 | 0.46 | 5.57 | 0.08 | 12.59 | 0.14 |
| High Qualification | 32.97 | 0.89 | 44.80 | 0.42 | 21.98 | 0.26 | 27.05 | 0.22 |
| Education Missing | -14.69 | 1.07 | 2.16 | 0.79 | -2.25 | 0.28 | 3.25 | 0.31 |
| Dummy Regressors | | | | | | | | |
| Medium Qualification | 11.48 | 0.12 | 12.71 | 0.12 | - | - | - | - |
| High Qualification | 27.66 | 0.21 | 29.57 | 0.13 | - | - | - | - |
| Foreigner | -3.35 | 0.08 | -2.43 | 0.07 | - | - | - | - |
| Foreigner (Adv.) | 5.65 | 0.16 | 7.30 | 0.19 | - | - | - | - |
| Entry after 2000 | -2.58 | 0.21 | -0.53 | 0.16 | -0.66 | 0.05 | 0.33 | 0.05 |
| Exit before 2009 | -2.90 | 0.23 | -2.29 | 0.06 | -0.99 | 0.05 | -1.10 | 0.05 |
| Observations | 14,657,638 | | 14,618,801 | | 14,657,638 | | 14,618,801 | |

Source: Extract from the employment register, German Federal Employment Agency.

Sample: Western German male workers (full-time), 20-55 years.

Notes: All Coefficients and standard errors are multiplied by 100 to ease reading. Standard errors (S.E.) are robust to clustering at the district level. All regressions include 60 Industry dummies, 13 Occupation dummies, 8 year Dummies and 9 Federal State dummies (the coefficients are available from the author upon request.)