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# Ownership change and its implications for the match between the plant and its workers

BY

**Ragnhild Balsvik** AND **Stefanie A. Haller**



Norges Handelshøyskole

NORWEGIAN SCHOOL OF ECONOMICS

# Ownership change and its implications for the match between the plant and its workers*

Ragnhild Balsvik† Stefanie A. Haller‡

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**Abstract**

Is ownership change an opportunity for new owners to make systematic changes in the workforce of the acquired plant? This paper explores the adjustments to plant size and the composition of the workforce that occur around ownership change using matched employer-employee data. Furthermore, we explore changes in the workforce along unobservable dimensions of worker quality and the quality of the match between the plant and its workers. We observe excess labour turnover around ownership change, but only in the case of foreign acquisitions do we find an improvement in unobserved worker and match quality at the plant level.

**Keywords:** ownership change, matched employer-employee data, multinationals, worker reallocation, unobserved fixed effects

**JEL Classification:** F66, F23, J20

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†Norwegian School of Economics, Helleveien 30, 5045 Bergen, Norway; email: ragnhild.balsvik at nhh.no

‡University College Dublin, School of Economics, Belfield, Dublin 4, Ireland; email: stefanie.haller at ucd.ie

# 1 Introduction

Mergers and acquisitions (M&A) are regarded as a tool for restructuring the ownership and control of plants. Much of the literature views M&As as a way to improve the allocation of resources towards more efficient firms and owners by improving the match between the firm and its plants (Jovanovic and Rousseau, 2008; Lucas, 1978; Lichtenberg and Siegel, 1987; Maksimovic and Phillips, 2002; Maksimovic et al., 2011). For example, Lichtenberg and Siegel (1987) argue that below average productivity of a plant is a signal of a bad match and an indicator for the firm to sell the plant.[1] Siegel and Simons (2010) take this perspective of M&As as a matching between firms and plants to the match between workers and plants and argue that new owners "will recognize the opportunity to improve the sorting and matching of workers across plants. They discard unproductive workers, upgrade existing workers' skills, and hire new workers whose skills benefit the organization" (ibid. p. 904). This may explain why, for the affected workers, ownership change is often associated with fears over job losses. Indeed, governments have intervened with the aim of preserving jobs in some of the larger foreign takeovers in recent years, such as the French government in the bid of General Electric for Alstom and the UK government in Pfizer's bid for Astra Zeneca.[2]

This paper provides an empirical exploration of the adjustments to the size and composition of the workforce that occur around ownership change. Is ownership change followed by substantial downsizing? Do new owners seize the opportunity to make changes to the workforce of the plant? And does this lead to an improvement in the quality of the workforce or the quality of worker-plant match quality after the ownership change? Siegel and Simons (2010) associate the notion of match quality to observable characteristics such as education, skills and wages. We first document how

[1] Their argument for firm and plant matching in M&As is based on the theory of job turnover in Jovanovic (1979).

[2] See, e.g., `http://fortune.com/2014/11/05/france-gives-green-light-to-ges-alstom-acquisition/` for the Alstom case and for the Astra Zeneca case `http://www.bloomberg.com/news/articles/2014-05-07/pfizer-has-cameron-channeling-hollande-amid-job-fears`. The UK government intervened despite the absence of provisions for government intervention in the case of foreign takeovers in British law. Countries like the U.S., Canada, France and Australia have direct legal mechanisms to halt foreign acquisitions.

worker transitions around ownership change affect the composition of the work force in terms of observable worker characteristics. Our main contribution to the literature on ownership change and employment is to provide a first assessment of changes to the composition of the workforce in terms of unobservable characteristics that can proxy for match quality. We use estimates of unobservable worker-fixed effects and match-fixed effects from Mincer wage equations to study the development of average worker and match quality at the plant level from before to after ownership change. We use comprehensive census and register data for Norwegian manufacturing plants and their employees for the period from 1996 to 2007 to investigate these transitions around both foreign and domestic ownership change.

The management perspective referred to in the first paragraph suggests that ownership change is an opportunity to effect changes in the workforce which ideally results in a workforce that is better matched to the plant and the new owners. Based on this, we expect to observe higher than usual worker turnover around acquisitions, and we start our analysis by documenting patterns in labour turnover around ownership change. There are only a few studies using matched employer-employee data that we are aware of that provide evidence on this. One example is the study by Csengödi et al. (2008) using data on foreign acquisitions in Hungary; they document a substantially higher share of new workers in the year of acquisition than the years before and after. Pesola (2009) finds increased job separation hazards following both domestic and foreign acquisitions in a sample of Finnish matched employer-employee data for 1990–2002. Although not based on matched employer-employee data, Davis et al. (2014) provide evidence of excess job reallocation following private equity buy-outs in the US.

Even in the absence of excess labour turnover, new owners may change the composition of the workforce by being more selective in their hires and separations. If new owners bring in new technology or new management practices, they may want to adjust the workforce (for example by skill upgrading) to complement these changes. We further investigate whether the worker turnover that we observe is associated with changes in the level of employment and changes in the skill and age composition of the workforce. This relates our paper to the empirical literature

on employment effects of ownership change. Previous studies on the effects of ownership change on the level of employment are not conclusive.[3] In terms of the effects on observable aspects of workforce composition, results again differ between studies.[4]

We find above average worker turnover at the plant level around acquisitions. In plants subject to domestic acquisitions this is associated with downsizing at the cost of high-skilled workers before the acquisition. From before to after domestic ownership change we also find a small reduction in the share of high-skilled workers, but no lasting changes to the age distribution of workers. Around foreign acquisitions the excess turnover does not give rise to a reduction in employment, nor significant changes to the skill or age composition of workers. In addition to this plant-level perspective on turnover, we also document that the probability of separation, from the perspective of workers, is higher when they work in a plant close to acquisition than in other periods of their career.

The ambiguous evidence from existing studies on changes to the skill composition after ownership change, does not rule out that systematic changes to the composition of the workforce take place as plants may screen workers along dimensions that are not observable in research data sets. Recent theoretical models that link globalization to sorting in the labour market put forward the idea that high-productivity firms have strong incentives to screen when selecting their workers. For example, in the model in Helpman et al. (2010), firms may use resources to screen ex-ante similar workers in order to select workers that are a good match to the firm ex-post. Because of complementarities in production, high-productivity exporters screen more intensively and end up with a workforce with higher average match quality than low-productivity firms. In this setting, a reduction in trade costs will increase the returns to screening for exporting firms and therefore

[3]Negative employment effects of acquisitions are found for the UK by Conyon et al. (2002) and Hijzen et al. (2013), and Lichtenberg and Siegel (1990) find that takeovers in the US are followed by a reduction in administrative overhead by cutting head-office employment. No significant change in employment levels following foreign acquisitions are found for Brazil and Germany (Hijzen et al., 2013), while positive effects are found for Sweden (Bandick and Karpathy, 2011), Portugal and Indonesia (Hijzen et al., 2013).

[4]Csengödi et al. (2008) find an increase in the share of highly educated workers after foreign acquisition in a panel of Hungarian manufacturing firms, Huttunen (2007) finds a reduction in the high-skill share in a panel of Finnish establishments, while Almeida (2007) finds no changes in the level of education following foreign acquisitions in Portugal.

increase average match quality in exporting firms. Krishna et al. (2014) provide empirical evidence from trade liberalization in Brazil consistent with this prediction.[5] Given that firms which are part of multinationals tend to outperform exporting firms in terms of productivity,[6] plants which become part of a multinational through foreign acquisition are likely to screen workers more intensively, just as in the case of reduced export costs for exporting firms.

Our aim here is, therefore, to study changes in unobservable aspects of the workforce around acquisitions. We use a measure of "innate" ability of workers captured by the unobserved worker-fixed effect from the wage decomposition proposed by Abowd et al. (1999), and study the change in average "worker quality" at the plant level from before to after ownership change. We also use the unobserved fixed effect related to each job spell or worker-plant match as a measure of match quality. This unobserved effect represents the wage or productivity premium associated with each job match between a worker and a firm (Woodcock, 2011). An improvement in the average innate ability of workers or the average match-fixed effect can be regarded as one piece of evidence of the screening or selection that occurs in the labour turnover around acquisitions. By definition, workers who remain in the same plant (during a period of ownership change) cannot contribute to a change in the average worker- or match-fixed effect at the plant level. The new owners may introduce changes in the firm that improve also the match between these stayers and the plant. This may manifest in the form of higher wage growth or in longer continuation tenure than for stayers in firms without ownership change. We investigate also these possibilities.

We find some evidence of firms selecting workers more carefully around foreign acquisitions. The distribution of unobserved fixed effects for newly hired workers dominates that of workers who are in the plant for a while; this difference is greater for workers in plants subject to foreign acquisitions. This selection is associated with a significant increase in the average of unobserved worker- and match-fixed effects at the plant level from before to after foreign acquisition. Workers who remain

[5] In a slightly different theoretical model, Davidson et al. (2008) predict that reduced trade costs should increase the correlation between worker and firm quality, i.e., positive sorting, in comparative advantage industries. Using data from Sweden, Davidson et al. (2014) find empirical support for this prediction.

[6] See Helpman et al. (2004) for a model and section 3 in Greenaway and Kneller (2007) for a summary of the evidence.

in the same plant around foreign acquisitions experience a wage increase from before to after acquisition, there is little evidence of an increased probability of longer tenure however. Workers who remain in plants subject to domestic acquisition around the acquisition do not experience wage increases, and their probability to stay on in the plant is lower than that for similar workers in plants that are not subject to acquisition in the short run.

Our results indicate that there is a substantial degree of disruption associated with acquisitions - to what extent this is driven by the plant or the workers themselves we are unable to distinguish. From the plants' point of view the reallocation is conducive to an improved match between the plant and the workers following foreign acquisitions, while this is not the case for domestic ownership change.

In what follows, Section 2 introduces the data sets used in the analysis and provides descriptive statistics. Section 3 documents changes in employment and the components of excess labour turnover both from the perspective of the employees as well from the perspective of the plants subject to acquisitions. Section 4 looks at the effects of the observed restructuring on the match between the plant and its employees using our different proxies for match quality. Section 5 summarises and concludes.

# 2 Data and Definitions

## 2.1 Data sources and cleaning

In our analysis we use five different annual data bases for the years 1996–2007. All of these data bases are censuses that can be linked to each other through firm or plant identifiers. All data sources are administered by Statistics Norway. Our starting point is the Norwegian Manufacturing Statistics, which is collected at the plant level. We keep only plants that are observed for at least three years during 1996–2007 and do not have one or more missing years before they reappear in

the manufacturing statistics. We further drop plants with on average less than three workers every year or with average production value or total wage costs of less than one million NOK per year.

We identify foreign acquisitions by using the register of foreign ownership interests in Norwegian firms (the SIFON register), and define a foreign acquisition of a plant as occurring in year t if the largest foreign ownership share is above 50% in year $t$, but was below this threshold in year $t-1$. We are further interested in plants that experience a change of ownership from one Norwegian owner to a different Norwegian owner. In order to identify these domestic acquisitions, we use the plant and firm identifiers in the manufacturing statistics. While the plant identifiers are connected to a specific location with production in a specific industry, the firm identifier is related to the legal owner. A plant experiences a domestic ownership change in year $t$ if the plant changes firm identifier from year $t-1$ to year $t$, and the new firm id in year $t$ owned other plants in $t-1$. Further, the plant must not be defined as foreign owned in either year $t$ or $t-1$. We do observe plants with more than one ownership change and cases where the foreign ownership share drops from above to below 50%. Due to the small number of these cases we drop these plants from our analysis.[7]

We then link the income tax files, which contain information on job spells and the associated earnings over the course of a job spell for individuals, to the plant panel. Based on this match, we drop plants that have one or more years without any matched workers from the job-spell data. The resulting plant panel at this stage accounts for between 68 and 71% of total employment and between 74 and 77% of total production in the full manufacturing statistics in each year. We then use register data on the whole population to include individual characteristics like age, gender and education.[8] With the workers and job spells we have linked to manufacturing plants at this

[7] In earlier work we also identified domestic plants that were taken over by Norwegian multinationals (Balsvik and Haller, 2010). During our sample period we are able to identify less than 20 such cases and therefore drop these plants from our analysis. The few studies that are able to identify domestic multinationals in their studies of ownership change, (e.g., Heyman et al. (2007), Bandick and Görg (2010) and Criscuolo and Martin (2009)), typically find that the impact on firm performance is rather similar whether a domestic MNE or a foreign MNE acquires a local firm.

[8] 2-3% of person identifiers with job spells in manufacturing plants according to the spell data, are not found in the register data on the whole population. We drop these individuals.

stage, we construct our plant-level variable for employment. In doing this we take the number of workers employed by the plant at three different dates during the year (10th of each February, June and October) and construct a measure of the number of workers as the average of these three points during the year. Workers recorded working part time are given a lower weight than fulltime workers.[9] Finally, we use firm-level customs data to identify whether a plant belongs to a firm that exports and/or imports. We use this information as part of our controls for plant characteristics in regressions.

The final part of our cleaning procedures is related to the information in the job-spell data. With spell-based data we have some workers in our panel that have more than one job and/or workers that start several new jobs in the same year. In our analysis we are interested in following individuals over time in their main jobs. In order to achieve this, we conduct the following cleaning on the job-spell data: We drop all observations of individuals that are only observed for one year in our panel. We also drop workers who do not work full-time in all the years they are in manufacturing plants, workers who change jobs five times or more between plants in our panel, workers with more than three parallel jobs in any one year, and workers who only have job spells of less than 90 days. Further, we drop workers observed in more than three different plants during a single year, and workers who seem to start a new job twice or more during a single year. Based on information about earnings during the job spell and start and stop dates of the spell, we calculate our wage measure as the daily wage during the job spell in a given year. Workers that always earn less than 350 NOK per day are dropped from our sample.[10] Finally, we exclude plants with changes in the number of matched fulltime workers in excess of 250 from one year to the next.

After these cleaning procedures, we are left with about 67,000 plant-year observations from just over 7,000 different plants for the period from 1996 to 2007. These plants employ in total over the period more than 290,000 different workers giving rise to 1.77 million worker-year observations.

[9]The data contains a categorical variable for expected weekly work hours. One group being 30 hours or more per week, these workers are given the weight of 1 in the calculations of the number of workers. Job spells with work hours between 20 and 30 hours are given a weight of 0.65, while shorter work hours are given a weight of 0.3.

[10]This is based on the earnings deflated by the consumer price index, and represents a daily wage that would be well below the expected average daily wage for a fulltime manufacturing worker in Norway.

## 2.2 Descriptive statistics

Table 1 shows that our plant panel consists of between 5,120 and 5,820 plants each year, with an annual average of about 30 workers, amounting to 160,000–195,000 workers per year (columns 2–4). Columns 5–7 of table 1 provide information on the number of plants, their average size and total number of workers subject to a domestic ownership change each year; columns 8–10 provide similar information for plants subject to a foreign acquisition. In total, we observe 162 domestic acquisitions and 427 foreign acquisitions. The number of workers in the acquired plants in the year of acquisition ranges from 608 to 4,109 in foreign acquisitions and from 296 to 1,824 in domestic acquisitions.

Table 1: Plants and workers involved in ownership change, by year

| | All plants | | | Domestic acquisitions | | | Foreign acquisitions | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Employment | | No. | Employment | | No. | Employment | |
| Year | | Mean | Total | | Mean | Total | | Mean | Total |
| 1996 | 5120 | 34 | 176199 | | | | | | |
| 1997 | 5462 | 34 | 185792 | 9 | 60 | 542 | 23 | 81 | 1854 |
| 1998 | 5711 | 34 | 195130 | 9 | 64 | 577 | 21 | 97 | 2032 |
| 1999 | 5650 | 33 | 188948 | 19 | 45 | 847 | 48 | 84 | 4019 |
| 2000 | 5747 | 31 | 180392 | 18 | 101 | 1824 | 62 | 70 | 4340 |
| 2001 | 5774 | 31 | 180864 | 30 | 48 | 1433 | 31 | 104 | 3236 |
| 2002 | 5808 | 30 | 176743 | 13 | 52 | 676 | 38 | 48 | 1820 |
| 2003 | 5820 | 29 | 168143 | 15 | 72 | 1083 | 43 | 28 | 1200 |
| 2004 | 5818 | 28 | 162980 | 7 | 42 | 296 | 21 | 29 | 608 |
| 2005 | 5677 | 28 | 160442 | 11 | 34 | 372 | 23 | 45 | 1042 |
| 2006 | 5477 | 29 | 160996 | 18 | 25 | 449 | 71 | 58 | 4109 |
| 2007 | 5211 | 31 | 160174 | 13 | 30 | 384 | 46 | 48 | 2214 |

Table 2 provides summary statistics of our worker panel. The average daily wage over the period was 846NOK. Workers in plants ever subject to a domestic acquisition earn less than average, while workers in plants ever subject to a foreign acquisition earn above average. We group workers into three skill groups defined by years of education: low-skilled workers have less than 10 years of education, medium-skilled workers have 10-13 years of education and high-skilled workers have more than 13 years of education. Looking at the skill shares, the low-skill share in plants subject

Table 2: Descriptive statistics on worker panel

| | All workers | | Domestic acq | | Foreign acq | |
|---|---|---|---|---|---|---|
| | mean | sd | mean | sd | mean | sd |
| Avg. daily wage (NOK) | 845.6 | 332.6 | 826.1 | 319.3 | 892.1 | 350.7 |
| - low skilled | 725.6 | 249.7 | 711.4 | 251.1 | 747.1 | 250.9 |
| - medium skilled | 830.4 | 292.4 | 819.2 | 280.2 | 863.0 | 300.3 |
| - high skilled | 1132.9 | 435.5 | 1134.2 | 420.3 | 1177.0 | 438.7 |
| Age | 40.7 | 11.6 | 41.4 | 11.7 | 40.7 | 11.4 |
| Tenure | 8.2 | 6.9 | 9.1 | 7.4 | 8.0 | 6.7 |
| Low skilled (%) | 28.0 | | 30.2 | | 25.0 | |
| Medium skilled (%) | 57.3 | | 57.4 | | 56.5 | |
| High skilled (%) | 14.7 | | 12.5 | | 18.5 | |
| Females (%) | 18.2 | | 19.8 | | 17.3 | |
| Obs | 1,774,549 | | 85,328 | | 258,522 | |

Note: Statistics on domestic and foreign acquisitions are for workers in plants ever subject to an acquisition.

to domestic acquisitions is higher than the sample average, whereas the high-skill share is lower than the sample average. In contrast, plants subject to foreign acquisitions have higher shares of high-skilled workers and lower shares of low-skilled workers than the sample average.

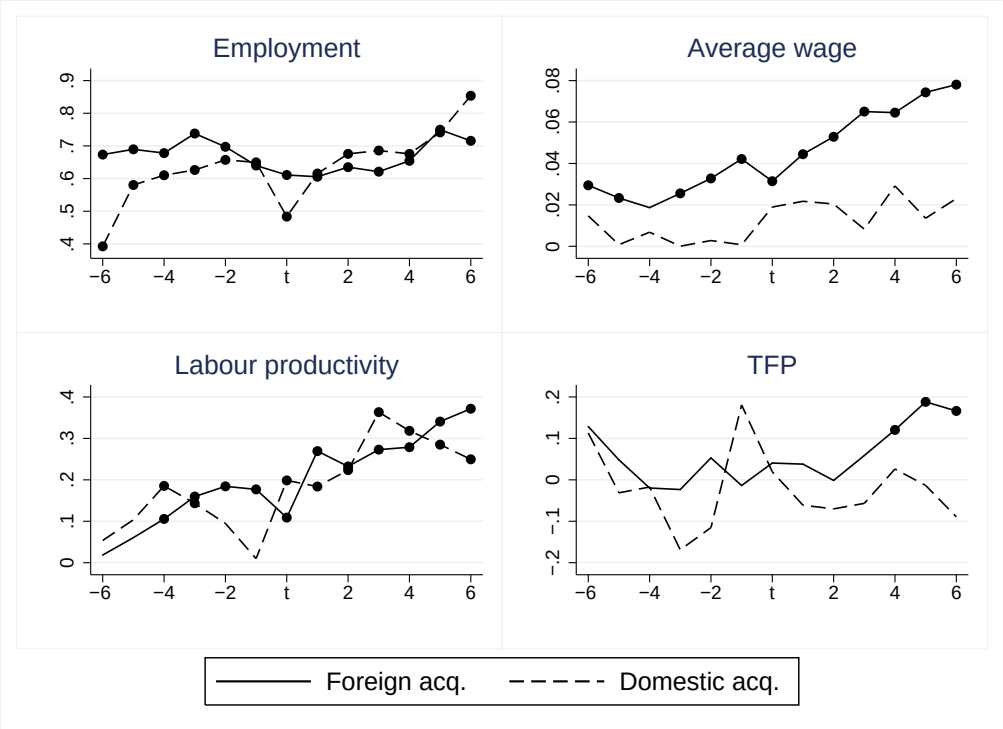
As an additional descriptive exercise we compare employment, wages and productivity in plants that are subject to an acquisition during our sample period to plants that do not experience ownership change during the time span of our data. Henceforth, these plants are also called non-acquired plants. We do this comparison by estimating OLS regressions of the following type:

$$y_{jt} = \sum_{\tau=t-6}^{t+6} \alpha_{D\tau} \text{Dom acq}_{j,\tau} + \sum_{\tau=t-6}^{t+6} \alpha_{F\tau} \text{For acq}_{j,\tau} + \gamma \ln emp_{jt} + \gamma_R + \gamma_t + \gamma_I + \gamma_{It} + \epsilon_{jt}. \quad (1)$$

The plant level outcome $y_{jt}$ is, in turn, the log of employment, the log average wage at the plant level, labour productivity (the log of sales per employee) and TFP. For $\text{acq}_{j,\tau}$ is a set of dummy variables equal to one if the observation of worker $i$ in plant $j$ is: six years before foreign acquisition, five years before, and so on, until six years after foreign acquisition. We construct a similar set of indicators around domestic acquisitions. In the regressions, we control for plant size and also

include dummy variables for labour market region, year, 2 digit NACE industry, and industry-year interactions.[11]

Figure 1: Characteristics of plants subject to acquisitions




Note: Graphical representation of regression results from estimating equation (1). Year $t$ = year of acquisition. Dots indicate significance at 5% or better (standard errors adjusted for clustering at the plant level).

Figure 1 plots the estimated coefficients on the dummies around ownership change. The employment premium for acquisition plants relative to non-acquired plants is in the order of 60 to 70%. Relative to the average of non-acquired plants, there is a slight decrease in employment in the years leading up to ownership change. This starts three years before foreign acquisitions, while in the case of domestic acquisitions there is a sharp drop in employment only in the year of acquisition. Plant-level average wages and labour productivity are higher in plants subject to foreign acquisitions, and these measures increase relative to industry-year average (of non-acquired plants) following acquisitions. Also plants subject to domestic acquisition see a rise in their la-

[11] We do not control for plant size in the regression where the outcome variable is plant size.

bour productivity, but average wages do not differ significantly from those in non-acquired plants. When it comes to total factor productivity (TFP), there is no clear evidence of a productivity premium in acquisition plants prior to acquisition, though it seems to be the case that foreign-owned plants have significantly higher productivity than average from four years after ownership change onwards.[12]

Table 3: Average worker retention rates over 2-year periods

| Workers in plants | Work in same plant | Work in other plant | Work outside our panel | Not working |
|---|---|---|---|---|
| never subject to acq. | 0.73 | 0.04 | 0.13 | 0.10 |
| before for. acq. ($t-3$ to $t-1$) | 0.69 | 0.04 | 0.13 | 0.14 |
| around for. acq. ($t-1$ to $t+1$) | 0.70 | 0.04 | 0.12 | 0.14 |
| after for. acq ($t+1$ to $t+3$) | 0.70 | 0.05 | 0.14 | 0.11 |
| before dom. acq. ($t-3$ to $t-1$) | 0.63 | 0.05 | 0.13 | 0.19 |
| around dom. acq. ($t-1$ to $t+1$) | 0.63 | 0.06 | 0.19 | 0.12 |
| after dom. acq ($t+1$ to $t+3$) | 0.71 | 0.04 | 0.14 | 0.12 |

Note: Year $t$ = year of acquisition. Workers classified as working outside our panel are found in other sectors of the economy or in manufacturing plants dropped in the cleaning procedures. Workers classified as not working are comprised of two main groups: The first group are people who are not observed in our employer-employee data files meaning they are either unemployed or out of the labour force. The second group are people where we observe an employer id, but their total annual earnings are below 50,000NOK.

Table 3 presents average two-year retention rates for different types of plants. We calculate this as the share of workers present in a plant who are still employed by the same plant two years later. The retention rate for plants never subject to acquisition (in the first row) is 73%. Of the non-retained workers; 4% are found in other plants in our sample, 13% are working with employers outside our sample of manufacturing firms, and 10% are not working. Table 3 also shows average retention rates calculated over different two-year periods relative to the year of ownership change ($t$. In plants close to ownership change – whether this is just before, during, or just after the ownership change – worker retention rates are lower than in plants not subject to ownership change. The retention rate is particularly low (63%) for plants experiencing a domestic ownership change in the near future.

[12]The TFP measure is based on estimates using the procedure suggested by Ackerberg et al. (2008).

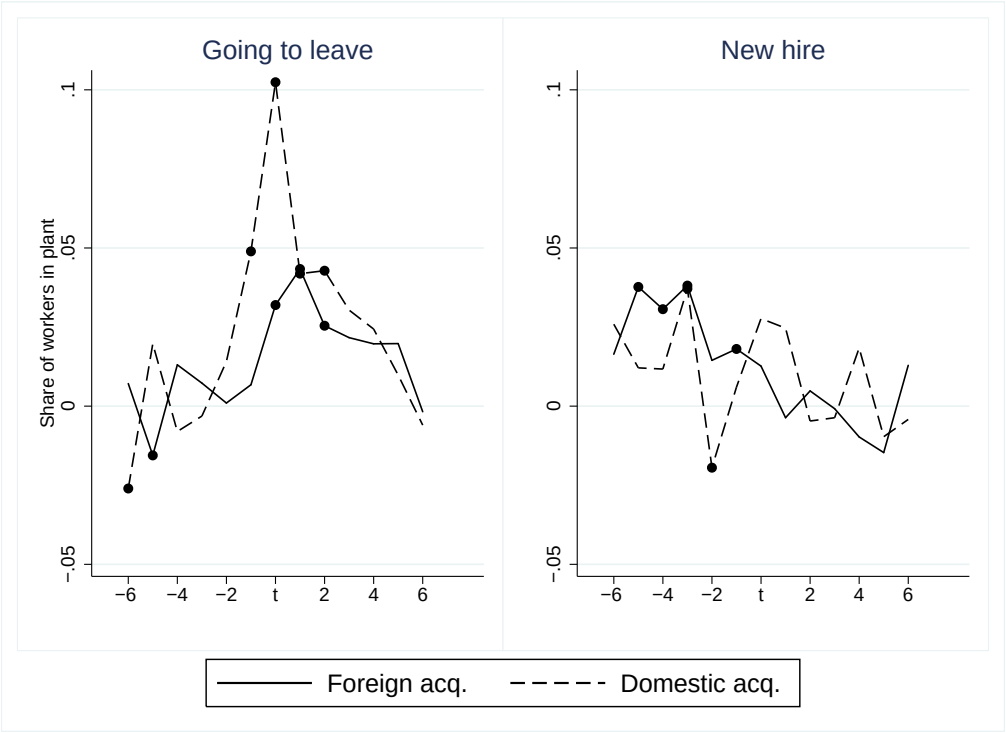
# 3 Turnover around acquisitions

The descriptive evidence in the previous section indicates that acquisitions are associated with changes in employment and wages at the plant level, and relatively low retention rates. Lower retention rates may suggest downsizing, but excess worker turnover could also give rise to low retention rates without implying downsizing if excess separations are accompanied by new hires. If ownership change is a type of event where the opportunity and the need to improve the match between workers and the plant is particularly large, we should observe excess turnover following ownership change; with or without downsizing as a result.

We compare turnover in acquisition plants to turnover in plants not subject to acquisition, by estimating equation (1) with the outcome variables being, respectively, the share of workers in the plant who will not be present in the plant next year (separations), and the share of workers who are present in the plant for the first time (new hires). Figure 2 plots the estimated coefficients on the dummies around ownership change. The figure documents excess turnover, particularly in the form of separations. In the year of domestic acquisition, the share of leaving workers is on average about 10 percentage points higher than in the average non-acquired plant in the same industry and year; representing a doubling relative to the average leave rate of 9%. In plants subject to foreign acquisitions, the share of leaving workers is also significantly higher than in non-acquired plants from the year of acquisition to two years after acquisition, but in economic terms the difference is not quite as stark as in the case of domestic acquisitions. The share of newly hired workers is not significantly different from average close to and after ownership change, though the share of new hires is above average in plants subject to foreign acquisitions in some of the years before the acquisition.

The lower retention rates shown in table 3 and the excess turnover, primarily in the form of separations, shown in figure 2, suggest that plants that are acquired might be downsizing in the period around the acquisition. We investigate the extent of downsizing by regressing the log change in plant-level employment over different periods on indicator variables for the plant experiencing a

Figure 2: Share of newly hired and leaving workers at the plant level




Note: Graphical representation of regression results from estimating equation (1). Year $t$ = year of acquisition. Dots indicate significance at 5% or better (standard errors adjusted for clustering at the plant level). The mean share of workers going to leave (being newly hired) in the data is 0.09 (0.11).

foreign or a domestic acquisition, while controlling for region, year and 2-digit industry dummies as well as initial plant size. Results are presented in the upper panel of table 4. The first three columns display the change in employment from three years before the acquisition until the year of acquisition, one year after, and three years after the acquisition. The last three columns show the change in employment from the year before acquisition until one, two, and three years after. In column 1 we see clear evidence of downsizing in the years leading up to domestic ownership change. Also for the other periods that we look at, the estimated coefficients on the domestic acquisition indicator are negative, but not statistically significant.[13] In the case of foreign acquisitions, the

[13]Note that there are fewer plants subject to domestic than to foreign acquisitions in our sample. Thus, these estimates tend to be estimated with greater error as well.

development in employment does not differ significantly from that of non-acquired plants in any of the periods around acquisition that we look at.[14]

The bottom three panels of table 4 report changes to the skill composition in plants around the time of acquisition. The downsizing prior to domestic acquisitions that is evident in the upper panel of the table, is primarily associated with a decline in the share of high-skilled workers. For plants subject to foreign acquisitions, we find no changes in the skill composition of these plants. In a similar approach as with the skill shares, we also check for changes in the age distribution of workers. Here, we divide the worker population into four age groups that are broadly in line with the quartiles of the age distribution in our data, and then compute changes in these shares over the same periods around acquisition as in table 4. These results are presented in table 9 in the appendix. Overall, there are no consistent and significant changes in the age-group shares from three years before to three years after acquisitions.

The excess turnover documented in figure 2 may play out differently for workers of different skill levels. Using our worker-level data we estimate the probabilities of being separated from – or being newly hired to – a plant in the years around acquisition. We estimate the following linear probability model

$$y_{ijt} = \sum_{\tau=t-2}^{t+2} \alpha_{D\tau} \text{For acq}_{j,\tau} + \sum_{\tau=t-2}^{t+2} \alpha_{F\tau} \text{Dom acq}_{j,\tau} + X_{it}\beta + X_{jt}\gamma + \epsilon_{it}, \quad (2)$$

where $y_{ijt}$ in the separation regressions is the indicator variable $leave_{ijt}$ which is equal to one if worker $i$ is observed in plant $j$ in year $t$, but will not be observed in this plant the following year.[15] Our main interest is whether for a given worker the probability of separation is higher when she is employed in a plant that is close to ownership change compared to other periods of the worker's career. Time-varying observable individual and plant-level traits may affect the probability of separation. The vector of individual-level control variables ($X_{it}$) includes age, tenure,

[14] Results are similar when including all plants, dropping only plants in the top and bottom half percentile of the distribution of employment changes or excluding plants with median employment of less than 10 employees over the period.

[15] Unfortunately, our data does not allow us to distinguish between voluntary and involuntary separations.

Table 4: Plant-level changes relative to non-acquired plants: employment and skill shares

| | Change in dependent variable from | | | | | |
|---|---|---|---|---|---|---|
| | 3 years before acquisition to year | | | 1 year before acquisition to year | | |
| | of acq | 1 after | 3 after | 1 after | 2 after | 3 after |
| Dependent variable: Employment | | | | | | |
| Foreign acquisition | 0.001 | -0.040 | -0.054 | 0.002 | 0.039 | -0.009 |
| | (0.027) | (0.038) | (0.048) | (0.034) | (0.033) | (0.038) |
| Domestic acquisition | -0.117 * | -0.088 | -0.089 | -0.090 | -0.057 | -0.084 |
| | (0.048) | (0.063) | (0.072) | (0.057) | (0.054) | (0.064) |
| $R^2$ | 0.094 | 0.107 | 0.137 | 0.072 | 0.094 | 0.106 |
| Dependent variable: Share of low skilled | | | | | | |
| Foreign acquisition | -0.006 | -0.005 | 0.002 | 0.004 | 0.001 | 0.019 * |
| | (0.007) | (0.009) | (0.012) | (0.006) | (0.007) | (0.008) |
| Domestic acquisition | -0.018 | 0.018 | 0.009 | 0.028 (*) | 0.023 | 0.033 |
| | (0.016) | (0.017) | (0.022) | (0.014) | (0.015) | (0.020) |
| $R^2$ | 0.010 | 0.011 | 0.018 | 0.007 | 0.010 | 0.011 |
| Dependent variable: Share of medium skilled | | | | | | |
| Foreign acquisition | -0.002 | 0.015 | 0.005 | -0.004 | 0.002 | -0.014 |
| | (0.008) | (0.010) | (0.013) | (0.007) | (0.009) | (0.010) |
| Domestic acquisition | 0.040 * | -0.002 | 0.015 | -0.024 | -0.007 | -0.012 |
| | (0.017) | (0.018) | (0.021) | (0.017) | (0.016) | (0.021) |
| $R^2$ | 0.009 | 0.011 | 0.018 | 0.006 | 0.009 | 0.011 |
| Dependent variable: Share of high skilled | | | | | | |
| Foreign acquisition | 0.008 | -0.009 | -0.007 | -0.000 | -0.004 | -0.005 |
| | (0.006) | (0.006) | (0.007) | (0.006) | (0.007) | (0.007) |
| Domestic acquisition | -0.021 * | -0.016 | -0.024 (*) | -0.004 | -0.016 * | -0.022 * |
| | (0.009) | (0.011) | (0.013) | (0.009) | (0.008) | (0.010) |
| Obs | 39247 | 33696 | 23579 | 45092 | 39247 | 33696 |
| $R^2$ | 0.005 | 0.007 | 0.012 | 0.003 | 0.005 | 0.007 |

(*) $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. Robust standard errors in parentheses.

Regressions include region, year, 2-digit industry dummies and the level of employment at the start of the period.

To exclude mass-layoffs, the sample used drops observations where the change in employment from one year to the next is in the top or bottom percentile.

their square terms, and a dummy for union membership. Our plant-level controls ($X_{jt}$) consist of log of employment and log production value, skill shares, the share of union membership at the plant level, and dummies for export, import, and multiplant status. Unobserved individual effects could be correlated with the probability of separation, thus we estimate equation (2) using worker-fixed effects. In addition, we include region, year and 2-digit industry-year interaction terms to make sure our results are not confounded by separations or ownership change being correlated with regional differences or industry-specific shocks.[16]

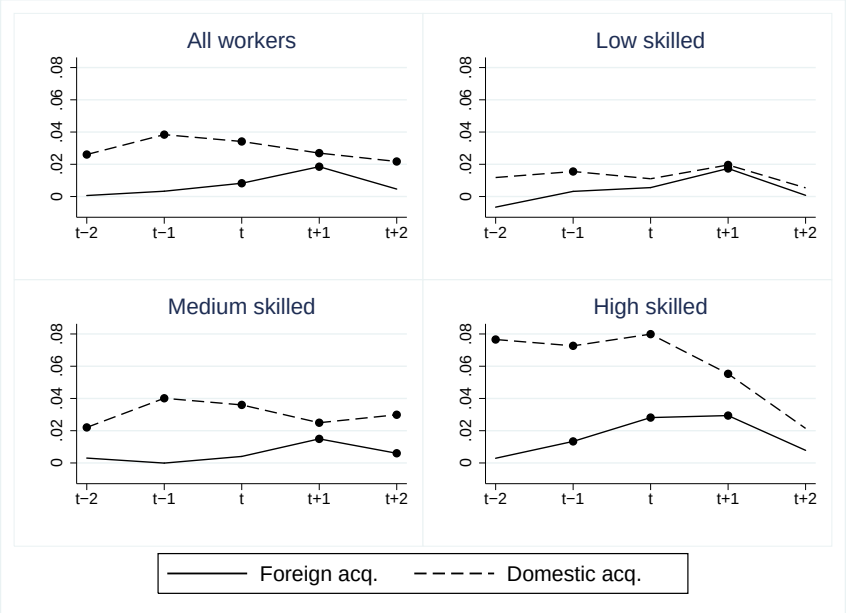
The estimated coefficients on the indicator variables for the years around ownership change are reported in figure 3.[17] The upper left graph shows the results from a regression using all workers; the three other graphs show the coefficients from estimating equation (2) separately by skill group. Since the results are based on worker-fixed effects, the coefficients can be interpreted as deviations from the individual worker's mean over time. Thus, the upper left panel of figure 3 indicates that the probability of separation is higher for workers when they are employed in a plant that is close to acquisition than at other times. The higher separation probability is persistent and more pronounced for workers in plants that experience domestic ownership change, while for workers in plants subject to a foreign takeover, the probability of separation is higher than normal in the year of acquisition and the year after. These results are consistent with the results on plant-level turnover reported in figure 2. Figure 3 also makes it clear that in plants subject to domestic acquisitions, it is the medium- and high-skilled workers that are more likely to face separations around acquisition. For the high-skilled workers this is the case especially before the ownership change. Given that the average probability of separation of high-skilled workers is around 6%, the estimated coefficient of around 0.07 for high-skilled workers in the year of domestic acquisition implies that the probability of separation is 7 percentage points higher relative to years further

[16] We want to condition separations on the plant being in existence after separations and we want to condition new hires on the plant being in existence before hires, thus we drop observations in the year of plant entry and the year of plant exit in both the separation and new hire regressions.

[17] The estimated coefficients are reported in table 10 in the appendix.

from acquisition, or more than double compared to the average probability of separation in the sample.

Figure 3: Probability of separation around acquisition

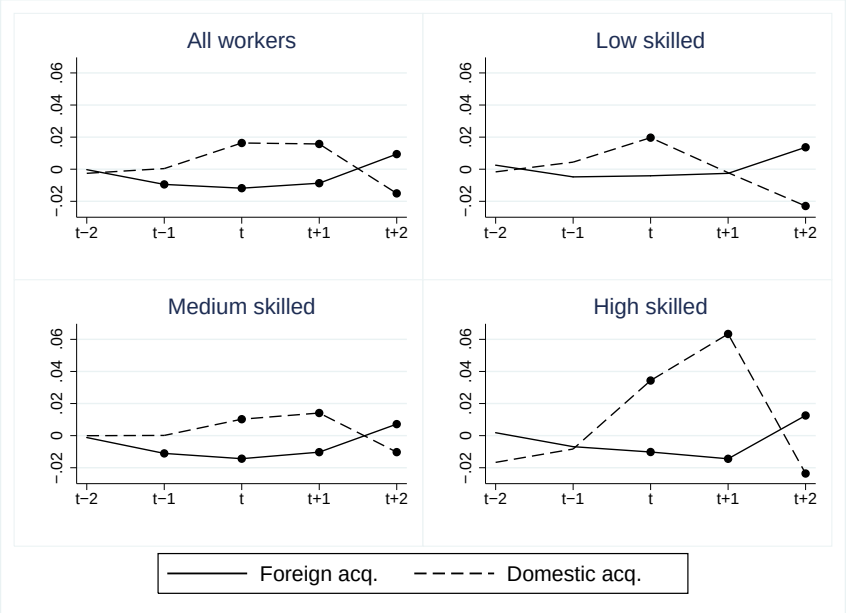



Note: Graphical representation of regression results from estimating equation (2) with dependent variable being an indicator for separation from the plant. Year $t$ = year of acquisition. Dots indicate significance at 5% or better (standard errors adjusted for clustering at the plant level).

We also assess whether the probability of being new to a plant is higher around acquisitions than at other times by re-estimating equation (2) using $new_{ijt}$ as dependent variable. This indicator variable equals one if worker $i$ is observed in plant $j$ in year $t$, but was not observed in this plant the year before. The results are displayed in figure 4. Workers in plants subject to domestic acquisitions have a higher probability of being newly hired to plants subject to domestic acquisitions in the year of, and the year after ownership change. This effect is significant for the medium- and in particular for the high-skilled workers, suggesting that the workers which separate before acquisition shown in figure 3 are partly replaced by new hires after the ownership change.[18] The probability of hire in the year after domestic acquisition is about 6 percentage points higher than usual for high-skilled

[18]This is not driven by re-hiring of the same workers separated from the plant before the ownership change.

Figure 4: Probability of hire around acquisition




Note: Graphical representation of regression results from estimating equation (2) with dependent variable being an indicator for new hire. Year $t$ = year of acquisition. Dots indicate significance at 5% or better (standard errors adjusted for clustering at the plant level).

workers. Compared to the overall probability of hire of 8.4% in the sample of high-skilled workers, this represents an increase in the hire probability of around 70%. The probability of being newly hired to foreign acquisition plants is lower than usual, but seems to pick up two years after foreign acquisitions for all skill groups. These effects are small in economic terms, however.

To summarize, our results indicate that acquisitions are associated with excess worker turnover, primarily related to separations. Excess turnover is much more pronounced in plants subject to domestic acquisitions, where downsizing occurs prior to ownership change. We find no evidence of plants reducing the overall size of the workforce around foreign acquisition. For domestic acquisitions, the downsizing prior to ownership change is driven by separations of medium- and high-skilled workers that seem to be at least partly replaced by new hires after ownership change. The outcome for domestic acquisitions is a small decline in the share of high-skilled workers,

otherwise we find very few changes in the age and skill composition of the workforce around acquisitions.

# 4 Match quality around acquisitions

Does the excess turnover documented in the previous section improve the match between the plant and its workers? From the previous results we found that the changes in the age and skill composition of the workforce around acquisitions do not differ markedly from changes in non-acquired plants. If anything, we found a decline in the share of high-skilled workers following domestic acquisitions. As firms may select their workers based on criteria other than only age and skills which we observe in our data, the workforce could change systematically along unobservable dimensions. Thus, in this section we explore other ways of assessing whether the turnover around acquisitions results in an improvement in worker and match quality relative to plants not subject to ownership change. First, in section 4.1 we look at the selection process in separations and hires, by using measures of unobservable worker and match quality from Mincer wage regressions, and by looking at the wage growth of new hires. By definition, the workers who stay in acquisition plants from before to after acquisition cannot contribute to a change in the plant-level average match quality, we therefore consider two alternative ways to assess whether there is any evidence that ownership change is an event that seems to improve the match between these workers and the plant. The metrics we use are wage growth and job tenure. The results are presented in section 4.2.

## 4.1 Selection in separations and new hires

To analyse the selection process in separations and hires, we turn to measures of unobserved worker quality and unobserved worker-plant match quality that we obtain from estimating Mincer wage equations. We make use of these two different estimated unobserved fixed effects in the following ways: First, we look at the distribution of these fixed effects for our sample, where workers are

grouped according to whether they are newly hired, leavers or stayers in their plants. Second, we calculate the average of these fixed effects at the plant-year level and then document the change in this average from before to after ownership change. We interpret a change in the average fixed effect at the plant level as a change in match quality.

Based on the methodology in Abowd et al. (1999) (henceforth AKM) we estimate unobserved worker-fixed effects from the following wage equation:

$$y_{ijt} = \mu + x'_{it}\beta + \theta_i + \psi_j + \epsilon_{ijt}. \tag{3}$$

The outcome variable, $y_{ijt}$, is the log wage of worker $i$ at plant $j$ in period $t$, and $x'_{it}$ is a vector of observable time-varying covariates for the worker and the plant she works in.[19] The fixed effects for the worker and plant, respectively, are $\theta_i$ and $\psi_j$. The identification of the two high-dimensional fixed effects relies on mobility of workers between plants, and we use the two-way fixed effect estimation procedure developed by Cornelissen (2008) to implement the AKM wage decomposition. We use the largest group of connected plants and workers, which includes about 91% of our sample, for this estimation.[20]

As an alternative and more direct measure of match quality, we estimate the wage equation above replacing the worker- and plant-fixed effects with a single fixed effect that is specific to each match between a worker and a plant, henceforth also called the match ore spell-fixed effect. While the worker-fixed effect can be said to capture the innate ability of the worker that is transferable across plants, the match effect captures a potential match-specific component to wages that

[19]The worker and plant characteristics included are the same as in the regressions for the probability of hire and separations reported in the previous section, including also 2-digit industry-year interaction terms. In addition we include a dummy for the year the worker is new to a plant and a dummy for the year that a worker is last observed in the plant as well as an indicator for foreign ownership.

[20]We focus only on the worker-fixed effect from the AKM decomposition. The main interest in much of the literature following AKM has been on the labour market correlation between the firm- and the worker-fixed effect, see for example Goux and Maurin (1999). The approach has also been used to investigate the role of individual and firm-specific components and assortative matching in explaining increased wage inequality, see, e.g., Bagger et al. (2013) and Bagger and Lentz (2014) for Denmark and Card et al. (forthc) for Germany.

measures the productivity of the match between the worker and the plant.[21] If match effects are important in wage determination, omitting the match specific component could bias the estimated worker-fixed effects (Woodcock, 2011). The estimated returns to observable characteristics could also be biased by omitting the match-specific component from equation 3. As an example, Woodcock (2011) and Sørensen and Vejlin (2013) using US and Danish data, respectively, find that the returns to experience are overestimated in wage regressions that omit the match effect, as part of the returns to experience are associated with workers moving towards better matches over time.

Replacing the worker- and plant-fixed effects in equation 3 with match-fixed effects means that the match effects subsume the worker- and plant-fixed effects, and we need not include these in our wage equation. This is of no cost to us, as we are interested in the change in the average of the match effects over time within a plant. As the plant-fixed effect is, by definition, constant during a job-spell, we do not need to separately identify the plant-fixed effect. We therefore interpret a change in the average match effect at the plant level as a change in match quality, and are agnostic about whether this is primarily due to worker turnover leading to a change in the unobserved worker-fixed effect or a change in the unobserved match effect. Estimating equation (3) with match effects has the additional advantage that the identification of the parameters of the wage equation relies on weaker assumptions than in the case of the AKM-approach.[22] The coefficients on the observable worker and plant characteristics from the two different fixed effects regressions are reported in table 11 in the appendix.

First, we compare the estimated unobserved worker-fixed effects from equation (3) across workers. In the top panel of figure 5 we plot the cumulative distribution functions of the worker fixed effect for leavers, stayers and new hires. The relative position of the lines in the figure shows that

[21] Match-specific wage components arise in models in which there is an idiosyncratic productivity component associated with each potential job match, and workers receive some share of the rents from a successful match, see for example Mortensen and Pissarides (1994).

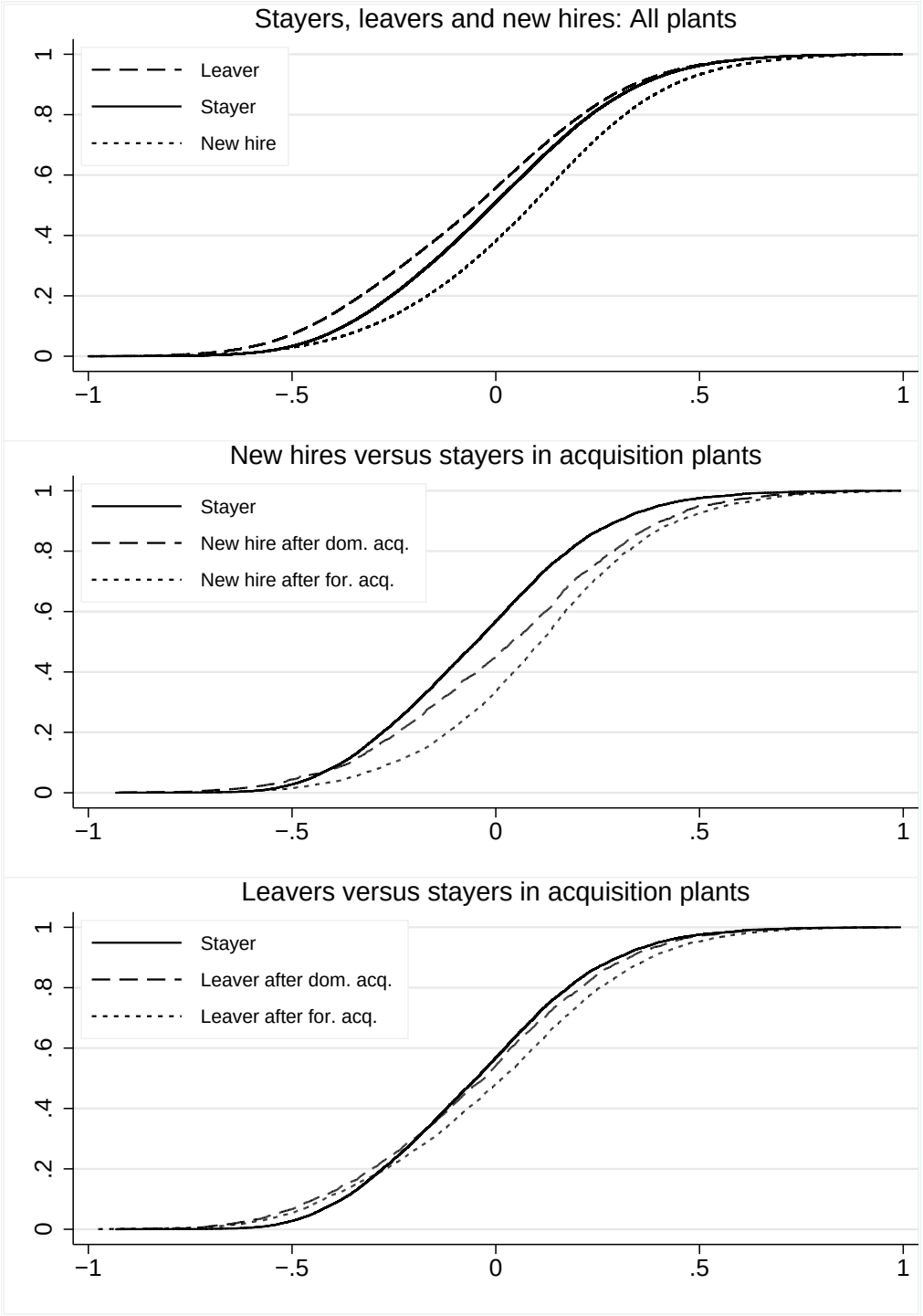
[22] The identifying assumption in the AKM approach is that the idiosyncratic disturbance term in each period is mean independent of observable worker and plant characteristics as well as plant- and worker-fixed effects, i.e., that worker mobility is random conditional on these effects. This assumption is at odds with for example the model of match-specific ability in Helpman et al. (2010). In the match-effects approach the identifying assumption is that worker mobility is random conditional on time-invariant match-specific worker ability and time-varying worker and firm characteristics. See Krishna et al. (2014) for a discussion.

new hires have a distribution that indicates higher unobserved quality than that of stayers, while the opposite is true for the leavers. Figure 6 in the appendix uses the match-fixed effects instead. The pattern is similar. Evidence of negative selection in separations is also found in the study by Weynandt (2014), who uses data from Austria to compare the average ability of workers who are laid off in single lay-offs from firms to the average ability of workers in mass-layoffs. This is consistent with the idea that in general, turnover tends to improve the sorting in the labour market (Jovanovic, 1979).

The middle panel of figure 5 shows the cumulative distribution functions of the estimated unobserved worker-fixed effects of new hires after acquisitions relative to stayers in acquisition plants. New hires after ownership change are defined as workers that are new to acquisition plants in the year of acquisition or one or two years after the acquisition, while stayers are defined as workers that are working in the plant consecutively from two years before to two years after the acquisition. Again, the distribution of the worker-fixed effects for new hires after acquisitions dominates that of stayers in the same plants. The difference between new hires and stayers is greater after foreign than after domestic acquisitions, suggesting that the foreign-acquired plants are recruiting better workers in terms of unobserved characteristics. The stayers in domestic and foreign acquisition plants in this and the figure in the bottom panel are combined into one line for readability as their distributions of unobserved fixed effects nearly overlap. The bottom panel of figure 5 shows the distributions for the unobserved worker-fixed effects comparing leavers to stayers. Compared to the clear negative selection of leavers relative to stayers in the full sample shown in the top panel, the quality of leavers in newly acquired plants is not so clearly different from that of stayers. If anything, the figure suggests that foreign acquired plants may be loosing some of their good workers right after acquisition.

Second, the descriptive evidence shown in figure 5 does not tell us whether there are changes in average worker quality at the plant level. Thus we use the estimated fixed effects from equation 3 to calculate the average of both the unobserved worker- and match-fixed effects for each plant-year observation in our sample. From the resulting plant panel, we calculate the changes in worker-

Figure 5: Cumulative distribution functions of unobserved worker fixed effects




Note: Cumulative distribution functions of the unobserved worker-fixed effects predicted from equation (3). With acquisitions occurring in t, stayers are observed in the plant from $t-2$ to $t+2$. New hires after acquisition are new in $t$, $t+1$ or $t+2$, leavers after acquisition are leaving the plant in $t$, $t+1$ or $t+2$.

and match-fixed effects over four- and five-year periods. We then compare the change in average worker and match quality from before to after acquisitions to the change in non-acquired plants in the same industry and over the same time period by regressing these changes on dummies for being two or three years after an ownership change. The regressions include industry- and year-fixed effects, and observations are weighted by the number of employees in the plants (i.e., the number of fixed effects used to calculate the average at the plant level). The results in table 5 show that plants experiencing a foreign acquisition experience a significantly larger improvement in both unobserved worker quality and match quality relative to non-acquired plants in the same industry and time-period. For plants subject to domestic ownership change, the improvement does not differ from the average trend in non-acquired plants. To rule out the possibility that the difference between domestic and foreign acquisitions found in table 5 is driven entirely by plants with large downsizing, we report a robustness check where we drop the one percent of observations with the largest downsizing in the number of employees over the four or five year periods investigated in the table. The results are reported in table 12 in the appendix. The finding that the improvement in worker and match quality in plants subject to foreign acquisitions is larger than that in domestically acquired plants is robust to this sample restriction, although the estimated coefficients are smaller in magnitude.

An alternative approach to study the extent of selection in new hires is to look for a premium in wage growth for mobile workers. From the perspective of workers who change jobs, the wage growth from the old to the new job could act as a measure of the extent to which the job change results in an improved match for the worker. To investigate this, we identify workers who two years ahead will be employed by a different plant than they are currently employed in, and calculate the change in log wages that we observe from year $t$ to $t+3$.[23] We keep only these moving workers in our sample and regress their wage growth on indicator variables for the type of plant they are moving to: plants never subject to acquisition and plants just before or just after an ownership change. Different versions of these regressions are presented in table 6. Column 1 presents the

[23]Year $t+3$ is the year after they are first observed in their new plant.

Table 5: Overall change in match quality at the plant level around ownership change

| | Change from before to after acquisition in the average unobserved worker-fixed effect | | unobserved match-fixed effect | |
|---|---|---|---|---|
| Change from 2 years before to 3 years after acquisition | | | | |
| Foreign acq | 0.013 (0.003)** | | 0.027 (0.006)** | |
| Domestic acq | 0.005 (0.004) | | 0.012 (0.009) | |
| Change from 2 years before to 2 years after acquisition | | | | |
| Foreign acq | | 0.008 (0.003)** | | 0.020 (0.005)** |
| Domestic acq | | 0.003 (0.004) | | 0.007 (0.008) |
| Average fixed effect | 0.030 | 0.023 | 0.034 | 0.028 |
| Obs | 20175 | 29207 | 20175 | 29207 |
| $R^2$ | 0.044 | 0.028 | 0.038 | 0.025 |

Note: All regressions include industry and year dummies and are weighted by the number of employees in the plant. The dependent variable in columns 1 and 2 is the change in the plant-level average of unobserved worker-fixed effects from a two-way fixed effect Mincer wage equation with plant- and worker-fixed effects, including also worker and plant controls and region, industry and year interaction dummies. Dependent variable in column 3 and 5 is the change in the plant-level average of unobserved match effect from a Mincer wage equation with match effects, including the same controls. Standard errors in parentheses, (*) $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

result of an OLS regression with industry-year fixed effects. The constant term captures the average three-year wage growth for movers to non-acquired plants: 7.3%. The estimated coefficients on the indicator variables for which type of plant the other movers move to indicate to what extent the wage growth of these movers differs from movers from the same industry and year that move to plants never subject to ownership change. Movers to plants that were just acquired by foreign owners exhibit higher wage growth than other movers; in economic terms the effect is not that large though. This result is not affected by adding worker controls and plant controls for the plant they are leaving in column 2. The results in columns 3 and 4 include plant-year fixed effects, thus here we are comparing the wage growth of leavers from the same plant year, depending on their type of destination plant. These results show much the same picture as the first two columns of table 6.

Table 6: Wage growth for movers: from year before leave to the second year in the new plant

| | Dependent variable: 3-year wage growth | | | |
|---|---|---|---|---|
| Movers to plants: | | | | |
| 1 or 2 years before foreign acq. | 0.003 | -0.001 | 0.011 | 0.009 |
| | (0.016) | (0.016) | (0.031) | (0.030) |
| 0, 1 or 2 years after foreign acq. | 0.066 | 0.062 | 0.041 | 0.039 |
| | (0.012) ** | (0.012) ** | (0.023) (*) | (0.022) (*) |
| 1 or 2 years before domestic acq. | -0.010 | 0.008 | 0.006 | 0.014 |
| | (0.027) | (0.026) | (0.079) | (0.077) |
| 0, 1 or 2 years after domestic acq. | 0.010 | 0.020 | 0.030 | 0.022 |
| | (0.013) | (0.033) | (0.033) | (0.033) |
| constant | 0.073 | 0.516 | 0.073 | 0.414 |
| | (0.002) ** | (0.047) ** | (0.002) ** | (0.057) ** |
| Worker controls | No | Yes | No | Yes |
| Plant controls | No | Yes | No | n/a |
| Industry-year fe | Yes | Yes | No | No |
| Plant-year fe | No | No | Yes | Yes |
| Obs | 18619 | 18619 | 18619 | 18619 |
| $R^2$ adj | 0.021 | 0.048 | 0.240 | 0.257 |

Note: The regression sample contains only within-sample movers grouped by the indicator variables defined by which type of plant the movers move to in year $t + 2$. Standard errors in parentheses, (*) $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

## 4.2 Match quality for stayers

Also for stayers, the quality of the match could change if there are changes at the plant level that improve the fit between the worker and the plant. This will not be captured in our estimates of the change in average match quality at the plant level in section 4.1, since by definition the workers that remain in the same plant cannot contribute to a change in average match quality (both the worker-fixed effect, and the match-fixed effect is constant for stayers). As an alternative measure of the fit between the stayers and the plant we consider wage growth. We calculate wage growth of stayers in plants subject to acquisition over two- and three-year periods. The set of stayers is restricted to workers who are present in the year before ownership change and are still in the plant two or three years after the ownership change. We compare their wage growth to that of stayers in plants not subject to ownership change in the same industry and year; results are displayed in table 7. While stayers in domestic acquisitions do not experience higher wage growth than stayers in plants never subject to ownership change, stayers in foreign acquisitions do. The economic size of the effect is small, however.

Table 7: Wage growth for stayers

| | Dependent variable: | | | |
|---|---|---|---|---|
| | 2-year difference (acq. occurred in t-1 or t-2) | | 3-year difference (acq. occurred in t-1 or t-2) | |
| Stayers in for. acq | 0.014 (0.005)** | 0.011 (0.006)(*) | 0.019 (0.006)** | 0.012 (0.006)(*) |
| Stayers in dom. acq | -0.003 (0.009) | -0.000 (0.010) | 0.003 (0.011) | 0.006 (0.010) |
| cons | 0.068 (0.001)** | 0.249 (0.012)** | 0.086 (0.001)** | 0.305 (0.013)** |
| Worker controls | No | Yes | No | Yes |
| Plant controls | No | Yes | No | Yes |
| Industry-year fe | Yes | Yes | Yes | Yes |
| Obs | 813551 | 813551 | 635748 | 635748 |
| $R^2$ adj | 0.020 | 0.052 | 0.021 | 0.059 |

Note: The regression sample contains only stayers. In columns 1 and 2 stayers are defined as workers being in the same plant from year $t-2$ until at least year $t$. In columns 3 and 4 stayers are defined as workers being in the same plant from year $t-3$ until at least year $t$. The estimated coefficients are interpreted relative to stayers in plants never subject to ownership change, their mean wage growth over 2 and 3 years are identified by the constant term in columns 1 and 3, respectively. Standard errors in parentheses, $(^*)$ $p < 0.10$, $^*$ $p < 0.05$, $^{**}$ $p < 0.01$.

The potential changes that may occur in the plant with the new owners could improve the fit between the plant and its employees by resulting in increased job satisfaction - which of course we cannot measure. What we can observe though is how long workers stay in a plant. If job satisfaction increases, this may lead workers to stay longer in the plant. Thus, as our last exercise, we look at continuation tenure as an alternative indicator of an improved match between the stayers and the plant.

Table 8: Linear probability of stayers to remain in the plant for at least another 2, 3 or 4 years

| | All | Low-skill | Medium-skill | High-skill |
|---|---|---|---|---|
| Probability of staying for at least 2 years in a plant that was | | | | |
| subject to for acq in previous year | 0.016 (0.018) | -0.004 (0.020) | 0.020 (0.021) | 0.038 (0.019)* |
| subject to dom acq in previous year | -0.112 (0.050)* | -0.085 (0.046)(*) | -0.102 (0.051)* | -0.209 (0.068)** |
| Constant | -0.635 (0.037)** | -0.746 (0.035)** | -0.592 (0.041)** | -0.455 (0.050)** |
| Obs | 1047421 | 294900 | 602373 | 150148 |
| $R^2$ | 0.474 | 0.458 | 0.493 | 0.436 |
| Probability of staying for at least 3 years in a plant that was | | | | |
| subject to for acq in previous year | -0.000 (0.014) | -0.004 (0.017) | -0.000 (0.016) | 0.012 (0.017) |
| subject to dom acq in previous year | -0.056 (0.041) | -0.054 (0.039) | -0.059 (0.044) | -0.042 (0.040) |
| Constant | -0.520 (0.032)** | -0.584 (0.031)** | -0.495 (0.036)** | -0.391 (0.040)** |
| Obs | 1047421 | 294900 | 602373 | 150148 |
| $R^2$ | 0.435 | 0.413 | 0.457 | 0.394 |
| Probability of staying for at least 4 years in a plant that was | | | | |
| subject to for acq in previous year | -0.007 (0.009) | -0.012 (0.009) | -0.012 (0.010) | 0.021 (0.013) |
| subject to dom acq in previous year | 0.010 (0.010) | 0.013 (0.008)(*) | 0.010 (0.012) | 0.006 (0.017) |
| Constant | -0.356 (0.026)** | -0.381 (0.023)** | -0.348 (0.029)** | -0.288 (0.031)** |
| Obs | 1047421 | 294900 | 602373 | 150148 |
| $R^2$ | 0.393 | 0.370 | 0.419 | 0.346 |

(*) $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. Standard errors adjusted for clustering at the plant level in parentheses.
Dependent variable is indicator equal to one if a person has been in the plant for the past two years and is still present in the same plant 2 or more, 3 or more or 4 or more years later; it is equal to zero for all other new hires.
Worker controls: experience, experience$^2$, tenure, tenure$^2$, union membership.
Plant controls: shares of medium- and high-skill workers, log employment, log turnover, share of unionised workers, exporter, importer and multiplant dummies.
Other controls: labour market region, year, 2-digit industry and 2-digit industry-year interaction terms.
Sample restricted to firms that are still in business in 4 years' time.

In table 8 we look at the probability of workers, conditional on having worked in the same plant also the two previous years, to remain in the plant for another 2, 3, or 4 years. The results suggest

that, measured from the year after an acquisition, all types of workers in plants subject to domestic acquisitions are less likely to stay on for another two years relative to workers in non-acquisition plants, but this effect is not significant for the 3- and 4-year horizon. For workers in plants subject to foreign acquisitions the only significant coefficient indicates that the high-skilled workers who were present in the plant before the acquisition are more likely to stay in the same plant than those in plants not subject to acquisition over a 2-year horizon. Thus, to the extent that we can approximate increased job satisfaction with the likelihood to remain in the plant, we do not see much of an improvement among those remaining in the plant around acquisition.

Taken together we find evidence of increased selection on unobservable characteristics of new hires after acquisitions, this is stronger in plants subject to foreign acquisitions. There is no clear evidence of selection among the leaving workers. This process results in a significant increase in average worker quality and match quality in plants subject to foreign acquisitions. The newly hired workers in plants subject to foreign acquisitions are also rewarded with higher wage growth compared to newly hired workers to non-acquisition plants. Workers who remain in a plant subject to foreign acquisition from before to after the acquisition also experience somewhat higher wage growth than similar workers in similar plants in the same industry and year. There is little evidence of improved worker retention for stayers in plants subject to foreign acquisitions. Stayers in plants subject to domestic acquisitions do not experience above average wage growth and have a lower probability of staying on than similar workers in non-acquisitions plants, this effect is short-lived, however.

# 5 Conclusion

In this paper we explore the adjustments to plant size and the composition of the workforce that occur around ownership change. Using detailed matched employer-employee data, we document changes in measures of both observable worker characteristics such as skill and age as well as measures of unobservable worker and match quality.

We find excess labour turnover at the plant level around acquisitions, a feature that is more pronounced around domestic acquisitions. Despite the excess turnover, we do not find evidence of downsizing in plants subject to foreign acquisitions, and also no substantial changes to the skill or age composition of the work force. In turn, in plants subject to domestic acquisitions we do observe a reduction in the overall size of the labour force before the acquisition. This is associated with an increase in the share of low-skilled workers at the expense of high-skilled workers. We also document that the probability of separation is greater from the workers' point of view during a period of acquisition relative to other periods in their career. This is the case in particular for high skilled workers in plants subject to domestic acquisitions, which may explain the negative development in the high-skill share before domestic acquisitions. Excess separations are primarily occurring before domestic ownership change, suggesting that this type of ownership change comes after a period of difficulty for the plant.

From a management perspective an ownership change presents an opportunity for restructuring and for improving the match between a plant and its employees. As we find little evidence of changes along observable dimensions of a plant's workforce, we move on to investigate whether the workforce changes around acquisitions along several alternative measures of unobserved worker and match quality. We find that the change in unobserved worker and match quality from two years before to two years after domestic ownership change is not different from the change in plants not subject to acquisitions in the same period and industry, while there is some evidence of improvement along these unobservable match quality metrics in foreign acquisitions. By looking at the distribution of the unobserved worker- and match-fixed effects, it is clear that the improvement in average match quality comes from more selective hirings after foreign acquisitions. This picture is confirmed by looking at the wage growth of movers: movers to plants that were just acquired by foreign owners have higher wage growth than other movers.

We further look at the workers who stay in their plant from before to after ownership change, only stayers in foreign acquisition plants have wage growth above the average of workers in non-acquired plants in the same industry. As a final metric of match quality we look at the continuation

tenure for workers in plants that are acquired, considering long tenure as one measure of a successful match. For workers that remain in the plant from before to after acquisitions, especially the high-skilled have a lower probability to stay on in plants subject to domestic acquisitions, while there is no evidence of a deterioration in job attachment after foreign acquisitions.

Thus, our results suggest that from the perspective of plants subject to foreign acquisitions the excess labour turnover associated with the acquisition results in improved match quality between the plant and the workers. In plants subject to domestic acquisitions the ownership change is associated with a substantial amount of excess labour turnover, the loss of high-skilled employees prior to the acquisition which is partly reversed in the aftermath, but does not lead to an overall improvement in match quality.

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# Appendix

Table 9: Plant-level changes relative to non-acquired plants: age distribution

| | Change in dependent variable from | | | | | |
|---|---|---|---|---|---|---|
| | 3 years before acquisition to year | | | 1 year before acquisition to year | | |
| | of acq | 1 after | 3 after | 1 after | 2 after | 3 after |
| Dependent variable: Share of workers aged 14-29 | | | | | | |
| Foreign acquisition | -0.013 $^{(*)}$ | 0.008 | -0.003 | 0.018 $^{**}$ | 0.001 | 0.005 |
| | (0.008) | (0.009) | (0.012) | (0.007) | (0.008) | (0.009) |
| Domestic acquisition | 0.014 | -0.003 | 0.018 | -0.012 | -0.008 | 0.008 |
| | (0.016) | (0.013) | (0.016) | (0.013) | (0.014) | (0.018) |
| $R^2$ | 0.014 | 0.017 | 0.024 | 0.012 | 0.014 | 0.017 |
| Dependent variable: Share of workers aged 30-39 | | | | | | |
| Foreign acquisition | 0.019 $^{*}$ | 0.008 | 0.010 | 0.003 | -0.004 | 0.001 |
| | (0.009) | (0.009) | (0.014) | (0.008) | (0.011) | (0.012) |
| Domestic acquisition | -0.057 $^{**}$ | -0.003 | -0.015 | 0.027 $^{(*)}$ | 0.006 | 0.004 |
| | (0.014) | (0.013) | (0.025) | (0.016) | (0.014) | (0.024) |
| $R^2$ | 0.018 | 0.017 | 0.029 | 0.011 | 0.017 | 0.023 |
| Dependent variable: Share of workers aged 40-49 | | | | | | |
| Foreign acquisition | -0.003 | -0.017 | -0.010 | -0.011 | 0.008 | 0.002 |
| | (0.011) | (0.012) | (0.016) | (0.008) | (0.012) | (0.011) |
| Domestic acquisition | 0.021 | 0.000 | 0.013 | -0.001 | -0.000 | 0.005 |
| | (0.017) | (0.016) | (0.022) | (0.012) | (0.014) | (0.017) |
| $R^2$ | 0.007 | 0.010 | 0.016 | 0.005 | 0.007 | 0.010 |
| Dependent variable: Share of workers aged 50-84 | | | | | | |
| Foreign acquisition | -0.003 | -0.002 | 0.003 | -0.010 | -0.005 | -0.008 |
| | (0.009) | (0.010) | (0.013) | (0.007) | (0.009) | (0.010) |
| Domestic acquisition | 0.022 | 0.009 | -0.015 | -0.014 | 0.002 | -0.017 |
| | (0.016) | (0.015) | (0.016) | (0.012) | (0.014) | (0.014) |
| Obs | 39247 | 33696 | 23579 | 45092 | 39247 | 33696 |
| $R^2$ | 0.007 | 0.011 | 0.018 | 0.005 | 0.007 | 0.011 |

$^{(*)}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$. Robust standard errors in parentheses.

Regressions include region, year, 2-digit industry dummies and the level of employment at the start of the period.

To exclude mass-layoffs, the sample used drops observations where the change in employment from one year to the next is in the top or bottom percentile.

Table 10: Probability of separations and hires

| | All (1) | | Low-skill (2) | | Medium-skill (3) | | High-skill (4) | |
|---|---|---|---|---|---|---|---|---|
| | | | | Probability of separation | | | | |
| for acq_$t-2$ | 0.001 | (0.002) | -0.007 | (0.004)$^{(*)}$ | 0.003 | (0.002) | 0.003 | (0.005) |
| for acq_$t-1$ | 0.003 | (0.002)$^{(*)}$ | 0.003 | (0.004) | -0.000 | (0.002) | 0.013 | (0.005)$^{**}$ |
| for acq_$t$ | 0.008 | (0.002)$^{**}$ | 0.006 | (0.005) | 0.004 | (0.003) | 0.028 | (0.005)$^{**}$ |
| for acq_$t+1$ | 0.019 | (0.002)$^{**}$ | 0.017 | (0.005)$^{**}$ | 0.015 | (0.003)$^{**}$ | 0.029 | (0.006)$^{**}$ |
| for acq_$t+2$ | 0.005 | (0.002)$^{(*)}$ | 0.001 | (0.005) | 0.006 | (0.003)$^{*}$ | 0.008 | (0.005) |
| dom acq_$t-2$ | 0.026 | (0.004)$^{**}$ | 0.012 | (0.006)$^{(*)}$ | 0.022 | (0.004)$^{**}$ | 0.077 | (0.012)$^{**}$ |
| dom acq_$t-1$ | 0.038 | (0.004)$^{**}$ | 0.016 | (0.007)$^{*}$ | 0.040 | (0.005)$^{**}$ | 0.073 | (0.013)$^{**}$ |
| dom acq_$t$ | 0.034 | (0.004)$^{**}$ | 0.011 | (0.008) | 0.036 | (0.006)$^{**}$ | 0.080 | (0.016)$^{**}$ |
| dom acq_$t+1$ | 0.027 | (0.004)$^{**}$ | 0.020 | (0.007)$^{**}$ | 0.025 | (0.005)$^{**}$ | 0.055 | (0.012)$^{**}$ |
| dom acq_$t+2$ | 0.022 | (0.004)$^{**}$ | 0.005 | (0.007) | 0.030 | (0.005)$^{**}$ | 0.021 | (0.012)$^{(*)}$ |
| Obs | 1261904 | | 337153 | | 739781 | | 184970 | |
| $R^2$ | 0.041 | | 0.051 | | 0.037 | | 0.049 | |
| *meanprob* | 0.055 | | 0.058 | | 0.052 | | 0.062 | |
| | | | | Probability of hire | | | | |
| for acq_$t-2$ | -0.000 | (0.002) | 0.003 | (0.004) | -0.001 | (0.002) | 0.002 | (0.005) |
| for acq_$t-1$ | -0.009 | (0.002)$^{**}$ | -0.005 | (0.003) | -0.011 | (0.002)$^{**}$ | -0.007 | (0.005) |
| for acq_$t$ | -0.012 | (0.002)$^{**}$ | -0.004 | (0.004) | -0.014 | (0.002)$^{**}$ | -0.010 | (0.005)$^{*}$ |
| for acq_$t+1$ | -0.009 | (0.002)$^{**}$ | -0.003 | (0.004) | -0.010 | (0.003)$^{**}$ | -0.014 | (0.006)$^{*}$ |
| for acq_$t+2$ | 0.009 | (0.002)$^{**}$ | 0.014 | (0.004)$^{**}$ | 0.007 | (0.003)$^{**}$ | 0.013 | (0.006)$^{*}$ |
| dom acq_$t-2$ | -0.003 | (0.003) | -0.002 | (0.006) | -0.000 | (0.004) | -0.017 | (0.010)$^{(*)}$ |
| dom acq_$t-1$ | 0.000 | (0.003) | 0.004 | (0.006) | 0.000 | (0.004) | -0.008 | (0.009) |
| dom acq_$t$ | 0.016 | (0.004)$^{**}$ | 0.020 | (0.007)$^{**}$ | 0.010 | (0.005)$^{*}$ | 0.034 | (0.013)$^{*}$ |
| dom acq_$t+1$ | 0.016 | (0.004)$^{**}$ | -0.002 | (0.006) | 0.014 | (0.005)$^{**}$ | 0.063 | (0.014)$^{**}$ |
| dom acq_$t+2$ | -0.015 | (0.003)$^{**}$ | -0.023 | (0.005)$^{**}$ | -0.010 | (0.004)$^{**}$ | -0.024 | (0.011)$^{*}$ |
| Obs | 1261904 | | 337153 | | 739781 | | 184970 | |
| $R^2$ | 0.190 | | 0.189 | | 0.183 | | 0.234 | |
| *meanprob* | 0.061 | | 0.059 | | 0.056 | | 0.084 | |

$^{(*)}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$. Standard errors in parentheses. Regressions include worker fixed effects.

Worker controls: experience, experience$^2$, tenure, tenure$^2$, union membership.

Plant controls: shares of medium- and high-skill workers, log employment, log turnover, share of unionised workers, exporter, importer and multiplant dummies.

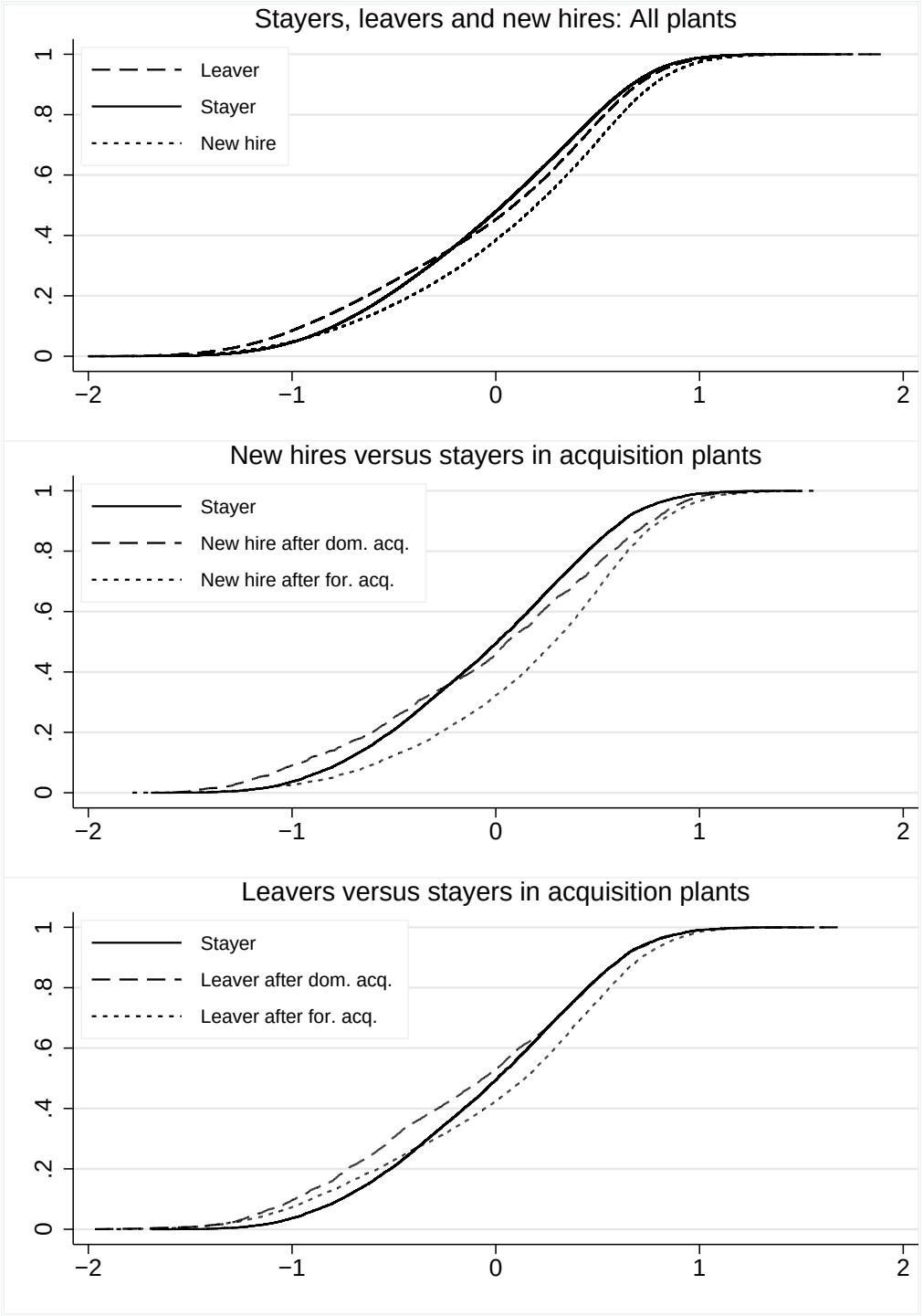
Other controls: labour market region, year, 2-digit industry and 2-digit industry-year interaction terms.

Table 11: Wage regressions

| fixed effects | worker- and plant | | job-spell | |
|---|---|---|---|---|
| Dependent variable: log wage | | | | |
| *Worker characteristics* | | | | |
| experience | 0.0356 | (0.00262) ** | 0.0776 | (0.00336) ** |
| experience$^2$ | -0.0003 | (0.000003) ** | -0.0003 | (0.000003) ** |
| tenure | 0.0003 | (0.00001) ** | -0.0021 | (0.00003) ** |
| tenure$^2$ | 0.0000 | (3.9E-11) ** | 0.0000 | (4.0E-11) ** |
| up to lower secondary | -0.2128 | (0.01466) ** | | . |
| started upper secondary | -0.1992 | (0.01198) ** | | . |
| completed upper secondary | -0.1658 | (0.01177) ** | 0.0336 | (0.00230) ** |
| post-secondary non-tertiary | -0.1515 | (0.01243) ** | 0.0072 | (0.00601) |
| undergraduate degree | -0.0860 | (0.00847) ** | -0.0568 | (0.00990) ** |
| graduate and higher | omitted category | | omitted category | |
| female * experience | -0.0099 | (0.00065) ** | -0.0067 | (0.00105) ** |
| female * experience$^2$ | 0.0001 | (0.000007) ** | 0.0002 | (0.000008) ** |
| female * tenure | -0.0002 | (0.00003) ** | -0.0007 | (0.00008) ** |
| female * tenure$^2$ | 0.0000 | (9.4E-11) ** | 0.0000 | (9.4E-11) ** |
| female * up to lower secondary | -0.0687 | (0.03852) (*) | | . |
| female * started upper secondary | -0.0473 | (0.02839) (*) | -0.0558 | (0.02024) ** |
| female * completed upper secondary | -0.0296 | (0.02768) | -0.0380 | (0.01949) * |
| female * post-secondary non-tertiary | -0.0004 | (0.03207) | | . |
| female * undergraduate degree | 0.0256 | (0.01651) | -0.0023 | (0.01848) |
| union member | -0.0099 | (0.00070) ** | -0.0090 | (0.00072) ** |
| new in plant | -0.0392 | (0.00060) ** | -0.0379 | (0.00059) ** |
| about to leave plant | 0.1419 | (0.00059) ** | 0.1339 | (0.00061) ** |
| *Plant characteristics* | | | | |
| log employment | -0.0076 | (0.00078) ** | -0.0032 | (0.00079) ** |
| log value of production | 0.0300 | (0.00048) ** | 0.0300 | (0.00048) ** |
| foreign-owned | 0.0078 | (0.00097) ** | 0.0071 | (0.00097) ** |
| exporter dummy | 0.0003 | (0.00060) | 0.0006 | (0.00059) |
| importer dummy | -0.0031 | (0.00069) ** | -0.0031 | (0.00068) ** |
| part of multiplant firm | 0.0020 | (0.00078) ** | 0.0013 | (0.00077) (*) |
| share of high-skilled workers in plant | 0.0503 | (0.00515) ** | 0.0524 | (0.00515) ** |
| share of medium-skilled workers in plant | -0.0110 | (0.00340) ** | -0.0068 | (0.00339) * |
| share of unionised workers in plant | 0.0020 | (0.00201) | 0.0010 | (0.00201) |
| Obs | 1,571,411 | | 1,571,411 | |
| $R^2$ adj | | | 0.78 | |
| F (worker + firm fe = 0), p-value | 10.85 | (0.00000) | | |

Note: All regressions include industry, industry-year and region dummies.
Standard errors in parentheses, (*) $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

Figure 6: Cumulative distribution functions of unobserved spell fixed effects




Note: Cumulative distribution functions of the unobserved match-fixed effects predicted from equation (3) with unobserved match-fixed effects instead of worker- and plant-fixed effects. With acquisitions occurring in $t$, stayers are observed in the plant from $t-2$ to $t+2$. New hires after acq. are new in; $t$, $t+1$ or $t+2$, leavers after acq. are leaving the plant in; $t$, $t+1$ or $t+2$.

Table 12: Overall change in match quality at the plant level around ownership change
Dropping plants with large downsizing

| | Change from before to after acquisition in the average | | | |
|---|---|---|---|---|
| | unobserved worker-fixed effect | | unobserved match-fixed effect | |
| Change from 2 years before to 3 years after acquisition | | | | |
| Foreign acq | 0.007 (0.003)* | | 0.019 (0.006)** | |
| Domestic acq | 0.001 (0.005) | | -0.000 (0.010) | |
| Change from 2 years before to 2 years after acquisition | | | | |
| Foreign acq | | 0.001 (0.003) | | 0.008 (0.006) |
| Domestic acq | | -0.007 (0.004) | | -0.018 (0.009)* |
| Average fixed effect | 0.030 | 0.023 | 0.034 | 0.028 |
| Obs | 19946 | 28911 | 19946 | 28911 |
| $R^2$ | 0.030 | 0.023 | 0.026 | 0.019 |

Note: All regressions include industry and year dummies and are weighted by the number of employees in the plant. The dependent variable in columns 1 and 2 is the change in the plant-level average of unobserved worker-fixed effects from a two-way fixed effect Mincer wage equation with plant- and worker-fixed effects, including also worker and plant controls and region, industry and year interaction dummies. Dependent variable in column 3 and 5 is the change in the plant-level average of unobserved match effects from a Mincer wage equation with match effects, including the same controls. Standard errors in parentheses, $(^{*})$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**})$ $p < 0.01$.

NHH

**Norges Handelshøyskole**

Norwegian School of Economics

NHH
Helleveien 30
NO-5045 Bergen
Norway

Tlf/Tel: +47 55 95 90 00
Faks/Fax: +47 55 95 91 00
nhh.postmottak@nhh.no
www.nhh.no