Supplementary Material: Appendix

– NOT INTENDED FOR PUBLICATION –

Wage Formation: Towards Isolating Search and Bargaining Effects from the Marginal Product.

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A Derivation of the wage equation

This section provides a detailed explanation on how equation (12) in the manuscript is derived. Wages are set according to the following Nash bargaining rule

$$\left[V_{jc}^{f}(n) - V_{jc}^{v}(n)\right] = \left[U_{jc}^{e}(n) - U_{jc}^{u}(n)\right]\kappa. \tag{1}$$

To obtain the wage equation one has to derive the match surplus for both the firm and the worker. Deriving the match surplus for the firm is straightforward and implies the following equation

$$V_{jc}^{f}(n) - V_{jc}^{v}(n) = \frac{VMPL_{jc}(n) - w_{jc}(n)}{\rho + \delta + \psi_c}. \tag{2}$$

Deriving the match surplus for the worker deserves more attention and is described in details in what follows.

Deriving the match surplus for the worker

First, the paper rewrites the discounted value of employment as a function of the discounted value of unemployment. An employed worker in job j, city c and firm with managerial ability n receives the wage $w_{jc}(n)$ and is laid off with probability δ in the next period. Therefore, the discounted value to a worker of being employed is

$$\rho U_{jc}^{e}(n) = w_{jc}(n) - \delta\left[U_{jc}^{e}(n) - U_{jc}^{u}(n)\right]. \tag{3}$$

Solving for the discounted value of employment one obtains

$$\rho U_{jc}^{e}(n) = \frac{1}{\rho + \delta} w_{jc}(n) + \frac{\delta}{\rho + \delta} U_{jc}^{u}(n). \tag{4}$$

Second, the discounted value of unemployment is rewritten as a function of averaged discounted values of employment. The probability of an unemployed worker previously employed in jc being matched to kc is $\psi_c \psi_{kc|j}$. The probability of him or her remaining unemployed in the coming period is $(1-\psi_c)$. Thus, the discounted value of being unemployed is given by

$$\rho U^u_{jc}(n) = \psi_c \sum_{k\in S} \psi_{kc|j} U^e_{kc} - \psi_c U^u_{jc}(n), \tag{5}$$

where U^e_{kc} is the average discounted utility of employment in job k and city c, averaged over all firms that operate in city c. Solving for the discounted value of unemployment, one obtains

$$\rho U^u_{jc}(n) = \frac{\psi_c}{\rho+\psi_c} \sum_{k\in S} \psi_{kc|j} U^e_{kc}, \tag{6}$$

where the summation term reflects the outside options of a worker in job j and city c, and is independent of a firm's managerial ability n.

Third, the paper obtains an expression for the discounted value of employment as a function of averaged discounted values of employment. Substituting (6) into (4), one can rewrite the discounted value of being employed as follows

$$U^e_{jc}(n) = \frac{1}{\rho+\delta} w_{jc}(n) + \frac{\delta\psi_c}{(\rho+\delta)(\rho+\psi_c)} \sum_{k\in S} \psi_{kc|j} U^e_{kc}. \tag{7}$$

Averaging equation (7) over all firms that operate in city c, one obtains that

$$U^e_{jc} = \frac{1}{\rho+\delta} w_{jc} + \frac{\delta\psi_c}{(\rho+\delta)(\rho+\psi_c)} \sum_{k\in S} \psi_{kc|j} U^e_{kc}, \tag{8}$$

where w_{jc} is the average wage in job j and city c, averaged over all firms that operate in city c.

Fourth, the paper solves for the weighted average of averaged discounted values of employment $\sum_{k\in S} \psi_{kc|j} U^e_{kc}$. Multiplying the average discounted value of employment given by equation (8) by the corresponding transition probabilities and summing over jobs, one obtains

$$\sum_{k\in S} \psi_{kc|j} U^e_{kc} = \frac{1}{\rho+\delta} \sum_{k\in S} \psi_{kc|j} w_{kc} + \frac{\delta\psi_c}{(\rho+\delta)(\rho+\psi_c)} \sum_{k\in S} \psi_{kc|j} \sum_{k'\in S} \psi_{k'c|k} U^e_{k'c}. \tag{9}$$

This paper assumes that if an unemployed worker is matched to a particular job, then he or she develops skills which are identical to those of his co-workers, which means that the measures of relative mobility satisfy $\chi_{k'c|k}\chi_{kc|j} = \chi_{k'c|j}$. Recalling that $\psi_{kc|j} = \chi_{kc|j}\eta_{kc}$, one can rewrite (9) as follows

$$\begin{aligned}\sum_{k\in S}\psi_{kc|j}U^e_{kc} &= \frac{1}{\rho+\delta}\sum_{k\in S}\psi_{kc|j}w_{kc}+\frac{\delta\psi_c}{(\rho+\delta)(\rho+\psi_c)}\sum_{k'\in S}\chi_{k'c|j}\eta_{k'c}U^e_{k'c}\underbrace{\sum_{k\in S}\eta_{kc}}_{=1}\\ &= \frac{1}{\rho+\delta}\sum_{k\in S}\psi_{kc|j}w_{kc}+\frac{\delta\psi_c}{(\rho+\delta)(\rho+\psi_c)}\sum_{k'\in S}\psi_{k'c|j}U^e_{k'c}. \qquad (10)\end{aligned}$$

Since the summation term on the right-hand side is jc-specific, then $\sum_{k'\in S}\psi_{k'c|j}U^e_{k'c}=\sum_{k\in S}\psi_{kc|j}U^e_{kc}$. Solving for the weighted average of averaged discounted values of employment, one obtains

$$\sum_{k\in S}\psi_{kc|j}U^e_{kc}=\frac{\rho+\psi_c}{\rho(\rho+\delta+\psi_c)}\sum_{k\in S}\psi_{kc|j}w_{kc}. \qquad (11)$$

Finally, the paper obtains the match surplus for the worker. To do so, equation (11) can be used to express both, the discounted value of being employed and unemployed as a function of wages. That is,

$$U^e_{jc}(n)=\frac{1}{\rho+\delta}w_{jc}(n)+\frac{\delta\psi_c}{\rho(\rho+\delta)(\rho+\delta+\psi_c)}\sum_{k\in S}\psi_{kc|j}w_{kc}, \qquad (12)$$

and

$$U^u_{jc}=\frac{\psi_c}{\rho(\rho+\delta+\psi_c)}\sum_{k\in S}\psi_{kc|j}w_{kc}. \qquad (13)$$

Combining equations (12) and (13), the match surplus for a worker is given by

$$U^e_{jc}(n)-U^u_{jc}=\frac{1}{\rho+\delta}w_{jc}(n)-\frac{\psi_c}{(\rho+\delta)(\rho+\delta+\psi_c)}\sum_{k\in S}\psi_{kc|j}w_{kc}. \qquad (14)$$

Deriving the wage equation from the Nash bargaining rule

Substituting the expressions (2) and (14) into (1), one obtains

$$\frac{VMPL_{jc}(n)-w_{jc}(n)}{\kappa(\rho+\delta+\phi_c)}=\left[\frac{1}{\rho+\delta}w_{jc}(n)-\frac{\psi_c}{(\rho+\delta)(\rho+\delta+\psi_c)}\sum_{k\in S}\psi_{kc|j}w_{kc}\right]. \qquad (15)$$

Solving for the wage in job j and city c offered in a firm with managerial ability n, equation (15) rewrites

$$w_{jc}(n) = \gamma_{1c} VMPL_{jc}(n) + \gamma_{2c} \sum_{k \in S} \psi_{kc|j} w_{kc}, \tag{16}$$

where $\gamma_{1c} = \frac{(\rho+\delta)}{(\rho+\delta)+\kappa(\rho+\delta+\phi_c)}$ and $\gamma_{2c} = \frac{\kappa(\rho+\delta+\phi_c)}{(\rho+\delta)+\kappa(\rho+\delta+\phi_c)} \frac{\psi_c}{(\rho+\delta+\psi_c)}$. Averaging (16) over all firms which operate in the market in city c, one obtains the following expression for the wage in job j and city c,

$$w_{jc} = \gamma_{1c} VMPL_{jc} + \gamma_{2c} \sum_{k \in S} \psi_{kc|j} w_{kc}, \tag{17}$$

where $VMPL_{jc}$ is the value of the marginal product of labour associated with job j and city c.

In order to avoid estimating a tautological relationship, the wage in job j and city c can be expressed as a function of wages in alternate jobs only. Using the fact that $\psi_{kc|j} = \mu$ if $k = j$, equation (17) can be rewritten as

$$w_{jc} = \gamma_{1c} VMPL_{jc} + \gamma_{2c} \mu w_{jc} + \gamma_{2c}(1-\mu) \sum_{k \in S \setminus \{j\}} \psi_{kc|j} w_{kc}, \tag{18}$$

and solving for w_{jc},

$$w_{jc} = \tilde{\gamma}_{1c} VMPL_{jc} + \tilde{\gamma}_{2c} \sum_{k \in S \setminus \{j\}} \psi_{kc|j} w_{kc}, \tag{19}$$

where $\tilde{\gamma}_{1c} = \frac{\gamma_{1c}}{1-\gamma_{2c}\mu}$ and $\tilde{\gamma}_{2c} = \frac{\gamma_{2c}(1-\mu)}{1-\gamma_{2c}\mu}$. The parameters $\tilde{\gamma}_{1c}$ and $\tilde{\gamma}_{2c}$ are functions of the city-specific employment rate, as captured by γ_{1c} and γ_{2c}.

B Log linear approximation of the wage equation

In order to make the relationship between job-city wages, a city's employment rate and the components of the value of the marginal product explicit, the paper performs a first-order linear approximation of equation (13) in the manuscript.

Let $\mathbf{e} = \left[p_{ic}, f_{ic}, \theta_{qic}, \ln N_{qic}, \sum_{k \in S \setminus \{qi\}} \psi_{kc|qi} w_{kc}, ER_c \right]$ be the vector of variables affecting the wage equation and with respect to which the log linear approximation is taken. Making this relationship explicit and taking logs on both sides of equation (13) in the manuscript, on obtains

$$\ln\left[w_{qic}(\mathbf{e})\right] = \ln\left[\tilde{\gamma}_{1c}(\mathbf{e})VMPL_{qic}(\mathbf{e}) + \tilde{\gamma}_{2c}(\mathbf{e})\sum_{k\in S\setminus\{qi\}}\psi_{kc|qi}(\mathbf{e})w_{kc}(\mathbf{e})\right], \tag{20}$$

where $VMPL_{qic}(\mathbf{e}) = f_{ic}(\mathbf{e})g_{qic}(\mathbf{e})h_{qic}(\mathbf{e})$. The linear approximation is expanded around the point where cities have identical employment rates ($ER_c = ER$) and where employment is uniformly distributed across jobs ($\eta_{qic} = \frac{1}{QI}$). This occurs at the point $\mathbf{e_0} = [p, f, \theta, \ln N, w, ER]$, when both the value of the marginal product of labour and mobility costs are constant across jobs and cities (i.e. when $VMPL_{qic} = VMPL = pfgh$ and $\varphi_{k|qi} = \varphi$). The approximation is given by

$$\ln\left[w_{qic}(\mathbf{e})\right] \approx \ln\left[w_{qic}(\mathbf{e_0})\right] + \bigtriangledown\ln\left[w_{qic}(\mathbf{e_0})\right](\mathbf{e} - \mathbf{e_0}). \tag{21}$$

In what follows, the paper derives both components of the right-hand side of (21) separately.

Deriving $w_{qic}(\mathbf{e_0})$:

$$\ln\left[w_{qic}(\mathbf{e_0})\right] = \ln\left[\tilde{\gamma}_{1c}(\mathbf{e_0})VMPL_{qic}(\mathbf{e_0}) + \tilde{\gamma}_{2c}(\mathbf{e_0})\sum_{k\in S\setminus\{qi\}}\psi_{kc|qi}(\mathbf{e_0})w_{kc}(\mathbf{e_0})\right]$$

Since $ER_c(\mathbf{e_0}) = ER$, then $\tilde{\gamma}_{1c}(\mathbf{e_0}) = \tilde{\gamma}_1$ and $\tilde{\gamma}_{2c}(\mathbf{e_0}) = \tilde{\gamma}_2$. Moreover, since mobility costs are constant across jobs and cities, then $\psi_{kc|qi}(\mathbf{e_0}) = \frac{1}{QI-1}$ and $\sum_{k\in S\setminus\{qi\}}\psi_{kc|qi}(\mathbf{e_0})w_{kc}(\mathbf{e_0}) = w$. Therefore, equation (22) can be rewritten as

$$\ln\left[w_{qic}(\mathbf{e_0})\right] = \ln\left[\tilde{\gamma}_1 VMPL + \tilde{\gamma}_2 w\right]. \tag{22}$$

Deriving $\bigtriangledown w_{qic}(\mathbf{e_0})(\mathbf{e}-\mathbf{e_0})$:

$$\bigtriangledown \ln\left[w_{qic}(\mathbf{e_0})\right](\mathbf{e}-\mathbf{e_0}) = \frac{1}{w_{qic}(\mathbf{e_0})} \begin{pmatrix} \tilde{\gamma}_{1c} MPL_{qic} \\ \tilde{\gamma}_{1c} p_{ic} g_{qic} h_{qic} \\ \tilde{\gamma}_{1c} p_{ic} \left(\frac{\partial MPL_{qic}}{\partial \theta_{qic}}\right) \\ \tilde{\gamma}_{1c} p_{ic} \left(\frac{\partial MPL_{qic}}{\partial \ln N_{qic}}\right) \\ \tilde{\gamma}_{2c} \\ \left(\frac{\partial \tilde{\gamma}_{1c}}{\partial ER_c}\right) VMPL_{qic} + \left(\frac{\partial \tilde{\gamma}_{2c}}{\partial ER_c}\right) \sum_{k\in S\backslash\{qi\}} \psi_{kc|qi} w_{kc} \end{pmatrix}' \Bigg|_{(\mathbf{e_0})} \cdot (\mathbf{e}-\mathbf{e_0}), \tag{23}$$

where $\frac{\partial MPL_{qic}}{\partial \theta_{qic}} = \left[\left(\frac{\partial f_{ic}}{\partial \theta_{qic}}\right) g_{qic} h_{qic} + f_{ic}\left(\frac{\partial g_{qic}}{\partial \theta_{qic}}\right) h_{qic}\right]$ and $\frac{\partial MPL_{qic}}{\partial \ln N_{qic}} = \left[\left(\frac{\partial f_{ic}}{\partial \ln N_{qic}}\right) g_{qic} h_{qic} + f_{ic} g_{qic}\left(\frac{\partial h_{qic}}{\partial \ln N_{qic}}\right)\right]$. Evaluating the vector of derivatives at the point $\mathbf{e_0} = [p, f, \theta, \ln N, w, ER]$ and recalling that $\tilde{\gamma}_{1c}(\mathbf{e_0}) = \tilde{\gamma}_1$ and $\tilde{\gamma}_{2c}(\mathbf{e_0}) = \tilde{\gamma}_2$, one obtains

$$\bigtriangledown \ln\left[w_{qic}(\mathbf{e_0})\right](\mathbf{e}-\mathbf{e_0}) = \frac{1}{\gamma_1 VMPL + \gamma_2 w} \begin{pmatrix} \tilde{\gamma}_1 fgh \\ \tilde{\gamma}_1 pgh \\ \tilde{\gamma}_1 p\left[\left(\frac{\partial f}{\partial \theta}\right) gh + f\left(\frac{\partial g}{\partial \theta}\right) h\right] \\ \tilde{\gamma}_1 p\left[\left(\frac{\partial f}{\partial \ln N}\right) gh + fg\left(\frac{\partial h}{\partial \ln N}\right)\right] \\ \tilde{\gamma}_2 \\ \left(\frac{\partial \tilde{\gamma}_1}{\partial ER}\right) fgh + \left(\frac{\partial \tilde{\gamma}_2}{\partial ER}\right) w \end{pmatrix}' \begin{pmatrix} p_{ic} - p \\ f_{ic} - f \\ \theta_{qic} - \theta \\ \ln N_{qic} - \ln N \\ \sum_{k\in S\backslash\{qi\}} \psi_{kc|qi} w_{kc} - w \\ ER_c - ER \end{pmatrix}. \tag{24}$$

Obtaining the linear approximation:

Combining (22) and (24), one obtains

$$\ln w_{qic} = \alpha_0 + \tilde{\gamma}_1 \alpha_1 p_{ic} + \tilde{\gamma}_1 \alpha_2 f_{ic} + \tilde{\gamma}_1 \alpha_3 \theta_{qic} + \tilde{\gamma}_1 \alpha_4 \ln N_{qic} + \tilde{\gamma}_2 \sum_{k\in S\backslash\{qi\}} \psi_{kc|qi} w_{kc} + \alpha_5 ER_c, \tag{25}$$

where α_0-α_5 are constant terms obtained from the linear approximation. Specifically,

$$\begin{aligned}
\alpha_1 &= \frac{fgh}{\gamma_1 VMPL + \gamma_2 w} \\
\alpha_2 &= \frac{pgh}{\gamma_1 VMPL + \gamma_2 w} \\
\alpha_3 &= \frac{p}{\gamma_1 VMPL + \gamma_2 w}\left[\left(\frac{\partial f}{\partial \theta}\right) gh + f\left(\frac{\partial g}{\partial \theta}\right) h\right] \\
\alpha_4 &= \frac{p}{\gamma_1 VMPL + \gamma_2 w}\left[\left(\frac{\partial f}{\partial \ln N}\right) gh + fg\left(\frac{\partial h}{\partial \ln N}\right)\right] \\
\alpha_5 &= \frac{1}{\gamma_1 VMPL + \gamma_2 w}\left[\left(\frac{\partial \tilde{\gamma}_1}{\partial ER}\right) fgh + \left(\frac{\partial \tilde{\gamma}_2}{\partial ER}\right) w\right]
\end{aligned}$$

and

$$\alpha_0 = \ln\left[\gamma_1 pfgh + \gamma_2 w\right] - \frac{\gamma_1 \alpha_1 p + \tilde{\gamma}_2 \alpha_2 f + \tilde{\gamma}_1 \alpha_3 \theta + \tilde{\gamma}_1 \alpha_4 \ln N + \tilde{\gamma}_2 w + \alpha_5 ER}{\gamma_1 VMPL + \gamma_2 w}.$$

C Implications of workers' mobility across cities

This section discusses the implications of allowing for labour mobility across cities. Such an extension modifies the value of being unemployed by expanding the set of a worker's outside options. Whether modeled as random or directed search, this extension generates an additional occupation-industry-specific term. This term reflects the option of searching for a job across all cities and is captured by job time-varying dummies in the empirical section. Therefore, including labour mobility across cities has no impact on the estimate of interest.

To see why, consider first random search. An unemployed worker has probability $(1-\Gamma)$ of getting a random draw in his city; probability Γ of getting a draw in *any* city. In this case, the value of being unemployed in job j and city c can be expressed as

$$\rho U^u_{jc} = (1-\Gamma)\psi_c \sum_{k\in S} \psi_{kc|j} U^e_{kc} + \underbrace{\Gamma \sum_{c'=1}^{C} \psi_{c'} \sum_{k\in S} \psi_{kc'|j} U^e_{kc'}}_{\text{j-specific term}} - \psi_c U^u_{jc}, \tag{26}$$

where $\Gamma \sum_{c'=1}^{C} \psi_{c'} \sum_{k\in S} \psi_{kc'|j} U^e_{kc'}$ captures the option to search across cities. Since job-specific skill transferability $\varphi_{k|j}$ is measured at the national level, workers' mobility across cities will be captured by a job-specific term.

Consider now directed search. An unemployed worker has probability Λ of being able to change geographic location and choosing to move to the city which maximises his value of being employed. Then,

$$\rho U^u_{jc} = (1-\Lambda)\psi_c \sum_{k\in S} \psi_{kc|j} U^e_{kc} + \underbrace{\Lambda \max_{c'} \left[\psi_{c'} \sum_{k\in S} \psi_{kc'|j} U^e_{kc'} \right]}_{\text{j-specific term}} - \psi_c U^u_{jc}, \tag{27}$$

where $\max_{c'} \left[\psi_{c'} \sum_{k\in S} \psi_{kc'|j} U^e_{kc'} \right]$ results from a directed search across cities. As for a given job there is only one location which maximises the value of being unemployed, workers' mobility across cities can be captured by an occupation-industry-specific term.

D Implications of directed search across occupations

As for the case of directed search across cities, directed search across occupations modifies the value of being unemployed by expanding the set of a worker's outside options. Assume that an unemployed worker has probability Λ' of being able to direct his search towards the occupation that maximises his value of being employed. Then, the vaule of being unemployed in job j and city c is given by

$$\rho U^u_{jc} = (1-\Lambda')\psi_c \sum_{k\in S} \psi_{kc|j} U^e_{kc} + \underbrace{\Lambda' \max_{q'} \left[\sum_{c'=1}^{C} \psi_{c'} \sum_{k\in S} \psi_{kc'|j} U^e_{kc'} \right]}_{\text{j-specific term}} - \psi_c U^u_{jc}, \tag{28}$$

where the term $\max_{q'} \left[\sum_{c'=1}^{C} \psi_{c'} \sum_{k\in S} \psi_{kc'|j} U^e_{kc'} \right]$ results from a directed search across occupations. Since the occupation that maximises a worker's utility of employment is similar for all workers of a particular job-type, implications of directed search across occupations will be captured by job time-varying dummies in the empirical section.

E Examining consistency

Writing the transition probability as a function of comparative advantages:

In order to examine consistency, it is helpful to first explicitly express the transition probability as a function of comparative advantages. To achieve this goal, one can rewrite ε_{qic} as the sum of a term common to all jobs of the same city ε_c, and another comparative advantage component, $\upsilon^{\varepsilon}_{qic}$, where by definition $\sum_{q=1}^{Q}\sum_{i=1}^{I}\upsilon^{\varepsilon}_{qic} = 0$.[1] By the same token, define $\Omega_{ic} = \Omega_c + \upsilon^{\Omega}_{ic}$, where $\sum_{i=1}^{I}\upsilon^{\Omega}_{ic} = 0$. Using this formulation, one can rewrite equation (23) of the manuscript as

$$\begin{aligned}\psi_{q'i'c|qi} &\approx \frac{1}{QI-1} + \pi_1\left[\upsilon^{\Omega}_{i'c} + \frac{1}{QI-1}\upsilon^{\Omega}_{ic}\right] + \pi_2\left[\upsilon^{\varepsilon}_{q'i'c} + \frac{1}{QI-1}\upsilon^{\varepsilon}_{qic}\right] \\ &+ \pi_3\left[\varphi_{q'i'|qi} - \frac{1}{QI-1}(1-\varphi_{qi|qi})\right]. \qquad (29)\end{aligned}$$

A similar expression can be obtained for the predicted transition probability. However, instead of being a function of current components, $\hat{\psi}_{q'i'c\tau|qi}$ depends on past sources of comparative advantages, i.e.

$$\begin{aligned}\hat{\psi}_{q'i'c\tau|qi} &\approx \frac{1}{QI-1} + \pi_1\left[\upsilon^{\Omega}_{i'c(\tau-1)} + \frac{1}{QI-1}\upsilon^{\Omega}_{ic(\tau-1)}\right] + \pi_2\left[\upsilon^{\varepsilon}_{q'i'c(\tau-1)} + \frac{1}{QI-1}\upsilon^{\varepsilon}_{qic(\tau-1)}\right] \\ &+ \pi_3\left[\varphi_{q'i'|qi} - \frac{1}{QI-1}(1-\varphi_{qi|qi})\right], \qquad (30)\end{aligned}$$

where τ is the time subscript. Equation (30) has been obtained using the fact that predicted employment shares can be written as

$$\hat{\eta}_{qic\tau} = \eta_{qic(\tau-1)}\frac{g_{qi\tau}}{\sum\limits_{q'=1}^{Q}\sum\limits_{i'=1}^{I}\eta_{q'i'c(\tau-1)}g_{q'i'\tau}},$$

where $g_{qi\tau} = \frac{N_{qi\tau}}{N_{qi(\tau-1)}}$.

[1] Note that the comparative advantage of city c for job qi is given by:

$$\begin{aligned}\left(\theta_{qic} - \sum_c \theta_{qic}\right) - \left(\sum_{q'=1}^{Q}\sum_{i'=1}^{I}\left[\theta_{q'i'c} - \sum_c \theta_{q'i'c}\right]\right) &= \varepsilon_{qic} - \varepsilon_c \\ &= \upsilon^{\varepsilon}_{qic}.\end{aligned}$$

Evaluating the validity of the instruments:

In what follows, the paper examines the validity of the first set of instruments $IV_{1qic\tau}$ and $IV_{2qic\tau}$. Examining consistency for the second set of instruments is analogous. This first set of instruments is given by

$$IV_{1qic\tau} = \sum_{k \in S \backslash \{qi\}} \hat{\psi}_{kc\tau|qi} \Delta \nu_{k\tau} \quad \text{and} \quad IV_{2qic\tau} = \sum_{k \in S \backslash \{qi\}} \nu_{k(\tau-1)} \Delta \hat{\psi}_{kc\tau|qi}.$$

$IV_{1qic\tau}$ is uncorrelated with the error term if [2]

$$\frac{1}{1-\mu} \tilde{\gamma}_1 \alpha_3 \lim_{Q,I,C \to \infty} \sum_{c=1}^{C} \sum_{q=1}^{Q} \sum_{i=1}^{I} \left(\sum_{k \in S} \hat{\psi}_{kc\tau|qi} \Delta \nu_{k\tau} - \mu \Delta \nu_{qi\tau} \right) \Delta \varepsilon_{qic\tau} = 0. \tag{31}$$

Since the wage premia do not vary across cities, condition (31) can be rearranged as follows

$$\lim_{Q,I,C \to \infty} \left(\sum_{k \in S} \Delta \nu_{k\tau} \cdot \sum_{c=1}^{C} \sum_{q=1}^{Q} \sum_{i=1}^{I} \hat{\psi}_{kc\tau|qi} \Delta \varepsilon_{qic\tau} - \mu \sum_{q=1}^{Q} \sum_{i=1}^{I} \Delta \nu_{qi\tau} \sum_{c=1}^{C} \Delta \varepsilon_{qic\tau} \right) = 0. \tag{32}$$

where the second term on the left-hand side is zero because $\sum_{c=1}^{C} \varepsilon_{qic\tau} = 0$. Allowing $C \to \infty$ first, condition (32) is satisfied if

$$\lim_{C \to \infty} \sum_{c=1}^{C} \sum_{q=1}^{Q} \sum_{i=1}^{I} \hat{\psi}_{kc\tau|qi} \Delta \varepsilon_{qic\tau} = 0. \tag{33}$$

Hence, the validity of $IV_{1qic\tau}$ hinges on the exogeneity of the prediction $\hat{\psi}_{kc|qi}$ with respect to shocks to $\varepsilon_{qic\tau}$. Using (30) together with the fact that $\sum_{k \in S} \upsilon^{\varepsilon}_{kc} = 0$, $\sum_{i=1}^{I} \upsilon^{\Omega}_{ic} = 0$ and $\sum_{c=1}^{C} \varepsilon_{qic\tau} = 0$, condition (33) rewrites

$$\lim_{C \to \infty} \sum_{c=1}^{C} \sum_{q=1}^{Q} \sum_{i=1}^{I} \hat{\psi}_{kc\tau|qi} \Delta \varepsilon_{qic\tau} \quad = \quad \sum_{q=1}^{Q} \sum_{i=1}^{I} \lim_{C \to \infty} \sum_{c=1}^{C} \left[\pi_1 \frac{1}{QI-1} \upsilon^{\Omega}_{ic(\tau-1)} \Delta \varepsilon_{qic\tau} + \pi_2 \frac{1}{QI-1} \upsilon^{\varepsilon}_{qic(\tau-1)} \Delta \varepsilon_{qic\tau} \right].$$

Therefore, $IV_{1qic\tau}$ is exogeneous if $E(\upsilon^{\Omega}_{ic(\tau-1)} \Delta \varepsilon_{qic\tau}) = 0$ and $E(\upsilon^{\varepsilon}_{qic(\tau-1)} \Delta \varepsilon_{qic\tau}) = 0$ and $E(\Delta \upsilon^{\varepsilon}_{qic\tau}) =$

[2]Note that in writing this condition, the paper uses the fact that $\sum_{k \in S} \psi_{kc|qi} \nu_k = \mu \nu_{qi} + (1-\mu) \sum_{k \in S \backslash \{qi\}} \psi_{kc|qi} \nu_k$ and that $\Delta \tilde{\xi}_{qic\tau} = \tilde{\gamma}_1 \alpha_3 \Delta \varepsilon_{qic\tau}$.

0, i.e. if shocks to the source of comparative advantages $\Delta\varepsilon^{\varepsilon}_{qic\tau}$ are independent of *past* comparative advantages $\upsilon^{\Omega}_{ic\tau}$, $\upsilon^{\varepsilon}_{qic\tau}$.

Similarly, $IV_{2qic\tau}$ is a valid instrument if it satisfies

$$\frac{1}{1-\mu}\tilde{\gamma}_1\alpha_3 \lim_{Q,I,C\to\infty}\sum_{c=1}^{C}\sum_{q=1}^{Q}\sum_{i=1}^{I}\left(\sum_{k\in S}\nu_{k(\tau-1)}\Delta\hat{\psi}_{kc\tau|qi}-\nu_{qi(\tau-1)}\Delta\mu\right)\Delta\varepsilon_{qic\tau}=0. \tag{34}$$

As for $IV_{1qic\tau}$, this limiting argument can be developed to obtain the following expression

$$\lim_{C\to\infty}\sum_{c=1}^{C}\sum_{q=1}^{Q}\sum_{i=1}^{I}\Delta\hat{\psi}_{kc\tau|qi}\Delta\varepsilon_{qic\tau} = \sum_{q=1}^{Q}\sum_{i=1}^{I}\lim_{C\to\infty}\sum_{c=1}^{C}\left[\pi_1\frac{1}{QI-1}\Delta\upsilon^{\Omega}_{ic(\tau-1)}\Delta\varepsilon_{qic\tau}+\pi_2\frac{1}{QI-1}\Delta\upsilon^{\varepsilon}_{qic(\tau-1)}\Delta\varepsilon_{qic\tau}\right].$$

Therefore, $IV_{2qic\tau}$ is exogeneous if $E(\Delta\upsilon^{\Omega}_{ic(\tau-1)}\Delta\varepsilon_{qic\tau})=0$ and $E(\Delta\upsilon^{\varepsilon}_{qic(\tau-1)}\Delta\varepsilon_{qic\tau})=0$, i.e. if shocks to the source of comparative advantages $\Delta\varepsilon^{\varepsilon}_{qic\tau}$ are independent of *past* changes in comparative advantages.

F Definition of cities

Cities are constructed in accordance with the definition of labour markets proposed by Kropp and Schwengler (2011; KS labour markets henceforth).[3] According to their definition, Western Germany comprises 38 labour markets and 9 regions. The constraint of 20 individuals per cell requires merging KS labour markets since without any further aggregation, some labour markets would represent less than 1500 individuals per year, i.e. on average, less than 6 individuals per cell if one would work with 250 occupation-industry cells. In order to obtain 5000 individuals per city-year, KS labour markets are merged in two steps. The first one aggregates KS labour markets at a higher digit in conformity with the official classification. The second one aggregates zones with an insufficiant number of individuals to their neighbours. To maintain geographical coherence, this study makes sure that the aggregated labour markets belong to the same region. It follows that the original 38 KS labour markets are merged into 19 geographical areas ('cities'), of which 10 correspond to KS labour markets and 9 are aggregates. Table 1 describes these steps.

[3] Online material including Kropp and Schwengler's (2011) correspondence table between districts, labour markets and regions can be downloaded at http://www.iab.de/389/section.aspx/Publikation/k110222301

Table 1: Aggregation of labour markets

Labour markets as defined in Kropp and Schwengler				'Cities'	Regions
N	38 official	25 official	bridges	19 merged	9 official
Hamburg	2000000	20	20	2	2
Braunschweig/Wolfsburg	3101000	31	31	31	3
Göttingen	3152012	31	31	31	3
Hannover	3241001	32	32	32	3
Oldenburg(O.)	3403000	34	34	34	3
Osnabrck	3404000	34	34	34	3
Bremen	4011000	40	40	4	4
Düsseldorf-Ruhr	5113000	51	51	51	5
Aachen	5313000	53	53	53	5
Köln	5315000	53	53	53	5
Münster	5515000	55	55	55	5
Bielefeld/Paderborn	5711000	57	57	57	5
Siegen	5970040	59	merged with 53	53	5
Frankfurt a.M.	6412000	64	64	6	6
Kassel	6611000	66	merged with 64	6	6
Koblenz	7111000	71	71	7	7
Trier	7211000	72	merged with 71	7	7
Stuttgart	8111000	81	81	81	8
Karlsruhe	8212000	82	82	82	8
Mannheim	8222000	82	82	82	8
Freiburg i.Br.	8311000	83	83	83	8
Offenburg	8317096	83	83	83	8
Villingen-Schwenningen	8326074	83	83	83	8
Konstanz	8335075	83	83	83	8
Lörrach	8336050	83	83	83	8
Ulm	8421000	84	84	84	8
Ravensburg	8436064	84	84	84	8
München	9162000	91	91	91	9
Passau	9262000	92	92	92	9
Regensburg	9362000	93	merged with 92	92	9
Weiden i.d.OPf.	9363000	93	merged with 92	92	9
Bayreuth	9462000	94	merged with 95	95	9
Coburg	9463000	94	merged with 95	95	9
Hof	9464000	94	merged with 95	95	9
Nürnberg	9564000	95	95	95	9
Schweinfurt	9662000	96	merged with 95	95	9
Würzburg	9663000	96	merged with 95	95	9
Saarbrücken	10041100	100	100	10	10

G Industrial classification into 16 categories

Table 2: Industrial classification into 16 categories.

Primary sector
Industry 1
Agriculture, hunting, forestry and fishing
Mining and quarrying
Electricity, gas and water supply

Secundary sector
Industry 2
Wood and products of wood and cork
Pulp, paper, paper products, printing and publishing
Chemical, rubber, plastics and fuel products
Basic metals and fabricated metal products
Other non-metallic mineral products

Industry 3
Machinery and equipment (nec)
Motor vehicles, trailers and semi-trailers

Industry 4
Electrical and optical equipment
Other transport equipment

Industry 5
Textiles and textile products
Leather, leather products and footwear
Other non-metallic mineral products
Manufacturing n.e.c.

Industry 6
Food products, beverages and tobacco

Industry 7
Construction trades

Industry 8
Finishing trades

Tertiary sector
Industry 9
Wholesale, trade and commission excl. motor vehicles

Industry 10
Sale of automotive fuel
Retail trade excl. motor vehicles - repair of household goods

Industry 11
Transport storage and communications

Industry 12
Finance, insurance, real estate and business services

Industry 13
Hotels and restaurants
Recreational, cultural and sporting activities
Other service activities
Private households with employed persons

Industry 14
Education
Health and social work

Industry 15
Sewage and refuse disposal, sanitation and similar activities
Activities of membership organizations (nec)

Industry 16
Public admin. and defense - compulsory social security
Extra-territorial organizations and bodies

Source: The IAB anonymised sample.

H Occupational classification into 32 categories

Table 3: Occupational classification into 32 categories.

Agricultural	
Occupation 106:	Farming, forestry, gardening, fishing
Mining and quarrywork	
Occupation 709:	Mining and quarrywork
Manufacturing	
Occupation 1011:	Stone, jewelery, brickwork
Occupation 1213:	Glass and ceramics
Occupation 1415:	Chemicals, plastics and rubber
Occupation 1617:	Paper and printing
Occupation 18:	Woodwork
Occupation 1924:	Metalworkers, primary product
Occupation 2530:	Skilled metal work and related
Occupation 31:	Electrical
Occupation 32:	Metal and assembly / installation
Occupation 3336:	Textiles
Occupation 37:	Leather goods
Occupation 3943:	Food, drink and tobacco
Occupation 4447:	Construction
Occupation 4849:	Building
Occupation 50:	Carpenters
Occupation 51:	Painters
Occupation 52:	Goods sorters, packagers
Occupation 53:	Assistants
Occupation 54:	Machine operators
Technicians	
Occupation 6061:	Technicians - engineers and related
Occupation 6263:	Technicians - manufacturing and science
Services and professionals	
Occupation 68:	Buying and selling
Occupation 6970:	Banking, insurance, agents
Occupation 8283:	Arts, creative and recreational
Occupation 9093:	Other services, personal and leisure services
Occupation 7174:	Travel and transport
Occupation 7578:	Administration and bureaucracy
Occupation 7981:	Public order, safety and security
Occupation 8485:	Health services
Occupation 8689:	Teaching and social employment

Note: Occupations in the IAB anonymised sample are classified into 32 broader categories according to the 1975 German classification of occupations.

I Occupation-industry mix

An important step of the data work consists in defining the aggregation level of occupations, industries and cities. To ensure the precision of the measures reflecting wage premia, employment shares and employment transitions, this paper requires that each occupation-industry-city cell contains at least 20 employed individuals every year. Finally, an occupation-industry cell is retained if it is present over the years 1977-2001 and if it is observed in at least 5 cities. 135 occupation-industry cells meet these two criteria. Table 4 shows which occupation-industry mix is retained for this study. The table also informs on the representation of occupations within industries and across cities. The figures indicate the number of cities in which an occupation-industry cell (which satisfies the aforementioned criteria) is observed.

Table 4: Occupation-industry mix

Occupation/Industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
106	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1011	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1213	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
1415	0	18	0	9	18	0	0	0	0	0	0	0	0	0	0	0
1617	0	16	0	0	17	0	0	0	0	0	0	0	0	0	0	0
18	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0
1924	0	17	19	19	0	0	0	0	0	0	0	0	0	0	0	0
2530	9	19	19	19	17	0	8	19	10	16	10	5	0	0	0	9
31	13	7	13	19	0	0	0	19	0	6	9	0	0	0	0	0
32	0	0	17	18	0	0	0	0	0	0	0	0	0	0	0	0
3336	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
3943	0	0	0	0	0	19	0	0	0	0	0	0	19	14	0	0
4447	0	7	0	0	0	0	19	0	0	0	0	0	0	0	0	14
4849	0	0	0	0	6	0	11	10	0	0	0	0	0	0	0	0
50	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0
51	0	0	7	5	0	0	0	18	0	0	0	0	0	0	0	0
52	0	8	10	12	13	12	0	0	7	7	0	0	0	0	0	0
53	0	0	9	0	7	0	0	0	0	0	0	0	0	0	0	0
54	5	6	0	0	0	0	12	0	0	0	0	0	0	0	0	0
6061	0	6	11	12	0	0	7	0	0	0	0	10	0	6	0	9
6263	8	16	16	19	13	0	0	5	8	0	0	13	0	7	0	12
68	0	9	11	10	10	19	0	0	19	19	0	0	11	0	0	0
6970	0	0	0	0	0	0	0	0	0	0	11	19	0	0	0	0
8283	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
9093	0	0	0	0	0	0	0	0	0	7	0	13	19	19	12	19
7174	0	19	16	12	14	14	8	0	19	18	19	6	5	0	5	19
7578	15	19	19	19	19	17	18	12	19	19	18	19	14	19	18	19
7981	0	0	0	0	0	0	0	0	0	0	0	7	0	8	5	13
8485	0	0	0	0	0	0	0	0	0	6	0	0	0	19	19	0
8689	0	0	0	0	0	0	0	0	0	0	0	0	0	19	14	11

J Industrial and occupational employment shares

Table 5 shows summary statistics of yearly local industrial employment shares (i.e. of $\eta_{ict} = \frac{N_{ict}}{N_{ct}}$, where t is the time subscript), computed over the entire sample. The rest of the table computes the summary statistics of local industrial employment shares (i.e. of $\eta_{ic} = \frac{N_{ic}}{N_c}$) by industry. Table 6 presents the occupational counterpart of Table 5. Both tables suggest substantial variation in the industrial and occupational composition of employment across cities.

Table 5: Industrial employment shares

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Overall	0.063	0.035	0.006	0.250	7904
Primary sector					
Primary sector	0.017	0.007	0.007	0.034	19
Secondary sector					
Wood, chemicals, basic metals	0.066	0.028	0.029	0.130	19
Machinery, motor vehicles	0.109	0.045	0.056	0.228	19
Electrical	0.091	0.032	0.050	0.166	19
Texiles, leather	0.075	0.041	0.029	0.172	19
Food, beverages, tobacco	0.036	0.013	0.024	0.068	19
Construction trades	0.054	0.013	0.042	0.093	19
Finishing trades	0.028	0.004	0.019	0.034	19
Tertiary sector					
Wholesale	0.055	0.010	0.035	0.075	19
Retail trade	0.084	0.012	0.062	0.107	19
Transport and communications	0.044	0.017	0.030	0.095	19
Finance, insurance, real estate	0.092	0.022	0.059	0.130	19
Restauration, recreational	0.043	0.008	0.033	0.062	19
Education, health, social	0.104	0.014	0.074	0.127	19
Sewage, sanitation	0.039	0.008	0.024	0.052	19
Public administration	0.064	0.014	0.035	0.086	19

Table 6: Occupational employment shares

Variable	Mean	Std. Dev.	Min.	Max.	N
Overall	5.7	2.0	1.6	17.2	18315
Agricultural					
Farming, forestry, gardening, fishing	0.009	0.002	0.005	0.016	19
Manufacturing					
Stone, jewelery, brickwork	0.004	0.003	0.002	0.01 0	10
Glass, ceramics	0.008	0.009	0.001	0.029	9
Chemicals, plastics, rubber	0.021	0.008	0.009	0.043	18
Paper, printing	0.013	0.004	0.007	0.022	17
Woodwork	0.005	0.005	0.001	0.015	6
Metalworkers, primary product	0.034	0.013	0.015	0.064	19
Skilled metal work	0.089	0.01	0.073	0.106	19
Electrical	0.025	0.005	0.015	0.032	19
Metal assembly, installation	0.026	0.010	0.007	0.047	18
Textiles	0.016	0.011	0.003	0.038	14
Leather goods	0.008	0.011	0.002	0.030	6
Food, drink, tobacco	0.028	0.008	0.018	0.053	19
Construction	0.045	0.014	0.029	0.087	19
Building	0.007	0.002	0.003	0.013	14
Carpenters	0.011	0.006	0.005	0.026	19
Painters	0.008	0.002	0.005	0.016	18
Goods sorters, packagers	0.014	0.006	0.006	0.028	18
Assistants	0.009	0.008	0.002	0.031	12
Machine operators	0.006	0.002	0.003	0.010	13
Technicians					
Eengineers	0.018	0.009	0.003	0.030	15
Manufacturing, science	0.037	0.012	0.016	0.058	19
Services, professionals					
Buying, selling	0.087	0.008	0.076	0.107	19
Banking, insurance, agents	0.042	0.008	0.030	0.057	19
Arts, creative, recreational	0.004	0.001	0.002	0.006	10
Other services, personal, leisure services					
Travel, transport	0.076	0.008	0.065	0.098	19
Administration, bureaucracy	0.223	0.015	0.196	0.243	19
Public order, safety, security	0.007	0.003	0.003	0.012	13
Health services	0.065	0.009	0.048	0.082	19
Teaching, social employment	0.038	0.006	0.027	0.052	19

K Additional results

K-1 Occupation-city time-varying dummies

Table 7 presents a specification that includes occupation-city time-varying dummies ($d_{qc\tau}$). Such a specification does not arise naturally within the framework of the paper, yet it is interesting to see how far the identification can go. When occupation-city-time dummies are included, the triple difference estimation focuses on periodical changes in wages across industries in the same occupation and city, which means for instance comparing wage differentials in the manufacturing sector with those in the tertiary sector for secretaries in city A. To allow for identification, such a comparison requires that there be sufficient variation in observed mobility of secretaries across industries within city A. The IV estimates are positive and similar to those of the baseline but quite imprecisely measured. This result is not too surprising as one would expect variation across sectoral switches to be much less pronounced than occupational movements.

Table 7: Occupation-city time-varying dummies.

Dependent variable	Δ log wages$_{qic\tau}$		
	(1) OLS	**(2)** IV	**(3)** IV
Δ Outside options$_{qic\tau}$:			
$\Delta \sum_{k\in S\setminus\{qi\}} \psi_{kc\tau\|qi} w_{kc\tau}$	−0.279***	0.723	0.569*
	(0.102)	(0.440)	(0.332)
$\Delta\ d_{qi\tau}$	yes	yes	yes
$\Delta\ d_{qc\tau}$	yes	yes	yes
Instrument Set		set I	set II
F-stat.		13.60	35.61
Over-id. p-val.		0.690	0.518
AP p-val.		0.00	0.00
Observations	6449	6449	6449

Notes: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-2 Unobserved abilities

The baseline estimates rely on the assumption that the sample is a random draw of the population. However, in practice workers tend to self-select into cities (Dahl, 2002) and occupations (Gibbons et al., 2005; Groes et al., 2009) for unobserved earnings-related reasons. The baseline specification may provide a biased estimate of search and bargaining mechanisms if the structure of employment within cities correlates with unobserved abilities.

To deal with that issue, this section exploits the traceability of individuals in the database and estimates adjusted wages using workers who stay within the same firm, occupation, industry and city from one year to the next (the 'stayers' henceforth). Specifically, this section pools the years 1976 to 2001 together and regresses yearly changes in stayers' wages on an entire set of job-city-specific time-varying dummies. The estimates on the dummies correspond to yearly changes in job-city-specific wages, purged of workers and firms' unobserved fixed characteristics. These estimates are then used to construct both the dependent variable and the national wage premia in a similar way to the baseline. Results are shown in Table 8.

Columns (1)-(3) correspond to the baseline specification, estimated using changes in wages for stayers. As for the previous specifications, diagnostic tests are satisfactory at any conventional level. The IV estimates do not statistically differ from the baseline estimates and are comparable across sets of IVs, which again supports the identifying assumption. Columns (4)-(6) introduce industry-city-time dummies. Relative to the preceding three columns, this exercise is particularly demanding as the estimate is now identifed by comparing wages along an additional dimension, i.e. by focusing on periodical changes in stayers' wages across occupations of the same industry and city. The next three columns add changes in log job-city employment. The last columns interact the employment variable with occupational dummies. Importantly, once the endogeneity of workers' outside options is taken into account, the estimate of interest is qualitatively similar to the baseline estimate. Finally, it is interesting to note that, since the estimates are identified on stayers only, this set of results also suggests that wages tend to be renegotiated over time.

Table 8: Focusing on firm-job-city stayers.

Dependent variable	Δ log wages$_{qic\tau}$											
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV	**(4)** OLS	**(5)** IV	**(6)** IV	**(7)** OLS	**(8)** IV	**(9)** IV	**(10)** OLS	**(11)** IV	**(12)** IV
Δ Outside options$_{qic\tau}$:												
$\Delta \sum_{k \in S \setminus \{qi\}} \psi_{kc\tau \mid qi} w_{kc\tau}$	0.150***	0.613***	0.609***	−0.099	0.708***	0.627***	−0.223***	1.100***	1.117***	−0.230***	0.839***	0.849***
	(0.036)	(0.167)	(0.168)	(0.067)	(0.245)	(0.147)	(0.073)	(0.392)	(0.357)	(0.071)	(0.271)	(0.253)
Δ log employment$_{qic\tau}$							−0.001	0.339**	0.339**			
							(0.012)	(0.147)	(0.147)			
Δ (log empl$_{qic\tau}$ * d_q)										yes	yes	yes
Δ $d_{qi\tau}$	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Δ $d_{c\tau}$	yes	yes	yes									
Δ $d_{ic\tau}$				yes	yes	yes	yes	yes	yes	yes	yes	yes
Instrument set		set I	set II		set I	set II		set I	set II		set I	set II
F-stat.		39.34	26.26		19.58	13.58		11.10	8.35		16.79	11.35
Over-id. p-val.		0.15	0.25		0.35	0.58		0.44	0.74		0.37	0.67
AP p-val.		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00
Observations	5334	5334	5334	5334	5334	5334	4845	4845	4845	4845	4845	4845

Notes: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-3 On-the-job search

This section discusses the implications of allowing workers to search while on the job. Such an extension modifies the utility of being employed in the following way.

If a worker is not laid off, the probability of which is $\beta(1-\delta)$, the probability of him or her receiving an offer from kc is $(1-\delta)\psi_c\psi_{kc|j}$. The worker accepts the offer if the utility of being employed with kc exceeds the utility derived in his current job. Thus,

$$\begin{aligned} U^e_{jc} &= w_{jc} + \beta\delta U^u_{jc} + \beta(1-\delta)\left\{(1-\psi_c)U^e_{jc} + \psi_c \sum_{k\in S}\psi_{kc|j}\left[Pr\left(U^e_{kc} < U^e_{jc}\right)U^e_{jc} + Pr\left(U^e_{kc} \geq U^e_{jc}\right)U^e_{kc}\right]\right\} \\ &= w_{jc} + \beta\delta U^u_{jc} + \beta\Lambda_{jc}U^e_{jc} + \beta(1-\delta)\psi_c\sum_{k\in S}\psi_{kc|j}Pr\left(U^e_{kc} \geq U^e_{jc}\right)U^e_{kc}, \end{aligned} \tag{35}$$

where $\Lambda_{jc} = (1-\delta)\left[(1-\psi_c) + \psi_c\sum_{k\in S}\psi_{kc|j}Pr\left(U^e_{kc} < U^e_{jc}\right)\right]$ is the probability that a worker remains in his current job (either because he or she did not receive any other offer or rejected an outside offer). Including on-the-job search augments the utility of employment by two additional terms: a first term that reflects the probability of being a stayer (Λ_{jc}), and a second one which captures workers' outside options when on the job $\left(\psi_c\sum_{k\in S}\psi_{kc|j}Pr[U^e_{kc} \geq U^e_{jc}]U^e_{kc}\right)$.

To understand the empirical implications of on-the-job search, it is useful to take a linear approximation of equation 35.[4] One obtains

$$U^e_{jc} = \Upsilon_0 + \Upsilon_1 w_{jc} + \Upsilon_2 U^u_{jc} + \Upsilon_3\psi_c + \Upsilon_4\Lambda_{jc} + \Upsilon_5 \underbrace{\sum_{k\in S}U^e_{kc}}_{\text{city-specific}}, \tag{36}$$

where the Υs are constant terms obtained from the linear approximation. Equation 36 implies that one can control for the wage effects of on-the-job search by adding the probability Λ_{jc} to the baseline specification. The city-specific variables ψ_c and $\sum_{k\in S}U^e_{kc}$ are absorbed by the city-specific time-varying dummies. Table 9 shows that controlling for the probability of being a stayer leaves the baseline results unchanged.

[4] As previously, the linear approximation is taken around the point where cities have identical employment rates ($ER_c = ER$) and where employment is uniformly distributed across jobs ($\eta_{kc} = \frac{1}{QI}$).

Table 9: On-the-job search.

Dependent variable	Δ log wages$_{qic\tau}$		
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV
Δ Outside options$_{qic\tau}$:			
$\Delta \sum_{k \in S \setminus \{qi\}} \psi_{kc\tau \mid qi} w_{kc\tau}$	0.263***	0.721***	0.662***
	(0.049)	(0.166)	(0.154)
Δ Probability of staying$_{qic\tau}$	0.021	0.033	0.031
	(0.022)	(0.022)	(0.022)
$\Delta\ d_{qi\tau}$	yes	yes	yes
$\Delta\ d_{c\tau}$	yes	yes	yes
Instrument set		set I	set II
F-stat.		41.73	35.55
Over-id. p-val.		0.29	0.15
AP p-val.		0.00	0.00
Observations	6632	6632	6632

Notes: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-4 Top coding

The IABS sample is top-coded at the highest level of earnings that are subject to social security contributions. Top coding affects around 10% of the observations each year. The issue can be severe for highly educated groups: 50% of the wage observations for university and polytechnic graduates are right-censored. Columns (1)-(3) and (4)-(6) of Table 10 show the estimates obtained when dropping top-coded observations and highly educated individuals, respectively. This exercise does not alter the qualitative aspect of the results.

Table 10: Using uncensored wages only and excluding highly educated.

Dependent variable	Δ log wages$_{qic\tau}$					
	Drop					
	Top-coded observations			**Highly educated individuals**		
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV	**(4)** OLS	**(5)** IV	**(6)** IV
Δ Outside options$_{qic\tau}$:						
$\Delta \sum_{k \in S \setminus \{qi\}} \psi_{kc\tau\|qi} w_{kc\tau}$	0.231***	0.748***	0.711***	0.304***	0.879***	0.753***
	(0.038)	(0.136)	(0.127)	(0.048)	(0.181)	(0.155)
$\Delta\ d_{qi\tau}$	yes	yes	yes	yes	yes	yes
$\Delta\ d_{c\tau}$	yes	yes	yes	yes	yes	yes
Instrument set		set I	set II		set I	set II
F-stat.		49.05	37.04		46.51	38.70
Over-id. p-val.		0.13	0.31		0.76	0.10
AP p-val.		0.00	0.00		0.00	0.00
Observations	6632	6632	6632	6632	6632	6632

Notes: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-5 Alternative mobility measures

Table 11 introduces some flexibility in computing the mobility measure $\varphi_{k|qi}$ from job qi to k. In columns (1)-(3), $\varphi_{k|qi}$ is computed over two different intervals, 1976-1991 and 1992-2001. Columns (4)-(6) introduce spatial flexibility by separating the sample between Northwest and Southwest Germany. Since the constraint of 20 individuals per job-city-year cell leaves little room for manoeuvre in the construction of $\varphi_{k|qi}$, it is difficult to allow for even more flexibility. Whichever column one looks at, the estimates remain robust to using period-specific or region-specific measures of mobility.

Table 11: Computing the mobility measures over two periods/regions.

Dependent variable	Δ log wages$_{qic\tau}$					
	Two periods			**Two regions**		
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV	**(4)** OLS	**(5)** IV	**(6)** IV
Δ Outside options$_{qic\tau}$:						
$\Delta \sum_{k\in S\setminus\{qi\}} \psi_{kc\tau\|qi} w_{kc\tau}$	0.264***	0.513***	0.515***	0.294***	0.591***	0.611***
	(0.042)	(0.132)	(0.130)	(0.048)	(0.123)	(0.111)
$\Delta\ d_{qi\tau}$	yes	yes	yes	yes	yes	yes
$\Delta\ d_{c\tau}$	yes	yes	yes	yes	yes	yes
Instrument set		set I	set II		set I	set II
F-stat.		52.14	41.80		102.60	80.41
Over-id. p-val.		0.27	0.50		0.42	0.39
AP p-val.		0.00	0.00		0.00	0.00
Observations	6552	6552	6552	6458	6458	6458

Note: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-6 Sample split

Table 12 examines whether the effect of interest exhibits anything particular after the accession of East Germany to the IAB sample in 1991 (or the fall of the Iron Curtain in 1989). The pre-1991 period experienced relatively higher pressure from trade unions. If, as a result, wage premia were relatively smaller, one may be worried that the baseline estimate is driven by the post-1991 period only. To investigate this possibility, this section splits the sample into two intervals, the pre- and post-1991 periods. Whichever period one considers, the estimates remain statistically significant and similar to those of the baseline specification.

Table 12: Sample split.

Dependent variable	Δ log wages$_{qic\tau}$					
	1977-1991			**1992-2001**		
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV	**(4)** OLS	**(5)** IV	**(6)** IV
Δ Outside options$_{qic\tau}$:						
$\Delta \sum_{k\in S\setminus\{qi\}} \psi_{kc\tau\|qi} w_{kc\tau}$	0.245***	0.709***	0.784***	0.277***	0.708***	0.557***
	(0.066)	(0.254)	(0.224)	(0.055)	(0.177)	(0.188)
$\Delta\ d_{qi\tau}$	yes	yes	yes	yes	yes	yes
$\Delta\ d_{c\tau}$	yes	yes	yes	yes	yes	yes
Instrument set		set I	set II		set I	set II
F-stat.		40.18	29.13		11.97	11.01
Over-id. p-val.		0.90	0.79		0.24	0.10
AP p-val.		0.00	0.00		0.00	0.00
Observations	3316	3316	3316	3316	3316	3316

Notes: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-7 Alternative time frame

Table 13 shows that averaging the data over three or eight years, as an alternative to five years, generates results which are qualitatively similar to the baseline estimates.

Table 13: Alternative time frame.

Dependent variable	Δ log wages$_{qic\tau}$					
	Three-years averages			**Eight-years averages**		
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV	**(4)** OLS	**(5)** IV	**(6)** IV
Δ Outside options$_{qic\tau}$:						
$\Delta \sum_{k \in S \setminus \{qi\}} \psi_{kc\tau\|qi} w_{kc\tau}$	0.255***	0.599***	0.566***	0.397***	0.942***	0.866***
	(0.041)	(0.161)	(0.153)	(0.063)	(0.200)	(0.208)
$\Delta\ d_{qi\tau}$	yes	yes	yes	yes	yes	yes
$\Delta\ d_{c\tau}$	yes	yes	yes	yes	yes	yes
Instrument set		set I	set II		set I	set II
F-stat.		35.98	27.64		19.92	17.84
Over-id. p-val.		0.310	0.249		0.516	0.372
AP p-val.		0.00	0.00		0.00	0.00
Observations	11606	11606	11606	3316	3316	3316

Notes: Standard errors, in parentheses, are clustered at the city level. *** p<0.01, ** p<0.05, * p<0.1.

K-8 Alternative clusterings

Table 14 shows that using alternative clusterings of the data does not alter the statistical significance of the results.

Table 14: Alternative clusterings.

Dependent variable				Δ log wages$_{qic\tau}$					
	City-time clustering			**Industry clustering**			**Industry-time clustering**		
Regressors	**(1)** OLS	**(2)** IV	**(3)** IV	**(4)** OLS	**(5)** IV	**(6)** IV	**(7)** OLS	**(8)** IV	**(9)** IV
Δ Outside options$_{qic\tau}$:									
$\Delta \sum_{k \in S \setminus \{qi\}} \psi_{kc\tau\|qi} w_{kc\tau}$	0.262***	0.713***	0.655***	0.262***	0.713***	0.655***	0.262***	0.713***	0.655***
	(0.041)	(0.181)	(0.168)	(0.046)	(0.185)	(0.178)	(0.041)	(0.181)	(0.168)
$\Delta\ d_{qi\tau}$	yes	yes	yes	yes	yes	yes	yes	yes	yes
$\Delta\ d_{c\tau}$	yes	yes	yes	yes	yes	yes	yes	yes	yes
Instrument set		set I	set II		set I	set II		set I	set II
F-stat.		35.96	24.76		56.86	40.84		0.27	0.37
Over-id. p-val.		0.27	0.37		0.31	0.25		0.263	0.362
AP p-val.		0.00	0.00		0.00	0.00		0.00	0.00
Observations	6632	6632	6632	6632	6632	6632	6632	6632	6632

Note: *** p<0.01, ** p<0.05, * p<0.1.

K-9 Industry/Occupation effects

Tables 15 and 16 investigate whether the baseline estimate differs across industries and occupations. For each industry (occupation), Tables 15 (Table 16) runs a regression interacting the measure of workers' outside options with a dummy for the corresponding industry (occupation). Columns (1), (3) and (5) show the main effect. Columns (2), (4) and (6) present the estimate for the interaction term. In general, the coefficient on the interaction term is statistically insignificant, which suggests that decentralisation forces are similar across industries (occupations), whichever the unionisation degree they exhibit.

Table 15: Transition index, by industry.

Dependent variable	Δ log wages$_{qic\tau}$					
	OLS		**IV - set I**		**IV - set II**	
	Main **(1)**	Interaction **(2)**	Main **(3)**	Interaction **(4)**	Main **(5)**	Interaction **(6)**
Primary sector						
Industry 1	0.285***	−0.152*	0.707***	−0.670	0.715***	−0.184
	(0.0503)	(0.0750)	(0.157)	(1.264)	(0.162)	(0.196)
Secondary sector						
Industry 2	0.259***	0.039	0.666***	0.246	0.666***	0.244
	(0.055)	(0.101)	(0.191)	(0.360)	(0.191)	(0.360)
Industry 3	0.242***	0.263**	0.618***	0.482	0.620***	0.477
	(0.050)	(0.081)	(0.170)	(0.413)	(0.169)	(0.388)
Industry 4	0.254***	0.119	0.785***	−0.618	0.787***	−0.623
	(0.051)	(0.062)	(0.173)	(0.418)	(0.174)	(0.419)
Industry 5	0.285***	−0.213	0.710***	−0.094	0.706***	−0.146
	(0.053)	(0.134)	(0.191)	(0.444)	(0.192)	(0.416)
Industry 6	0.270***	−0.275*	0.709***	−0.091	0.704***	−0.065
	(0.048)	(0.122)	(0.163)	(0.497)	(0.164)	(0.491)
Industry 7	0.262***	−0.019	0.730***	−0.221	0.742***	−0.190
	(0.049)	(0.187)	(0.162)	(0.339)	(0.169)	(0.348)
Industry 8	0.261***	0.0019	0.669***	0.202	0.664***	0.239
	(0.049)	(0.164)	(0.167)	(0.248)	(0.167)	(0.242)
Tertiary sector						
Industry 9	0.257***	0.198	0.718***	−0.300	0.721***	−0.552
	(0.050)	(0.132)	(0.158)	(1.833)	(0.158)	(1.960)
Industry 10	0.252***	0.330*	0.710***	0.523	0.712***	0.438
	(0.049)	(0.139)	(0.163)	(0.534)	(0.161)	(0.676)
Industry 11	0.263***	−0.0922	0.795***	−1.925*	0.795***	−1.956*
	(0.049)	(0.114)	(0.193)	(0.926)	(0.193)	(0.925)
Industry 12	0.254***	0.150	0.653***	1.194	0.643***	0.682
	(0.051)	(0.087)	(0.177)	(1.377)	(0.166)	(1.142)
Industry 13	0.241***	0.244	0.678***	1.951**	0.686***	1.783*
	(0.054)	(0.140)	(0.169)	(0.721)	(0.169)	(0.707)
Industry 14	0.282***	−0.251**	0.759***	−0.412	0.761***	−0.508
	(0.051)	(0.084)	(0.192)	(1.092)	(0.193)	(1.006)
Industry 15	0.249***	0.405	0.709***	0.224	0.710***	0.176
	(0.047)	(0.220)	(0.156)	(0.935)	(0.159)	(0.722)
Industry 16	0.283***	−0.224*	0.743***	−0.326	0.730***	−0.444
	(0.047)	(0.090)	(0.161)	(0.469)	(0.160)	(0.462)

Notes: Standard errors are clustered at the city level. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. p-values in brackets.

Table 16: Transition index, by occupation.

Dependent variable	Δ log wages$_{qic\tau}$					
	OLS		**IV - set I**		**IV - set II**	
	Main	Interaction	Main	Interaction	Main	Interaction
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Agricultural						
Occupation 106	0.259***	0.154	0.723***	−2.051	0.726***	−1.636
	(0.051)	(0.325)	(0.162)	(1.670)	(0.165)	(1.189)
Manufacturing						
Occupation 1415	0.266***	−0.246	0.792***	−0.782	0.794***	−0.818
	(0.048)	(0.198)	(0.179)	(0.448)	(0.179)	(0.461)
Occupation 1617	0.274***	−0.554*	0.737***	−0.568	0.736***	−0.556
	(0.054)	(0.235)	(0.153)	(0.352)	(0.155)	(0.326)
Occupation 1924	0.258***	0.163	0.697***	0.141	0.695***	0.129
	(0.050)	(0.137)	(0.172)	(0.301)	(0.169)	(0.303)
Occupation 2530	0.275***	−0.106	0.763***	−0.274	0.773***	−0.162
	(0.0479)	(0.0936)	(0.188)	(0.319)	(0.191)	(0.272)
Occupation 31	0.251***	0.099	0.719***	0.347	0.713***	0.173
	(0.053)	(0.087)	(0.168)	(0.414)	(0.163)	(0.345)
Occupation 32	0.255***	0.592**	0.752***	−1.143	0.762***	−1.178
	(0.049)	(0.215)	(0.172)	(0.613)	(0.173)	(0.620)
Occupation 3943	0.256***	0.206	0.708***	−0.118	0.715***	0.0626
	(0.048)	(0.144)	(0.167)	(0.336)	(0.167)	(0.286)
Occupation 4447	0.263***	−0.080	0.702***	−0.013	0.714***	−0.0571
	(0.049)	(0.167)	(0.166)	(0.411)	(0.171)	(0.393)
Occupation 4849	0.260***	0.152	0.645*	−7.647	0.720***	1.611
	(0.049)	(0.204)	(0.251)	(26.17)	(0.175)	(1.960)
Occupation 52	0.266***	−0.105	0.707***	−2.211	0.709***	−2.117
	(0.048)	(0.141)	(0.165)	(1.529)	(0.163)	(1.233)
Occupation 53	0.268***	−0.338	0.784**	16.16	0.663***	−0.437
	(0.049)	(0.189)	(0.252)	(29.12)	(0.170)	(0.944)
Technicians						
Occupation 6061	0.265***	−0.142	0.759***	5.707	0.766***	6.455
	(0.049)	(0.285)	(0.193)	(8.219)	(0.199)	(9.088)
Occupation 6263	0.270***	−0.111	0.705***	0.0272	0.702***	0.0247
	(0.053)	(0.096)	(0.172)	(0.391)	(0.171)	(0.391)
Services and professionals						
Occupation 68	0.257***	0.117	0.697***	0.577	0.695***	0.622
	(0.0508)	(0.132)	(0.162)	(0.443)	(0.165)	(0.424)
Occupation 6970	0.262***	−0.031	0.723***	−0.007	0.715***	0.194
	(0.0514)	(0.125)	(0.170)	(0.494)	(0.167)	(0.542)
Occupation 7174	0.258***	0.075	0.623***	0.594*	0.630***	0.684**
	(0.0473)	(0.125)	(0.176)	(0.244)	(0.175)	(0.252)
Occupation 7578	0.269***	−0.0902	0.841***	−2.874	0.859***	−3.455
	(0.0473)	(0.105)	(0.181)	(3.596)	(0.201)	(3.683)
Occupation 7981	0.257***	0.111	0.714***	0.152	0.720***	−0.241
	(0.0503)	(0.175)	(0.176)	(1.881)	(0.173)	(0.979)
Occupation 8485	0.269***	−0.221	0.708***	0.139	0.709***	0.0681
	(0.0491)	(0.138)	(0.177)	(0.776)	(0.177)	(0.660)
Occupation 8689	0.267***	−0.183	0.717***	−0.344	0.726***	−0.899
	(0.0519)	(0.253)	(0.168)	(1.645)	(0.166)	(0.835)
Occupation 9093	0.243***	0.375*	0.671***	1.259	0.660***	1.276
	(0.0477)	(0.158)	(0.159)	(0.721)	(0.157)	(0.720)

Note: Standard errors are clustered at the city level. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. p-values in brackets. Industry-specific occupations are not reported.

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