# The takeover and selection effects of foreign ownership in Germany: an analysis using linked worker-firm data*

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**Abstract**

We use a linked employer-employee data set from Germany over the period 2000–2004 to estimate the wage effect of foreign-affiliates in (the former) East and West Germany. We also consider the wage effects of the large number of West German affiliates which are located in East Germany. We implement techniques which allow us to control both for worker- and plant-level unobserved components of earnings.

We find large selection effects both in terms of worker- and firm unobserved components of wages. The selection effect is larger for East German plants. Once the selection effect is taken into account, the genuine takeover effect is small and in some cases insignificantly different from zero. In contrast to the selection effect, the takeover effect is slightly larger in West Germany.

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# 1 Introduction

There is now a fairly extensive literature which suggests that affiliates of foreign-owned firms outperform domestic firms and pay higher wages. However, as often noted (e.g. Girma, Greenaway & Wakelin 2001) much of this difference may be due to differences in other characteristics of firms which are correlated with foreign ownership. For example, affiliates of foreign-owned firms tend to be larger and operate in sectors of the economy which are inherently more productive. It is therefore important to control for firm size and sectoral distribution when comparing the wages and productivity of foreign and domestic firms. Since these characteristics are often observable in plant- or firm-level data, controlling for these differences is straightforward in a regression framework.

A potentially more serious problem is that foreign and domestic firms might differ in their unobservable characteristics. In particular, firms which are taken into foreign ownership might already be outperforming firms which are not taken over. For example, they might already be the higher-paying or more productive plants. With repeated observations at plant-level, it is possible to remove the influence of any fixed difference between firms which become foreign-owned and those which remain domestic by using difference-in-differences or fixed-effects techniques. However, it is difficult with plant-level data to control for differences in the quality of the workforce which may explain some of the apparent foreign-ownership wage premium.

In this study we use a large linked employer-employee data set from Germany over the period 2000–2004, and provide estimates of the wage effects of foreign-affiliates in (the former) East and West Germany. We also consider the wage effects of the large number of West German affiliates which are located in East Germany. We implement techniques which allow us to control both for worker- and plant-level unobserved components of earnings.

In the light of the recent literature on policy evaluation, we think of a change in ownership as a "treatment" which potentially affects the wage paid to workers in the plant. This allows us to partition the wage gap between different types of plant in terms of "selection" and "takeover". Selection reflects the fact that plants are not randomly selected into their ownership status. Takeover measures any additional wage gain which a change in ownership status yields.

This framework is also helpful in investigating whether any wage gain from ownership status is internalised within the firm, or whether there are spillovers to the domestic economy. We can do this by examining the wage changes of workers who move from

foreign-owned to domestic plants, and by examining the wage changes of plants which revert to domestic control.

Finally, the use of data on workers and firms allows us to investigate whether there are any distributional consequences of ownership status. For example, foreign-owned firms may implement a steeper wage-tenure profile, or they may change relative rewards to different skill groups.

We find evidence of large selection effects both in terms of worker and firm unobserved components of wages: plants which get taken over by foreign firms have higher plant-level wages and higher individual-level wages before they are taken over. The selection effect is larger for East German plants, both for those which change to West German ownership and foreign ownership. Once the selection effect is taken into account, the genuine takeover effect is small and in some cases insignificantly different from zero. In contrast to the selection effect, the takeover effect is slightly larger in West Germany.

The paper is structured as follows. We summarise previous estimates of the wage effect in Section 2, and we present a framework for measuring wage effects in Section 3 which explores the different empirical issues which may arise. Section 4 briefly describes the data we use, and our estimates are presented in Section 5. Section 6 concludes.

## 2 Previous estimates

As noted, there is now a wide range of estimates of the wage impact of foreign affiliates. As always, it is difficult to make direct comparisons across these studies because of differences in methods, samples, data and so on. Nevertheless, Table 1 attempts to draw together the relevant comparisons for as many studies as possible.

As can be seen, the 15 studies have been carried out for various developed and developing countries. They have been conducted either at the industry- or firm-level; and more recently -as employer-employee data became available- four studies were also carried out at the individual-level. The studies can also be broadly classified according to the identification of the ownership wage premium. The first group compares wages (or wage growth) between foreign-owned and domestically-owned plants, which is typically carried out by OLS. In this case, one can condition on human-capital and plant-characteristics available in the respective data-set, but not on unobservables. Hence, the obtained ownership effect may be confounded by a

selection effect if foreign- and domestically-owned firms differ in unobserved characteristics. To circumvent this problem, some studies identify the wage differential via comparing the change in wages of plants which change ownership and the change in wages of plants which do not. This is carried out by Fixed Effects or Difference-in-Difference Methods, by which unobserved time-invariant differences between both plant-types are swept away. Obviously, this is only possible if the data covers more than one period in time. The study of Conyon, Girma, Thompson & Wright (2002) is the only one which also considers the effect of changing from foreign- to domestically owned, although their control group comprises firms of both ownership types not changing their status.

There is a common consent from all studies that foreign owned firms pay higher wages. The premium appears to be much larger in less developed countries (the reported (raw) wage differential amounts to 65% for Ghana and ranges in Indonesia even between 67 and 90%), but lies also for developed country somewhere between 10 and 30%. We can also regard it as a stylized fact that the differential reduces after including human capital variables of the workers and/or characteristics of the firm (of which sectoral affiliation and firm size seem to be the most important). Nevertheless, if unobserved factors are not taken into account, a positive foreign wage differential remains. This is typically around 10% and the difference between developed and less-developed countries is much less pronounced. There is, of course, some variation between countries, but this may at least partly reflect different sets (or qualities) of control variables. However, studies which also account for unobserved factors often find no wage premium.

**Table 1:** Previous estimates of foreign ownership wage effects

| Study | Country | Data | Estimation method | Measure of ownership | Measure of remuneration | Differential |
|---|---|---|---|---|---|---|
| Aitken, Harrison & Lipsey (1996) | US, Mexico (M), Venezuela (V) | industry-level; manufacturing; 1987(US), 1984–1990(M), 1977–1989(V); 1,091(US), 4,717(M), 10,870(V) industry-states; also plant-level for V | OLS (2SLS); separately for skilled and unskilled in Venezuela and Mexico | employment share at region-industry level of firms with 10% or more (US) resp. with any (M, V) foreign owned equity | log. averages wages by four-digit industry, region, year | higher levels of foreign investment associated with higher wages for skilled and unskilled workers in Mexico (22 and 3%) and Venezuela (29 and 22 %) and in US (37%) in all enterprises; negative (Venezuela) or no (Mexico) wage spillovers from foreign investment to domestically owned plants, but positive for US (34%) |
| Buckey & Enderwick (1983) | Great Britain | manufacturing; 1980 wave of WIRS; 614 domestically-, 119 foreign-owned establishments | comparison of median wage in domestic and foreign-owned firms, by skill, industry and firm size | | typical weekly gross pay by group: semi-skilled manuals, skilled manuals, clerical workers, middle management | no difference in median wage for management employees, 7-8% for other three groups; differential most pronounced in small and very large plant sizes, no impact in intermediate sizes; foreign-owned firms do not invariably pay higher wages across industries |
| Conyon et al. (2002) | UK | manufacturing; private and public companies; 1989–1994; at least two years before and after acquisition; 331 domestic-, 129 foreign-owned acquisitions, 642 firms with no change | (firm) FE | foreign acquisition of existing UK firms (and vice versa) between year $t$ and $t-1$ (controls: firms subject to to no ownership change) | | 3.44% wage premium (4.7% in US-acquired, 3.9% in EU acquisitions and 3.2% in acquisitions from other foreign countries), but when productivity is added, wage premium disappears totally; -2.1% wage reduction after domestic acquisition, which is unaffected by the introduction of productivity; only for US acquisitions significant impact on growth rate of wages of 2.9% (but neither for other foreign or domestic acquisitions), but reduces again when adding labor productivity |
| Dale-Olsen (2003) | Norway | LEED; manufacturing; 1989–1995; at least two movers and 25 wage-observations per establishment; 1,994,751 observations; 1971 domestic-, 309 foreign-owned firms; 497,214 workers | FEiLSDVj; auxiliary regression of unobserved individual component on foreign ownership; ECM model for minimum ability (average of three lowest individuals) | foreign (domestic private): at least 50 (less than 20) % of capital is under control of foreign investors | log. hourly earnings | foreign-controlled establishments employ stayers with 10.4% higher minimum ability (no difference for mean and maximum ability); long-run relationship between ownership and ability in ECM is 11.5%, but changing ownership yields no short-term impact on any ability measure |

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| Study | Country | Data | Estimation method | Measure of ownership | Measure of remuneration | Differential |
|---|---|---|---|---|---|---|
| Feenstra & Hanson (1997) | Mexico | 1975–1988; state-level census data on two-digit industries (32 states, 9 industries), 4 time periods (1975, 1980, 1985, 1988); unbalanced panel of 746 differenced observations | First Differences; IV for ownership variable | regional activities of maquiladoras (foreign assembly plants) as a measure of FDI: ratio of foreign manufacturing establishments to domestic manufacturing establishments | skilled labor-share of total wages; skilled and unskilled labour proxied by non-production and production workers respectively | growth in FDI positively correlated with relative demand for skilled labor: FDI can account for 52.4% of increase in border region's non-production wage share increase |
| Feliciano & Lipsey (1999) | US | (two-digit SIC) industry-state level; manufacturing and non-manufacturing; 1987–1992; BEA and Census matched data | OLS; (separately for domestically-owned and all plants) growth rate in wages on changes in employment in foreign-owned plants | dummy variable indicating whether industry-state cell is composed of foreign-owned or domestically-owned establishments; spill-over effects: foreign-owned employment share within industry and state | log. annual wage per worker (for foreign-owned and domestically-owned) spill-over effects: log wage in (1) US owned and (2) all establishments | raw: 29% if employment-weighted; 23% (1987) and 15% (1992) if un-weighted; within-industry: 5-7% in manufacturing, 9-10% outside; within manufacturing: differential disappears after controlling for size, location, labor force (schooling, gender, unionization); non-manufacturing: 8-9% remain; only for non-manufacturing in 1992: significant positive relationship of foreign ownership to domestic establishment wages; no effect of foreign ownership growth on wage growth in domestically-owned plants |
| Girma et al. (2001) | UK | firm-level; manufacturing; 1991–96; 2,343 domestic, 1,408 foreign (525 US, 76 Japanese and 807 others); each firm observed at least three times and without a change of ownership in sample period | Random Effects | dummy; alternatively: three dummies for ownership from US, Japan, others; spillover regressions: sector share of employment in foreign-owned firms | log. wages, wage growth | raw: 13.7%; + controls: 9.51-5.34% ; wage growth not significantly different after productivity is controlled for; differential is highest for US and insignificant for Japanese firms; on average, no wage spillover to domestic firms, neither evidence of linking wage growth and growth in foreign presence; with higher levels of import competition, impact of FDI in sector on wages in domestic firms increases, but higher skill intensity dampens wage effect |

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| Study | Country | Data | Estimation method | Measure of ownership | Measure of remuneration | Differential |
|---|---|---|---|---|---|---|
| Girma & Görg (2006) | UK | plant-level; electronics and food industry; 1980–1994; 203 (100) acquisitions in electronic (food) sector; 108 US, 104 EU, 91 foreign acquisitions by other countries | PSM (control: plants which are always domestic) DID; different post-acquisition periods (1-4 years); by skilled and unskilled | dummies: US-, EU-, other ownership | log. plant-level wage | skilled (8%) and unskilled (9-13%) experience wage increase after US takeover; no effect if acquired by a EU firm; positive unskilled wage effects in the first two years (6.5%) following acquisitions from the rest of the world |
| Globerman, Ries & Vertinsky (1994) | Canada | plant-level; manufacturing; 1986; 5,553 Canadian-, 458 US-, 112 EC-, 38 Japanese-owned | OLS | dummies: US-, EC-, Japanese-ownership | log. average wage per production employee | raw + industry dummies: 18-29% (differences between source countries insignificant); + other variables: US and EC insignificant, negative differential for Japanese firms (-3.6%) |
| Görg, Strobl & Walsh (2002) | Ghana | LEED; manufacturing; 1998; 144 firms (34 with some foreign ownership); 1,365 workers | OLS | degree of foreign ownership (percentage); assumption for regressions of starting wage: foreign ownership has remained constant over time | log. hourly wage; separately: current wage and starting wage in the firm; wage growth | raw differential: 65%; + HK: 38 %; HK + firm-variables: 8.5%; no statistically significant difference in starting wages; no ownership differential in wage growth between workers not receiving training; workers receiving on-the-job training in foreign firms have higher wages (26%) and experience higher wage growth than workers being trained in domestic firms |
| Heyman, Sjöholm & Tingvall (2004) | Sweden | LEED; individual- and plant-level; 1990–2000 (plants) resp. 1996–2000 (workers); 61,520 plant-years; 1,627,908 worker-years (only non-movers) | OLS; Fixed Effects; PSM, DiD; Foreign-Owned vs. rest (alternatively: vs. multinationals vs. locals) | dummy (1 if more than 50% of equity is foreign owned); foreign takeover vs. greenfield | log. wage per employee (plant-level) resp. log. monthly wage (individual level) | raw + industry dummies: 11% at plant-, 4% at individual-level; all covariates: 12% resp. 2%; important is whether multinational rather than whether foreign-owned; effect of foreign takeover only about half to two third of effect of greenfield investments; zero wage premium on matched sample at individual-level; individual FE yields negative wage premium of -4%, suggests that foreign owners target high-wage firms, but wages increase at lower rate after ownership-change |

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| Study | Country | Data | Estimation method | Measure of ownership | Measure of remuneration | Differential |
|---|---|---|---|---|---|---|
| Lipsey (1994) | US | plant- and industry-level; Census-BEA match data (US Department of Commerce) & BLS data, different years for var. investigations (1987, 1990, 1991, 1992) | OLS | dummy | average annual compensation | raw: 10% in manufacturing, 30% in non-manufacturing, half due to industry distribution; foreign and domestic manufacturing plants of same size pay about the same wage; occupational mix within industries hardly accounts for pay premium within industries; higher level of foreign participation raises domestic establishment wages; wage levels in acquired firms little below those in continuing operations (but above average increases in wages); changes in average compensation negatively correlated with change in employment (new affiliates shedding employees were dropping lower paid and less skilled ones) |
| Lipsey & Sjöholm (2004) | Indonesia | plant-level census data (more than 20 employees); manufacturing; 1996; 19,911 observations | OLS, separately for blue-collar and white-collar workers | dummy, also dummy for public ownership | log. average plant wage | raw: 67% for blue-collar (bc), 90% for white-collar (wc); HK: 36% (bc), 69% (wc); HK + plant-variables: 12% (bc), 20% (wc); premium for tertiary education is larger in foreign-owned firms, in particular for bc-workers |
| Martins (2004) | Portugal | LEED; 80% sample of annual census of all firms in manufacturing sector; 1991–1999; 5,409,000 worker-years, 39,783 firms; 231 acquisitions of domestic firms by multinationals | OLS; Quantile Reg.; PSM, DiD (treatment: acquistion of domestic firms by foreign-owned; controls: firms that are always (i) domestic or (ii) foreign; only non-moving workers) | dummy (1 if at least 50% of equity is owned by foreign parties); different dummy variables for share of firm's equity owned by foreign parties | log. real hourly wage (change in ln wages) | raw: 32%; HK: 27%; HK + firm: 11%; no monotonic relationship between wage premia and share of foreign equity; wage premium at 75%-percentile 2-3% larger than at 25% percentile; PSM yields insignificant differences in wage premium; DiD: lower wage growth in firms that are acquired by foreign investors |

**Table 1:** Previous estimates of foreign ownership wage effects

| Study | Country | Data | Estimation method | Measure of ownership | Measure of remuneration | Differential |
|---|---|---|---|---|---|---|
| Velde & Morrissey (2001) | Cameroon, Ghana, Kenya, Zambia, Zimbabwe | LEED; 1990–1993; same firms, but repeated cross-sections of individuals; food, wood, textile and metal industries | OLS | dummy if some foreign ownership (usually by persons, also by firms); interaction with education/occupation and sector | log. individual monthly earnings | controlling for age, education and tenure: 20-37% differential; + firm-specific effects (size, sector, region): 8-23%; skilled workers benefit more from foreign ownership: completing secondary education raises wages in foreign-owned firms by 16-33%; skill-differential does not depend on plant size |

## 3 Measuring direct wage effects of MNCs

Let $y_{it}$ be worker $i$'s wage in period $t$. There are only two waves, $t = 1$ (namely 2000) and $t = 2$ (2004). The sample for these models is all workers who are observed twice. In each period, the identity of a worker's plant is given by $j = J(i, t)$. Note that the ownership status of worker $i$'s current plant may change either because the worker moves from one plant to another of different ownership status, or because the plant itself changes status.

The simplest framework in which to consider the wage effects of ownership is a standard linear three-way error components model:

$$y_{it} = \mathbf{x}'_{it}\boldsymbol{\beta}_1 + \mathbf{w}'_{J(i,t)t}\boldsymbol{\beta}_2 + \delta F_{J(i,t)t} + \lambda_t + \eta_{it} \qquad t = 1, 2. \tag{1}$$

where

$$\eta_{it} = \theta_i + \psi_{J(i,t)} + \varepsilon_{it}. \tag{2}$$

Here $\mathbf{x}_{it}$ is a vector of individual-level characteristics and $\mathbf{w}_{J(i,t)t}$ is a vector of plant-level characteristics. Some elements of $\mathbf{x}_{it}$ and $\mathbf{w}_{J(i,t)t}$ are, in fact, constant over time, such as gender or industry. The variable $F_{J(i,t)t}$ is unity if the worker's plant is foreign-owned and zero otherwise. $\lambda_1$ and $\lambda_2$ are standard macro effects.

Following Abowd, Kramarz & Margolis (1999), $\theta_i$ and $\psi_{J(i,t)}$ represent unobserved components of wages which are time-invariant at the individual- and plant-level respectively. $\theta_i$ might be thought of as "unobserved ability", while $\psi_j$ might be related to the unobserved fixed productivity of a particular plant if we think that more productive plants pay higher wages. As both might be correlated with foreign ownership, we have a three-way fixed-effects model. Estimating models that have both individual and plant fixed effects together is not straightforward, and so we first analyse what happens if $\psi_{J(i,t)}$ is ignored and is absorbed into the model's error term.

A natural interpretation of a foreign ownership takeover is that of a "treatment". In other words, we want to estimate the effect on average workers' wages in domestic firms in $t = 1$ of becoming foreign-owned in $t = 2$. Similarly, we want to estimate the effect on average workers' wages in foreign firms in $t = 1$ of becoming domestically-owned in $t = 2$. Some models suggest that these two effects should be equal and opposite, in which case we could pool the two types of takeover. But we do not wish to impose this restriction because it is possible, for example, that the wage benefits of foreign takeover are not reversed when plants revert to domestic control. We therefore consider these two cases separately.

Thus define the first treatment group to be those workers which are in domestic plants at $t = 1$ and which are in foreign-owned plants at $t = 2$. The comparable control group are those workers which remain in domestic plants at $t = 1$ and $t = 2$. There are analogous treatment and control groups consisting of those workers in foreign-owned plants at $t = 1$. In what follows we consider only the first comparison.

Thus the model we seek to estimate is written

$$y_{it} = \mathbf{z}_{it}'\boldsymbol{\beta} + \delta F_{jt} + \lambda_t + \theta_i + \psi_j + \varepsilon_{it}, \qquad t = 1, 2.$$

Here we have merged the two sets of observables into one vector $\mathbf{z}_{it}'$, and have replaced $J(i,t)$ by $j$. In this framework, the effect of foreign ownership on wages is given by $\delta$. To interpret what $\delta$ actually means, difference the model to remove the individual-level fixed-effects:[1]

$$\Delta y_i = \Delta\mathbf{z}_i'\boldsymbol{\beta} + \delta F_{j2} + \lambda + \Delta\psi_j + \Delta\varepsilon_i, \tag{3}$$

where $\Delta y_i = y_{i2} - y_{i1}$, $\Delta\mathbf{z}_i' = \mathbf{z}_{i2}' - \mathbf{z}_{i1}'$, $\Delta F_{jt} = F_{j2}$, $\lambda = \lambda_2 - \lambda_1$, $\Delta\psi_j = \psi_{J(i,t)} - \psi_{J(i,t-1)}$ and $\Delta\varepsilon_i = \varepsilon_{i2} - \varepsilon_{i1}$. For workers who do not change plant, $\Delta\psi_j = 0$. Now drop the observable covariates and it is easy to see that the OLS estimator of $\delta$ is the difference-in-difference estimator,

$$\delta = \Delta\bar{y}_{\mathcal{T}} - \Delta\bar{y}_{\mathcal{C}}, \tag{4}$$

where $\Delta\bar{y}_{\mathcal{T}}$ is the change in average wages in plants that are in the treatment group (those that become foreign-owned) and $\Delta\bar{y}_{\mathcal{C}}$ is the change in average wages in the control group. Equivalently, $\delta$ is the average wage of workers in foreign-owned plants relative to those in domestic-owned plants in $t = 2$ net of the gap between the same plants in $t = 1$, when they were all domestically-owned. In these models $\delta$ is identified by those workers whose $F_{jt}$ changes. As noted, this occurs either if a plant changes ownership status or if a worker moves to a plant of another status.

It has been suggested that foreign-owned firms might be more selective in recruitment (e.g. Dale-Olsen 2003), and employ workers with higher $\theta_i$, so that $E(\theta \mid F = 1) > E(\theta \mid F = 0)$. We label this a *selection effect*, as wages might be higher in plants that are about to become foreign-owned in $t = 2$ simply because these plants are better for the reasons just given, and have been for years before. As just shown, with panel data on individuals it is straightforward to control for $\theta_i$ by differencing. To actually obtain an estimate of the differential $\bar{y}^{\mathcal{T}} - \bar{y}_{\mathcal{C}}$ at $t = 1$, we estimate the

[1] With $T = 2$, differencing and mean-deviating are identical methods.

following:

$$y_{it} = \mathbf{z}'_{it}\boldsymbol{\beta} + \delta F_{jt} + \gamma T_i + \lambda_2 + \psi_j + \eta_{it}, \qquad t = 1, 2. \tag{5}$$

Here the time-invariant dummy variable $T_i = 1$ if the worker is in the treatment group and zero otherwise. When covariates are absent, this gives an identical estimate of $\delta$ above, but has the advantage that $\gamma$ gives an estimate of the selection effect discussed above. A variant of this model is to fix covariates at their $t = 1$ values, because one might argue that some observables might respond to potential foreign ownership effects.

OLS estimates of (1) will yield consistent estimates of $\delta$ if $F_{J(i,t)t}$ is uncorrelated with $\eta_{it}$. However, although we have a rich set of covariates (particularly at the plant level), and we can difference out $\theta_i$, it seems likely that foreign ownership is non-random with respect to unobservable determinants of wages, $\eta$. This is because foreign-owned firms might also select into plants which have some unobserved productivity advantage so that $E(\psi_j \mid F = 1) > E(\psi_j \mid F = 0)$. With panel data on plants one can eliminate the $\psi_j$ in the same way as we did for $\theta_i$ by collapsing the individual-level data to a plant-level panel, and estimate:

$$\bar{y}_{jt} = \bar{\mathbf{z}}'_{jt}\boldsymbol{\beta} + \delta F_{jt} + \lambda_t + \bar{\theta}_{jt} + \psi_j + \bar{\varepsilon}_{jt}.$$

$\bar{y}_{jt}$ is the average wage paid in plant $j$ at time $t$ etc. Now take first differences to get:

$$\Delta\bar{y}_j = \Delta\bar{\mathbf{z}}'_j\boldsymbol{\beta} + \delta F_{j2} + \Delta\lambda_t + \Delta\bar{\theta}_j + \Delta\bar{\varepsilon}_j, \tag{6}$$

where, for example, $\Delta\bar{y}_{jt} = \bar{y}_{jt} - \bar{y}_{jt-1}$. By analogy with the above, having controlled for observables, $\delta$ is the difference-in-difference estimator

$$\delta = \Delta\bar{y}_{\mathcal{T}} - \Delta\bar{y}_{\mathcal{C}},$$

where now $\bar{y}$ refers to plant-level sample means.

The problem with aggregating the data to the plant-level to difference out plant-level fixed-effects is that estimates of $\delta$ from (6) will now be biased if $\Delta\bar{\theta}_j$ is correlated with $F_{jt}$. This is so-called aggregation bias, caused by the selection effect we cannot control for with plant-level data. One advantage of linked employer-employee data is that one can eliminate both $\theta_i$ and $\psi_j$ together. To do this, define a *spell*, denoted $s$, as a unique worker-plant pair. So a worker who changes plant between 2000 and 2004 has two separate spells. Within a spell both $\theta_i$ and $\psi_j$ are constant (because both $i$ and $j$ are constant) and so one can eliminate both using "spell fixed-effects" (see Abowd et al. (1999) and Andrews, Schank & Upward (2006)):

$$\Delta y_i = \Delta \mathbf{z}_i' \boldsymbol{\beta} + \delta F_{j2} + \lambda + \Delta \varepsilon_i. \tag{7}$$

Note that, when estimating Equation (7), individuals who change plant are not included in the regression and therefore do not contribute to the estimates of $\delta$. Therefore one way of thinking about spell fixed-effects is that it controls for plant-level unobservables by only looking at "stayers". This is why Equation (3) contains the term $\Delta\psi_j$ whereas Equation (7) does not. This is, in fact, essentially the same method suggested by Martins (2004).[2]

Because (7) ignores information on movers, it is not the most efficient estimate of $\delta$ (or any other parameter). In addition, one cannot recover separately estimates of $\theta_i$ or $\psi_j$. An alternative method would be to estimate (3) but include a full set of (differenced) firm dummies to control for non-random selection on $\psi_j$. However, this method is likely to be computationally infeasible since we have many thousands of plants. A solution to this problem is to use the Classical Minimum Distance (CMD) estimator outlined in in Andrews et al. (2006). It forms a restricted estimator for $\boldsymbol{\beta}$, $\delta$, $\lambda$ and $\psi$ from the parameters of (3) and (7) estimated separately.[3] An additional advantage of the CMD estimator is that it provides a natural way of testing whether movers and non-movers are "different", by comparing, for example, $\delta$ across the two sub-samples using standard parameter-stability type tests.

Because we have a sample of plants, an individual is a mover only if they move from one plant to another plant in the sample. Therefore the number of movers is very small compared to the total number of observations. In addition, $\psi_j$ cannot be estimated for plants which experience no turnover, which reduces the number of dummy variables required. In short, (3) can be estimated using standard software.

To summarise, if (1) and (2) represents the true process by which wages are generated, one can obtain consistent estimates of the foreign-ownership on wages using: (1) if ownership is random; (3) if ownership is non-random with respect to $\theta_i$; (6) if ownership is non-random with respect to $\psi_j$; and (7) if ownership is non-random with respect to $\theta_i$ and $\psi_j$. More efficient estimates can also be obtained using a CMD estimate which combines both movers and non-movers.

All of the above is repeated for all foreign-owned plants in $t = 1$, some of whom become domestic (the second treatment group) in $t = 2$.

[2] Also note that, in the tables below, we decompose the *Raw DiD/FE* estimates into those for *Movers only* and *Stayers only*.

[3] See Wooldridge (2002, ch. 14.6) and Andrews et al. (2006) for further details.

# 4 The data and descriptive statistics

There are two data sources. The first is the *Institut für Arbeitsmarkt- und Berufsforschung (IAB) Establishment Panel*, an annual survey of approximately 8,250 plants located in the former West Germany and an additional 7,900 plants in the former East Germany. The survey started in 1993 and is ongoing. It covers 1% of all plants and 7% of all employment in Germany, and is therefore a sample weighted towards larger plants. Information is obtained by personal interviews with plant managers, and comprises about 80 questions per year, giving us information on, for example, total employment, bargaining arrangements, standard and overtime hours, output, exports, investment, wage bill, location, industry, profit level and nationality of ownership. Ownership is defined as either West German, East German, foreign, or public.[4] Complete information on plant ownership is available for all plants only in 2000 and 2004, so we restrict our analysis to those years. A detailed description of the IAB panel can be found in Kölling (2000).

The second source of data is the employment statistics register of the German Federal Office of Labour (*Beschäftigtenstatistik*). This register covers all employees or trainees registered by the social insurance system. The register covers about 80% of employees in Western Germany and about 85% in Eastern Germany. Information on employees includes basic demographics, start and end dates of employment spells, occupation and industry, earnings, qualifications (school and post-school), and a plant identification number. A detailed description of the employment data can be found in Bender, Haas & Klose (2000).

By using the plant identification number we can associate each worker with a plant in the panel. We therefore observe approximately 80% of all workers in about 14,000 plants each year. Because the employment register is spell-based (one record for each employment spell), the combined data is potentially complex. To simplify, we select all employees in the employment register who are employed by the surveyed plants on June 30th each year. This yields an unbalanced annual panel of employees together with detailed information on the plants in which they work. We refer to the linked data as the Linked IAB panel, or LIAB.

Table 2 summarises the basic sample which we use for the analysis.[5]

About 9% of plants in West Germany and 5% in East Germany are foreign affiliates.

[4] The relevant question is: "Is the establishment mainly or solely in: (a) West German Ownership (b) East German Ownership (c) Foreign Ownership (d) Public Ownership (e) No single owner which holds majority?" Our analysis considers only plants under (a)-(c).

[5] We exclude plants in agriculture, education and health and the public sector.

| | *West Germany* | | *East Germany* | |
|---|---|---|---|---|
| | 2000 | 2004 | 2000 | 2004 |
| *Plants* | | | | |
| West German-owned | 4,712 | 5,164 | 871 | 792 |
| East German-owned | 7 | 14 | 2,227 | 2,166 |
| Foreign-owned | 490 | 546 | 122 | 169 |
| Total | 5,209 | 5,724 | 3,220 | 3,127 |
| *Workers* | | | | |
| West German-owned | 662,134 | 683,816 | 88,431 | 79,097 |
| East German-owned | 765 | 863 | 53,291 | 48,182 |
| Foreign-owned | 187,703 | 169,396 | 23,344 | 24,800 |
| Total | 850,602 | 854,075 | 165,066 | 152,079 |

**Table 2:** The LIAB sample

However, these plants employ about 20% of West German workers and about 15% of East German workers, because they tend to be larger than average. As we would expect, there is considerable cross-border ownership of East German plants by West German firms, but almost no ownership of West German plants by East German firms.[6]

Because the plant-level information in our data come from a survey, rather than an administrative source, we have a large number of measurable covariates, shown in Table A.1. We have rather less information on workers, shown in Table A.2.

# 5 Results

All our estimates can be thought of as variants of the basic Difference-in-Differences estimator. We do not simply regress wages on a dummy for "ownership" and a set of control variables for two reasons. First, because doing so forces the effect of ownership to be the same regardless of the direction of takeover. That is, a firm which changes from West German to foreign is restricted to have the same wage change as a firm which changes from foreign to West German. Second, because it fails to distinguish between the selection effect and the genuine takeover effect.

Define dummy variables to measure the ownership status of a worker's plant in period $t$:

$$E_{J(i,t)t} = 1 \text{ if worker } i \text{ is in an East German-owned plant in period } t\text{, 0 otherwise}$$

$$W_{J(i,t)t} = 1 \text{ if worker } i \text{ is in an West German-owned plant in period } t\text{, 0 otherwise}$$

[6] In our analysis we therefore exclude East German-owned plants in West Germany.

$F_{J(i,t)t} = 1$ if worker $i$ is in a foreign-owned plant in period $t$, 0 otherwise

In West Germany we ignore $E_{J(i,t)t} = 1$, and therefore we have only two treatment and control groups defined by the following dummies:

$$T_{WF} = \begin{cases} 1 \text{ if } F_{J(i,1)1} = 0 \text{ and } F_{J(i,2)2} = 1 \\ 0 \text{ if } F_{J(i,1)1} = 0 \text{ and } F_{J(i,2)2} = 0 \end{cases}$$

$$T_{FW} = \begin{cases} 1 \text{ if } F_{J(i,1)1} = 1 \text{ and } F_{J(i,2)2} = 0 \\ 0 \text{ if } F_{J(i,1)1} = 1 \text{ and } F_{J(i,2)2} = 1 \end{cases}$$

Our two DiD estimators for West Germany are therefore

$$y_{it} = \mathbf{z}'_{it}\boldsymbol{\beta} + \delta_F F_{jt} + \gamma_{WF} T_{WF} + \lambda_2 + \varepsilon_{it} \tag{8}$$

for plants which are domestic at $t = 1$,

$$y_{it} = \mathbf{z}'_{it}\boldsymbol{\beta} + \delta_W W_{jt} + \gamma_{FW} T_{FW} + \lambda_2 + \varepsilon_{it} \tag{9}$$

For plants in East Germany there are six possible treatment and control groups. For example, $T_{EW}$ defines the group of plants who are domestic at $t = 1$ and become West German, while $T_{EF}$ defines the group who become foreign. Similarly we have $T_{WE}$ and $T_{WF}$ for plants which are West-German at $t = 1$ and $T_{FE}$, $T_{FW}$ for plants which are foreign at $t = 1$. The three DiD estimators for East Germany are therefore

$$y_{it} = \mathbf{z}'_{it}\boldsymbol{\beta} + \delta_W W_{jt} + \delta_F F_{jt} + \gamma_{EW} T_{EW} + \gamma_{EF} T_{EF} + \lambda_2 + \varepsilon_{it} \tag{10}$$

for plants which are domestic at $t = 1$,

$$y_{it} = \mathbf{z}'_{it}\boldsymbol{\beta} + \delta_E E_{jt} + \delta_F F_{jt} + \gamma_{WE} T_{WE} + \gamma_{WF} T_{WF} + \lambda_2 + \varepsilon_{it} \tag{11}$$

for plants which are West German-owned at $t = 1$ and

$$y_{it} = \mathbf{z}'_{it}\boldsymbol{\beta} + \delta_E E_{jt} + \delta_W W_{jt} + \gamma_{FE} T_{FE} + \gamma_{FW} T_{FW} + \lambda_2 + \varepsilon_{it} \tag{12}$$

for plants which are foreign at $t = 1$.

## 5.1 West Germany

The first panel shows the raw DiD estimate (Equation 4), which can be estimated either using OLS or fixed-effects. Our first basic result is that domestic firms which are taken over pay significantly higher wages *before* they are taken over. This is the coefficient on $T_F$, estimated at 0.106 log-points. Similarly, foreign-owned firms which become domestic pay lower wages ($-0.038$) before they become domestic, but this effect is insignificantly different from zero. There is then an additional boost to wages of 0.040 log points after takeover. This result is almost exactly mirrored by firms which switch from foreign to domestic (0.041 log points). In the raw data therefore, foreign firms appear to take over higher-paying domestic firms, but also boost wages after takeover. Foreign-owned firms which revert to domestic ownership do not pay significantly lower wages, but wages do drop significantly afterwards.

**Table 3:** Results for plants in West Germany

| | *Domestic in 2000* | | | | | *Foreign in 2000* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Individual level* | | *Plant level* | | | *Individual level* | | *Plant level* | |
| *Raw DiD/FE* | | | | | | | | | |
| $\gamma_{WF}$ | 0.106 | (0.037) | 0.211 | (0.056) | $\gamma_{FW}$ | $-0.038$ | (0.046) | $-0.092$ | (0.096) |
| $\delta_F$ | 0.040 | (0.015) | 0.045 | (0.010) | $\delta_W$ | $-0.041$ | (0.020) | $-0.003$ | (0.018) |
| *Stayers only* | | | | | | | | | |
| $\gamma_{WF}$ | 0.108 | (0.038) | 0.208 | (0.056) | $\gamma_{FW}$ | $-0.043$ | (0.049) | $-0.094$ | (0.096) |
| $\delta_F$ | 0.039 | (0.015) | 0.048 | (0.011) | $\delta_W$ | $-0.017$ | (0.011) | 0.006 | (0.018) |
| *Movers only* | | | | | | | | | |
| $\gamma_{WF}$ | 0.046 | (0.036) | | | $\gamma_{FW}$ | $-0.034$ | (0.048) | | |
| $\delta_F$ | 0.092 | (0.051) | | | $\delta_W$ | $-0.186$ | (0.098) | | |
| *OLS DiD, conditional on covariates* | | | | | | | | | |
| $\gamma_{WF}$ | 0.054 | (0.018) | 0.009 | (0.033) | $\gamma_{FW}$ | 0.035 | (0.015) | 0.001 | (0.034) |
| $\delta_F$ | 0.024 | (0.008) | 0.031 | (0.013) | $\delta_W$ | $-0.013$ | (0.014) | 0.003 | (0.021) |
| *OLS DiD, Covariates fixed at t=1* | | | | | | | | | |
| $\gamma_{WF}$ | 0.050 | (0.017) | 0.006 | (0.033) | $\gamma_{FW}$ | 0.036 | (0.016) | 0.009 | (0.031) |
| $\delta_F$ | 0.040 | (0.015) | 0.045 | (0.010) | $\delta_W$ | $-0.041$ | (0.019) | $-0.003$ | (0.021) |
| *FE(i), conditional on covariates* | | | | | | | | | |
| $\delta_F$ | 0.028 | (0.008) | 0.041 | (0.011) | $\delta_W$ | $-0.015$ | (0.009) | $-0.005$ | (0.016) |
| *FE(s), raw* | | | | | | | | | |
| $\delta_F$ | 0.039 | (0.015) | | | $\delta_W$ | $-0.017$ | (0.011) | | |
| *FE(s), conditional on covariates* | | | | | | | | | |
| $\delta_F$ | 0.026 | (0.009) | | | $\delta_W$ | $-0.017$ | (0.010) | | |
| *CMD, conditional on covariates* | | | | | | | | | |
| $\delta_F$ | 0.026 | (0.008) | | | $\delta_W$ | $-0.017$ | (0.010) | | |

Notes: reports estimates of (8) and (9). Robust standard errors in parentheses.

Because this is an individual-level wage equation, the estimates of $\delta_F$ and $\delta_W$ are driven both by plants which change their ownership status and by individuals who switch between plants of different ownership status. If movers are non-random with respect to ownership status, this might bias our DiD estimates. It is straightforward to control for this by looking at wages only of individuals who remain in the same plant. This has barely any effect on the takeover effect for plants which switch from domestic to foreign (0.039 log-points) but halves the estimated effect for plants which switch from foreign to domestic.[7] This shows that part of the apparent fall in wages is due to the fall in wages experienced by workers who change plant from foreign to domestic. Looking at the wages of movers only, we see that movers suffer a large fall of $-0.186$ log-points.

This large estimated loss for movers sheds light on whether the wage effects of foreign-ownership "spillover" into the domestic economy. It has been suggested that foreign-owned firms pay higher wages because they provide greater investment in human capital. If this human capital was general, we would expect to see *smaller* wage losses for movers from foreign to domestic plants than wage gains for movers from domestic to foreign. In fact, there is little evidence for this in the raw DiD estimates.

The raw DiD estimate controls for permanent differences in wages between plants which change ownership status and those that do not. These large differences (estimated to be about 10%) may in part be due to differences in observed characteristics, which we call $\mathbf{x}_{it}$ and $\mathbf{w}_{jt}$. For example, firms which get taken over may be larger or in higher-paying industries. Incorporating a full set of time-varying controls in the basic DiD regression reduces the estimate of $\gamma_{WF}$ from 0.106 to 0.054, as expected. Interestingly, the estimate of $\gamma_{FW}$ for plants which change from foreign to domestic changes sign and becomes positive and significant. In the raw data there appears to be negative selection: lower-paying firms switch from foreign to domestic. But this is due to differences in $\mathbf{x}_{it}$ and $\mathbf{w}_{jt}$. The inclusion of covariates also reduces the takeover effect a lot. However, this model is incorrectly specified because it allows the covariates to vary between 2000 and 2004. A change in ownership status may cause changes in wages and changes in the observable characteristics of the plant. For example, a plant which becomes foreign-owned may grow larger and pay higher wages. By including $\mathbf{x}_{it}$ and $\mathbf{w}_{jt}$ in the regression we incorrectly "control for" these changes. The alternative is to measure covariates only at $t = 2000$. This of course means that $\mathbf{x}_{it}$ is a fixed effect, and so this estimator gives identical estimates of $\delta_F$

[7] The overall DiD estimate is a weighted average of the movers' and non-movers' estimates. Only a small fraction of the sample comprise movers (2312/79770).

and $\delta_W$ as the raw DiD.

A generalisation of the DiD framework allows for individual-specific unobserved permanent components of wages, or unobserved fixed-effects, labelled $\theta_i$. If we have a balanced panel between $t = 1$ and $t = 2$ the average value of $\theta_i$ is constant for the treatment and control groups, and so the raw fixed-effects estimator gives identical estimates as the OLS DiD.

Using DiD or FE methods we can control for time and person-level fixed effects. In addition, we can control for plant-level fixed effects by using spell fixed-effects (7). In fact, without covariates using spell fixed-effects is equivalent to using information only on stayers because for stayers $\Delta\psi_j = \psi_{J(i,t)} - \psi_{J(i,t-1)} = 0$. So the FE(s) results are identical to stayers only model. Conditioning on covariates, we find that foreign takeover of domestic firms does boost wages, but only by about 0.026 log-points, or 2.6%. This is much smaller than the selection effect. Domestic takeover of foreign firms appears to have a slightly smaller (negative) effect of 0.017. Given the relatively large standard errors on these two estimates, we cannot reject the hypothesis that the effect of takeover is equal and opposite. Thus, some of the effect on wages appears to be a effect which is gained when firms become foreign and is lost when they become domestic.

The final row reports estimates from our Classical Minimum Distance (CMD) method. This method controls for both individual and plants fixed-effects, and (unlike spell fixed-effects) includes both movers and non-movers. Reassuringly, we find that the CMD estimates are almost identical to the spell-fixed effects estimates, and so our preferred estimates appear robust to the choice of method.

As noted in Section 3, it is also possible to estimate wage effects at the level of the plant. This is useful not least for comparison with the existing literature. Our estimates of the selection effect are generally much bigger in the raw data (0.224 and $-0.165$). Without covariates the individual-level estimates are just a re-weighting of the plant level estimates, with larger plants having a higher weight. This shows that the selection effect is bigger for smaller plants. We would therefore expect that the inclusion of covariates (including firm size) in the plant-level estimates would reduce the selection effect, and this is indeed what happens.

### 5.2 East Germany

The East German results are more complex because there are three treatment/control groups, and two possible treatments for each group as shown in Equations (10)–(12).

In Table 4 we report the two selection effects and the two takeover effects for each possible group at $t = 1$.

**Table 4:** Results for plants in East Germany

| | *Domestic in 2000* | | | | | *West-German in 2000* | | | | | *Foreign in 2000* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Individual level* | | *Plant level* | | | *Individual level* | | *Plant level* | | | *Individual level* | | *Plant level* | |
| *Raw DiD/FE* | | | | | | | | | | | | | | |
| $\gamma_{EW}$ | 0.192 | (0.047) | 0.231 | (0.038) | $\gamma_{WE}$ | −0.078 | (0.050) | −0.040 | (0.040) | $\gamma_{FE}$ | 0.026 | (0.075) | −0.044 | (0.101) |
| $\gamma_{EF}$ | 0.307 | (0.090) | 0.340 | (0.102) | $\gamma_{WF}$ | −0.046 | (0.058) | 0.122 | (0.054) | $\gamma_{FW}$ | 0.002 | (0.048) | 0.039 | (0.072) |
| $\delta_W$ | 0.015 | (0.013) | 0.020 | (0.012) | $\delta_E$ | −0.062 | (0.020) | −0.013 | (0.012) | $\delta_E$ | 0.031 | (0.040) | −0.012 | (0.033) |
| $\delta_F$ | 0.031 | (0.022) | −0.028 | (0.030) | $\delta_F$ | 0.024 | (0.028) | 0.083 | (0.020) | $\delta_W$ | −0.019 | (0.016) | 0.008 | (0.027) |
| *Stayers only* | | | | | | | | | | | | | | |
| $\gamma_{EW}$ | 0.217 | (0.048) | 0.231 | (0.038) | $\gamma_{WE}$ | −0.077 | (0.052) | −0.040 | (0.040) | $\gamma_{FE}$ | 0.037 | (0.073) | −0.044 | (0.101) |
| $\gamma_{EF}$ | 0.361 | (0.071) | 0.343 | (0.104) | $\gamma_{WF}$ | −0.049 | (0.060) | 0.129 | (0.056) | $\gamma_{FW}$ | 0.010 | (0.047) | 0.039 | (0.072) |
| $\delta_W$ | 0.003 | (0.012) | 0.019 | (0.012) | $\delta_E$ | −0.054 | (0.020) | −0.013 | (0.012) | $\delta_E$ | 0.048 | (0.033) | −0.012 | (0.033) |
| $\delta_F$ | 0.007 | (0.019) | −0.027 | (0.031) | $\delta_F$ | 0.024 | (0.014) | 0.078 | (0.016) | $\delta_W$ | −0.014 | (0.015) | 0.008 | (0.027) |
| *Movers only* | | | | | | | | | | | | | | |
| $\gamma_{EW}$ | −0.103 | (0.075) | | | $\gamma_{WE}$ | −0.001 | (0.099) | | | $\gamma_{FE}$ | −0.248 | (0.111) | | |
| $\gamma_{EF}$ | −0.162 | (0.093) | | | $\gamma_{WF}$ | 0.081 | (0.180) | | | $\gamma_{FW}$ | −0.191 | (0.110) | | |
| $\delta_W$ | 0.099 | (0.116) | | | $\delta_E$ | −0.184 | (0.156) | | | $\delta_E$ | −0.346 | (0.170) | | |
| $\delta_F$ | 0.187 | (0.137) | | | $\delta_F$ | 0.033 | (0.264) | | | $\delta_W$ | −0.124 | (0.156) | | |
| *OLS DiD, conditional on covariates* | | | | | | | | | | | | | | |
| $\gamma_{EW}$ | 0.160 | (0.024) | 0.145 | (0.025) | $\gamma_{WE}$ | −0.020 | (0.025) | 0.007 | (0.028) | $\gamma_{FE}$ | −0.093 | (0.039) | −0.434 | (0.096) |
| $\gamma_{EF}$ | 0.264 | (0.061) | 0.201 | (0.054) | $\gamma_{WF}$ | 0.032 | (0.035) | −0.008 | (0.027) | $\gamma_{FW}$ | 0.030 | (0.045) | 0.143 | (0.157) |
| $\delta_W$ | 0.002 | (0.013) | 0.009 | (0.016) | $\delta_E$ | −0.036 | (0.018) | 0.001 | (0.023) | $\delta_E$ | −0.034 | (0.044) | 0.036 | (0.099) |
| $\delta_F$ | −0.037 | (0.034) | −0.065 | (0.030) | $\delta_F$ | 0.017 | (0.024) | 0.095 | (0.023) | $\delta_W$ | 0.075 | (0.049) | 0.051 | (0.054) |
| *OLS DiD, Covariates fixed at t=1* | | | | | | | | | | | | | | |
| $\gamma_{EW}$ | 0.161 | (0.023) | 0.146 | (0.027) | $\gamma_{WE}$ | −0.020 | (0.028) | 0.011 | (0.027) | $\gamma_{FE}$ | −0.188 | (0.033) | −0.327 | (0.024) |
| $\gamma_{EF}$ | 0.258 | (0.061) | 0.175 | (0.062) | $\gamma_{WF}$ | 0.040 | (0.036) | −0.021 | (0.027) | $\gamma_{FW}$ | −0.149 | (0.029) | 1.315 | (0.019) |
| $\delta_W$ | 0.015 | (0.012) | 0.020 | (0.012) | $\delta_E$ | −0.062 | (0.019) | −0.013 | (0.013) | $\delta_E$ | 0.031 | (0.040) | −0.012 | (0.047) |
| $\delta_F$ | 0.031 | (0.019) | −0.028 | (0.030) | $\delta_F$ | 0.024 | (0.020) | 0.083 | (0.021) | $\delta_W$ | −0.019 | (0.015) | 0.008 | (0.039) |
| *FE(i), conditional on covariates* | | | | | | | | | | | | | | |
| $\delta_W$ | 0.012 | (0.011) | 0.020 | (0.013) | $\delta_E$ | −0.051 | (0.014) | −0.014 | (0.013) | $\delta_E$ | 0.015 | (0.046) | 0.113 | (0.167) |
| $\delta_F$ | 0.028 | (0.030) | −0.032 | (0.034) | $\delta_F$ | 0.025 | (0.014) | 0.060 | (0.016) | $\delta_W$ | 0.031 | (0.025) | 0.036 | (0.039) |
| *FE(s), raw* | | | | | | | | | | | | | | |
| $\delta_W$ | 0.003 | (0.012) | | | $\delta_E$ | −0.054 | (0.020) | | | $\delta_E$ | 0.048 | (0.033) | | |
| $\delta_F$ | 0.007 | (0.019) | | | $\delta_F$ | 0.024 | (0.014) | | | $\delta_W$ | −0.014 | (0.015) | | |
| *FE(s), conditional on covariates* | | | | | | | | | | | | | | |
| $\delta_W$ | 0.013 | (0.012) | | | $\delta_E$ | −0.047 | (0.015) | | | $\delta_E$ | 0.055 | (0.046) | | |
| $\delta_F$ | 0.007 | (0.037) | | | $\delta_F$ | 0.020 | (0.015) | | | $\delta_W$ | 0.032 | (0.027) | | |

Notes: reports estimates of (10), (11) and (12). Robust standard errors in parentheses.

The raw DiD estimates show first of all that the selection effect for domestic plants in 2000 is much larger than in West Germany. Plants which change from domestic to West-German pay 0.192 log-points more than those who remain domestic; plants which become foreign pay 0.307 more. Once these large selection effects are taken into account, the takeover effect on wages is small and insignificantly different from zero. Selection effects for West German-owned and foreign-owned plants in 2000 are much smaller and insignificantly different from zero. Once again, the large selection effects for domestic plants which become foreign or West-German is consistent with the idea that higher-paying plants are those which get taken over.[8]

The second and third panels show that these selection effects differ widely between stayers and movers. Workers who remain in the same plant have even larger selection effects, while workers who move actually have negative (albeit poorly determined) effects. This is evidence that those workers who were low-paid workers in domestic plants at $t = 1$ are those which leave. Note however that the selection effect is also large and negative for movers from plants which were foreign-owned in 2000. So it is not just that foreign takeovers weed out low-paying workers: takeovers in the reverse direction appear to do the same.

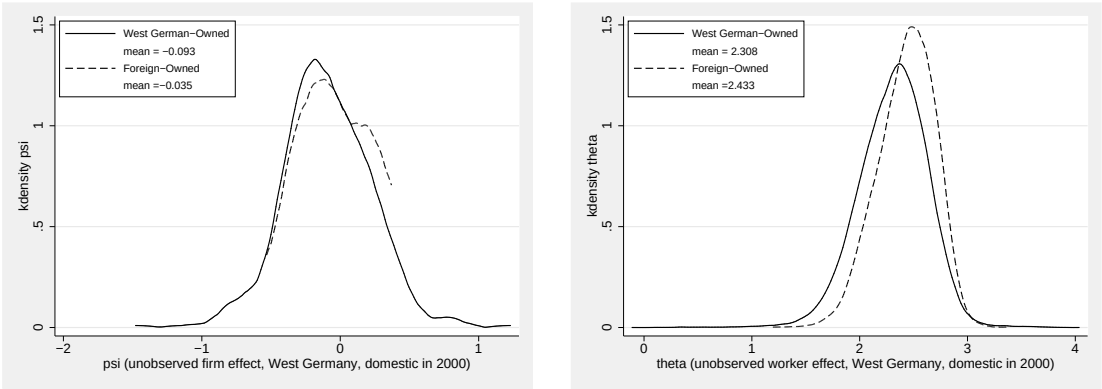
Our preferred estimates for the takeover effect are those which control for both worker and firm fixed-effects, labelled FE(s). In almost every case we find small and insignificant effects. The only exception is a fall of $-0.047$ log points for West German-owned plants which become domestic. Thus, we find that while selection is greater in East Germany, there is actually less evidence that takeover has any additional effect on wages.

### 5.3 Selection effects at the firm-level and the individual-level

Using the preferred fixed-effects methods, such as FE(s) or CMD, means that the parameter identifying the selection effect is not directly estimated. For example, in Equation (7), the treatment dummy $T$ is swept away by the within-spell transformation. However, using CMD we can recover estimates of both the worker and the firm fixed component of wages, denoted $\theta_i$ and $\psi_j$. This allows us to compare their mean or their distribution between the treatment and control groups of each type.

In Figure 1 we plot the distribution of our estimates of $\psi_j$ and $\theta_i$ for the control and treatment groups corresponding to those West German plants which were domestic in 2000.

[8] It is also consistent with a model in which the effects of foreign ownership on wages take a long time (more than four years) to develop.




(a) Plant effect $\hat{\psi}_j$ (b) Worker effect $\hat{\theta}_i$

**Figure 1:** Estimated distribution of unobserved fixed wage components, West German plants

In both cases, as we would expect, we find that the distribution of the fixed unobserved component of wages for the treatment group lies to the right of that for the control group. This is another way of showing the selection effect, but one which decomposes the selection effect into two components: one relating to the firm, and one to the worker. The difference in the mean of $\hat{\theta}_i$ is about 0.11 log-points, while the difference in $\hat{\psi}_j$ is about 0.058. In both cases, plants which are taken over have higher fixed worker- and plant-level characteristics, although it seems that the worker-level effect is quantitatively more important.

### 5.4 Heterogeneity in the foreign ownership effect

Even if the average effect of changing ownership status is small, it might be that this disguises some larger or smaller effects for subgroups in the data. For example, foreign-owned firms might implement a steeper wage-tenure profile, or might reward highly-skilled workers relatively more. The effects of foreign-owned firms might also vary by firm characteristic, such as size and profitability. A further benefit of linked employer-employee data is that we can disaggregate the foreign ownership effect by both worker characteristics and firm characteristics.

To enable comparison of a large number of coefficient estimates, we use graphical methods. In Figure 2 we plot the estimate of $\delta_F$ for each sub-group of the data, together with its 95% confidence interval. For reference we also draw vertical lines showing the FE(s) pooled estimate of $\delta_F = 0.026$ and the null hypothesis $\delta_F = 0$. The subgroups we choose are based on those covariates described in Tables A.1 and A.2, and include worker and firm characteristics.

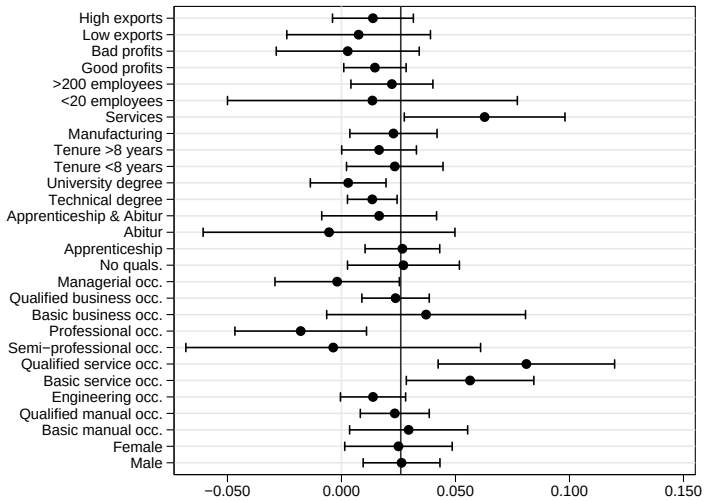



**Figure 2:** FE(s) estimates of $\delta_F$, West German plants

Figure 2 enables us to see at a glance that confidence intervals for almost all sub-groups of the data include the pooled estimate, and most also include zero, which partly reflects the fact that the pooled estimate itself is only 0.026 with a standard error of 0.009. Thus we find little evidence that takeover effects are much larger or much smaller for subgroups of the data. The only notable exceptions are for workers in service occupations and for firms in the service sector, where there is evidence of larger takeover effects. The coefficient on $\delta_F$ for service sector firms, for example, is 0.062. Thus, foreign firms do *not* appear to reward more highly-skilled occupations or more highly qualified individuals more.

In Figure 3 we repeat the exercise, but look at the takeover effect from domestic to foreign in East Germany. As Table 4 shows, our preferred pooled estimate for the $\delta_F$ is effectively zero (0.007), and most sub-groups have confidence intervals which include zero. Exceptions are workers in engineering and managerial occupations, which have much larger takeover effects, and workers in firms with high levels of exports.

Finally, Figure 4 plots estimates and confidence intervals for the West German takeover effect. Once again, there is very little evidence here that takeover effects are significantly different from zero for any subgroup of the population, with the exception of one occupational group (professionals). Taken as a whole, these results confirm that once selection is taken into account, the true takeover effect is small for most groups.

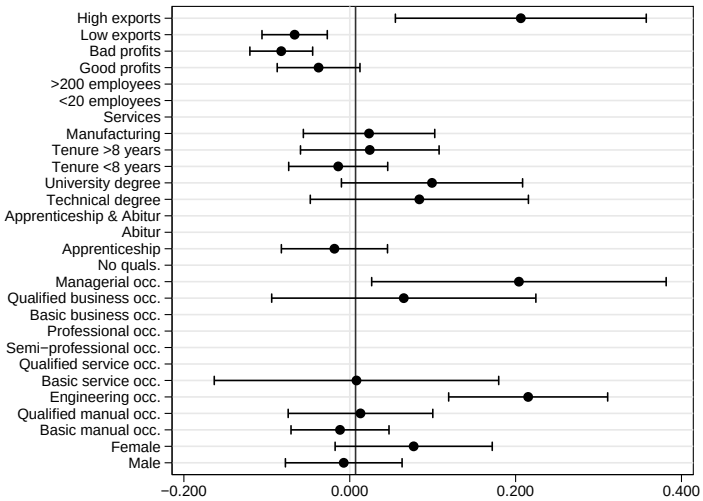



**Figure 3:** FE(s) estimates of $\delta_F$, East German plants, domestic in 2000

# 6 Conclusion

We have shown how the treatment-effects framework can be used to estimate the "selection" and "takeover" components of the wage gap between foreign and domestic firms. With linked worker-firm data it is possible to use this framework to isolate the effects of selection on both plant and worker unobservable components of wages.

We find evidence of large selection effects both in terms of worker- and firm unobserved components of wages: plants which get taken over by foreign firms have higher plant-level wages and higher individual-level wages before they are taken over. The selection effect are larger for East German plants, both for those which change to West German ownership and foreign ownership. Once the selection effect is taken into account, the genuine takeover effect is small and in some cases insignificantly different from zero. In contrast to the selection effect, the takeover effect is slightly larger in West Germany.

The framework we use also distinguishes between firms which change ownership status from domestic to foreign and *vice versa*. Most previous studies impose the restriction that these two effects are equal and opposite, as they would be if there was a simple wage bonus paid to workers in foreign-owned firms. In West Germany we cannot reject this simple model: the takeover effect is 2.6% in one direction and -1.7% in the other direction. In addition, workers who leave foreign-owned plants and join domestic plants experience significant wage falls. This evidence is not supportive of the idea that foreign-owned firms might offer spillover benefits to the

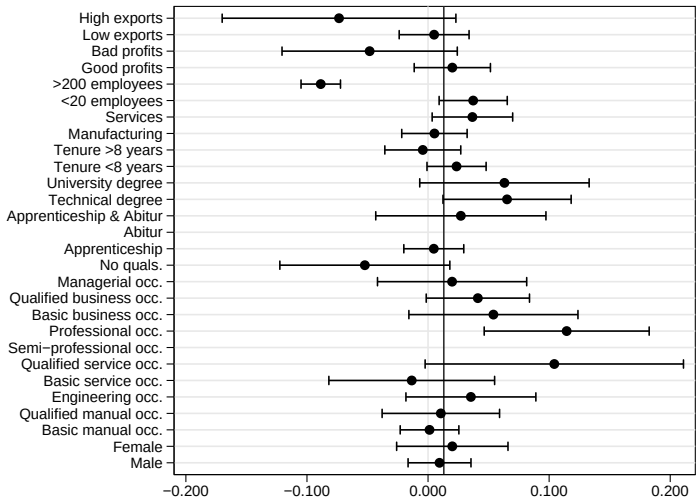



**Figure 4:** FE(s) estimates of $\delta_W$, East German plants, domestic in 2000

domestic economy.

The use of linked data on workers and firms allows us to investigate whether there are any distributional consequences of ownership status. We split the sample by a number of possibly relevant characteristics and re-estimate the takeover effect. We find little evidence that takeover effects are much larger or much smaller for subgroups of the data. In particular, there is no systematic pattern in terms of skill or occupational groups: foreign-firms do not appear to change the reward structure within firms significantly once selection effects are accounted for.

One interpretation of these results is that the true impacts of ownership structure on the labour market are small, at least in Germany in the 21st century. A second possibility is that wage effects take a long time to manifest themselves. What we call the selection effect is not distinguishable in our data from the long-run effect on wages of foreign-ownership.

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# A Sample means

| | | *West Germany* | | *East Germany* | | |
|---|---|---|---|---|---|---|
| | | *West* | *Foreign* | *East* | *West* | *Foreign* |
| size | Number of employees | 4610.076 | 3136.473 | 208.603 | 768.144 | 566.942 |
| — | Mining, energy | 0.023 | 0.012 | 0.070 | 0.075 | 0.075 |
| ind2 | Food | 0.036 | 0.022 | 0.051 | 0.048 | 0.057 |
| ind3 | Consumer goods | 0.053 | 0.049 | 0.028 | 0.052 | 0.047 |
| ind4 | Producer goods | 0.201 | 0.340 | 0.128 | 0.209 | 0.221 |
| ind5 | Investment goods | 0.445 | 0.464 | 0.221 | 0.371 | 0.444 |
| ind6 | Construction | 0.036 | 0.014 | 0.199 | 0.072 | 0.071 |
| ind7 | Trade | 0.076 | 0.042 | 0.068 | 0.067 | 0.023 |
| ind8 | Transport & communications | 0.052 | 0.014 | 0.068 | 0.033 | 0.010 |
| ind9 | Banks & insurance | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 |
| ind10 | Catering | 0.006 | 0.003 | 0.013 | 0.010 | 0.006 |
| ind11 | Business services | 0.058 | 0.033 | 0.104 | 0.049 | 0.028 |
| ind12 | Other services | 0.012 | 0.007 | 0.050 | 0.015 | 0.018 |
| — | Population >500,000 (central) | 0.333 | 0.387 | 0.108 | 0.125 | 0.106 |
| urban2 | Population >500,000 (outskirts) | 0.033 | 0.037 | 0.034 | 0.049 | 0.037 |
| urban3 | Population 100,000-500,000 (central) | 0.194 | 0.238 | 0.221 | 0.268 | 0.216 |
| urban4 | Population 100,000-500,000 (outskirts) | 0.161 | 0.079 | 0.089 | 0.101 | 0.069 |
| urban5 | Population 50,000-100,000 (central) | 0.024 | 0.009 | 0.058 | 0.043 | 0.110 |
| urban6 | Population 50,000-100,000 (outskirts) | 0.067 | 0.039 | 0.130 | 0.135 | 0.197 |
| urban7 | Population 20,000-50,000 | 0.094 | 0.127 | 0.149 | 0.127 | 0.096 |
| urban8 | Population 5,000-20,000 | 0.066 | 0.067 | 0.118 | 0.085 | 0.061 |
| urban9 | Population 2,000-5,000 | 0.018 | 0.014 | 0.059 | 0.037 | 0.078 |
| urban10 | Population <2,0000 | 0.009 | 0.003 | 0.035 | 0.029 | 0.031 |
| single | Plant not part of larger firm | 0.391 | 0.207 | 0.878 | 0.555 | 0.510 |
| B1 | Sectoral bargaining agreement | 0.735 | 0.829 | 0.353 | 0.579 | 0.635 |
| B2 | Firm-level bargaining agreement | 0.138 | 0.063 | 0.177 | 0.152 | 0.162 |
| inv | Investment (relative to median) | 1989.145 | 1989.369 | 263.948 | 717.698 | 475.996 |
| conc | Herfindahl concentration index (3-digit) | 0.017 | 0.017 | 0.006 | 0.015 | 0.023 |
| — | Profits "very good" | 0.077 | 0.073 | 0.037 | 0.059 | 0.064 |
| profit2 | Profits "good" | 0.300 | 0.349 | 0.315 | 0.342 | 0.329 |
| profit3 | Profits "Satisfactory" | 0.355 | 0.245 | 0.355 | 0.345 | 0.280 |
| profit4 | Profits "Just sufficient" | 0.158 | 0.136 | 0.185 | 0.131 | 0.183 |
| profit5 | Profits "Bad" | 0.110 | 0.197 | 0.107 | 0.123 | 0.143 |
| vin | Age of plant (years) | 20.946 | 18.853 | 2.067 | 2.369 | 2.142 |
| exp | Proportion of exports in total sales | 0.303 | 0.438 | 0.063 | 0.192 | 0.304 |

**Table A.1:** Plant-level sample means by location and ownership status

| | | *West Germany* | | *East Germany* | | |
|---|---|---|---|---|---|---|
| | | *West* | *Foreign* | *East* | *West* | *Foreign* |
| wage | Daily wage in € cents | 101.945 | 109.560 | 60.097 | 77.352 | 81.035 |
| female | Female | 0.193 | 0.187 | 0.281 | 0.254 | 0.233 |
| age | Age | 41.088 | 41.043 | 41.722 | 42.055 | 42.472 |
| — | Without apprenticeship or Abitur | 0.171 | 0.183 | 0.026 | 0.045 | 0.043 |
| qual2 | Apprenticeship, no Abitur | 0.641 | 0.583 | 0.768 | 0.717 | 0.725 |
| qual3 | No apprenticeship, with Abitur | 0.008 | 0.010 | 0.002 | 0.004 | 0.003 |
| qual4 | With apprenticeship and Abitur | 0.034 | 0.035 | 0.023 | 0.027 | 0.027 |
| qual5 | Technical college degree | 0.048 | 0.064 | 0.045 | 0.063 | 0.073 |
| qual6 | University education | 0.049 | 0.069 | 0.051 | 0.069 | 0.079 |
| qual7 | Education unknown | 0.048 | 0.055 | 0.086 | 0.075 | 0.050 |
| — | Basic manual occupation | 0.299 | 0.366 | 0.250 | 0.343 | 0.413 |
| occ2 | Qualified manual occupation | 0.211 | 0.157 | 0.296 | 0.211 | 0.198 |
| occ3 | Engineers and technicians | 0.151 | 0.174 | 0.094 | 0.125 | 0.139 |
| occ4 | Basic service occupation | 0.101 | 0.067 | 0.129 | 0.117 | 0.070 |
| occ5 | Qualfied service occupation | 0.010 | 0.004 | 0.024 | 0.007 | 0.012 |
| occ6 | Semi-professional | 0.004 | 0.003 | 0.003 | 0.005 | 0.002 |
| occ7 | Professional | 0.006 | 0.006 | 0.006 | 0.004 | 0.006 |
| occ8 | Basic business occupation | 0.044 | 0.048 | 0.042 | 0.035 | 0.023 |
| occ9 | Qualified business occupation | 0.149 | 0.142 | 0.123 | 0.116 | 0.104 |
| occ10 | Manager | 0.025 | 0.033 | 0.033 | 0.036 | 0.034 |
| tenure | Tenure in years | 10.896 | 10.101 | 5.922 | 6.426 | 6.642 |

**Table A.2:** Individual-level sample means by location and ownership status