# IAB·Discussion Paper 01/2012

# Wage growth and career patterns of German low-wage workers

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# Contents

## Abstract

Using administrative linked employer-employee data from Germany, this paper analyses the real wage growth and career patterns of full-time employed low-wage workers between 2001 and 2006. Multivariate models accounting for sample selection demonstrate the relevance of individual characteristics and firm heterogeneity in this context. I observe substantial upward and downward wage mobility in the low-wage sector, with the worst-paid workers having considerably higher relative wage growth than better-paid workers. The majority of those low-wage workers who had escaped the low-wage sector by 2004 were still higher-paid two years later, indicating that their upward mobility is not just a transitory phenomenon.

## Zusammenfassung

In diesem Artikel wird anhand eines verbundenen administrativen Arbeitgeber-Arbeitnehmer-Datensatzes aus Deutschland das Reallohnwachstum und die Karrieremuster von vollzeitbeschäftigten Geringverdienern zwischen 2001 und 2006 untersucht. Multivariate Modelle, die die Selektivität der Stichprobe berücksichtigen, zeigen den Einfluss von Personenmerkmalen und betrieblicher Heterogenität auf. Es existiert ein signifikantes Ausmaß von Aufwärts- und Abwärtsmobilität im Niedriglohnsektor, wobei die am schlechtesten bezahlten Geringverdiener ein höheres relatives Lohnwachstum aufweisen als die besserbezahlten. Die Mehrheit jener Geringverdiener, die bis 2004 aus dem Niedriglohnsektor aufgestiegen sind, befand sich zwei Jahre später immer noch in höher bezahlter Beschäftigung. Dies deutet darauf hin, dass die Aufwärtsmobilität von Geringverdienern kein lediglich temporäres Phänomen ist.

# 1 Introduction

In 2006, about 17% of full-time employees in the EU-27 countries received a wage below the threshold of 2/3 of the median wage, which usually demarcates the low-wage sector. Germany had a higher-than-average proportion of low-wage workers (19.6%) among its workforce (Casali/Alvarez 2010). In 2009, according to the German Federal Employment Agency, the low-wage sector in Germany accounted for 22% of all German workers (Bundesagentur für Arbeit 2010).

As a consequence, this "extremely interesting slice of employment […] at the lower end of the wage distribution" (Salverda 2010: p. 185) has attracted increased attention from researchers and policy-makers over the last years. A number of international studies have investigated various aspects of low-wage work and the mobility of these workers. Although an easy answer to the core question of whether low wages are a transitory or a persistent experience for these individuals does not seem to exist, virtually all previous studies have found that personal, firm and job characteristics affect the probability of escaping low wages. Furthermore, various methodological contributions have shown that initial conditions, state dependence and endogeneity are important in this area of research.[1] Most of these previous studies have defined the upward wage mobility of low-wage workers as the act of escaping the low-wage sector by crossing a certain relative or fixed low-wage threshold and obtaining higher pay. Usually, the threshold used for defining low wages was 2/3 of the median wage or a certain percentile of the wage distribution.[2]

Nevertheless, several important research gaps still remain. For example, empirical evidence on the *amount of wage growth* of individual low-wage workers is scarce, especially for Germany. However, this should be regarded as an important piece of information relating to the wage mobility of these workers: A low extent of individual wage growth in the low-wage sector or a high persistence of (very) low wages for certain individuals might call for labour market policies that will assist these workers. Additionally, it would also be interesting to know whether the wage mobility of relatively well-paid low-wage workers differs from the mobility of the worst-paid workers in the low-wage sector, for example, as a result of labour market segmentation. Finally, significant inter-firm differences regarding the extent of the wage growth of low-wage workers might point to the existence of firms who choose a "high road" strategy that also involves better prospects and career opportunities for low-wage workers.[3]

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[1]  For Germany, see for example Eichhorst et al. (2005), Uhlendorff (2006), Mosthaf/Schank/Schnabel (2009), Schank/Schnabel/Stephani (2009), Gürtzgen/Heinze (2010), Grün/Mahringer/Rhein (2011), Mosthaf (2011) and Mosthaf/Schnabel/Stephani (2011). Studies on other countries have been conducted by Andersson/Holzer/Lane (2005) for the U.S., Stewart/Swaffield (1999) and Cappellari/Jenkins (2008) for the UK, Bolvig (2005) for Denmark, Cappellari (2002) and Cappellari (2007) for Italy. While each of these studies covers one specific country, the multi-country studies by the OECD (1996), Asplund/Sloane/Theodossiou (1998) and the European Commission (2004) also provide a comparative analysis.

[2]  The process of defining the low-wage threshold to be used can be regarded as somewhat arbitrary, as McKnight (1998) pointed out. Nevertheless, Eichhorst et al. (2005) have shown that the development and the structure of the low-wage sector can be considered as robust towards the choice of a threshold. Sloane/Theodossiou (1998) provide a more detailed discussion of the methodological aspects of choosing a certain low-wage threshold.

[3]  See Pyke/Sengenberger (1992), p. 12 for an early discussion of possible "high road" and "low road" strategies of firms.

Another research gap concerns the in-depth analysis of the career patterns of low-wage workers. For example, we do not know whether these individuals are able to stay in higher-paid employment after having escaped the low-wage sector or not. Because downward mobility from the higher-wage sector also exists, it would be interesting to see whether the upward mobility of low-wage workers is only a transitory experience or whether it results in longer-lasting employment in higher-paid jobs. Furthermore, taking such a multi-period perspective by looking at the careers of low-wage workers after upward movement could broaden our understanding of low-wage careers. For example, it would be interesting to see how firm characteristics affect the probability of longer-lasting upward wage mobility of low-wage workers.

In this paper, I address both of the research gaps discussed above. First, I analyse the growth of the real wages of individual low-wage workers between 2001 and 2006. Second, I investigate these workers' chances of maintaining higher-paid employment after an upward move. The remainder of the paper is organised as follows: chapter 2 discusses the theoretical background; chapter 3 gives information on the data used; chapter 4 presents the descriptive evidence; chapter 5 present the multivariate analysis; and chapter 6 concludes the work.

## 2 Theoretical background

According to human capital theory and search theory, the main determinants of individual wage growth are the accumulation of general and firm-specific human capital and job searching (i.e., switching to a better-paid job) (e.g., Schönberg 2007). As a consequence, wages are predicted to increase with labour market experience and tenure, but at decreasing rates (e.g., Topel 1991). In line with this theoretical argument, I expect a positive relationship with a decreasing rate between labour market experience and tenure on the one hand and wage growth (and career stability) of low-wage workers on the other hand.[4]

In addition, human capital theory and search theory suggest comparatively lower wage growth for women, foreigners, elderly or lower educated individuals and workers belonging to low-skilled occupational groups.[5] The reasons for this are varied: for example, they might be rooted in gender differences in job preferences or a higher probability of work interruptions (for women), lower growth of individual productivity or a higher unemployment risk. For foreign workers, certain labour market barriers such as the lack of language skills may have a negative impact on wage growth. In addition, (statistical) discrimination may also hamper the future careers of these workers. In line with these theoretical considerations, I expect that low-wage workers who belong to these demographic groups experience a comparatively

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[4]   In this context, it has often been stated that age can be used as a proxy for labour market experience; therefore, in order to avoid multicollinearity, one should refrain from including both age and labour market experience in an earnings regression. However, in the case of low-wage workers this rule might not be appropriate: due to the high unemployment risk of low-wage workers, their age might not serve as a good measure for their labour market experience. For more information about the unemployment risk of low-wage workers, see de Lathouwer/Marx (2005) or Eriksson (1998).

[5]   See, e.g., the in-depth treatment of these two theories in Cahuc/Zylberberg (2004), chapters 2 and 3.

lower level of individual real wage growth and less often stay in higher-paid employment after having escaped the low-wage sector.

Furthermore, relatively well-paid jobs in the low-wage sector might coincide with more opportunities to accumulate general and firm-specific human capital than the worst-paid jobs. Therefore, they may constitute a better signal to other potential employers, while the opposite might be true for the worst-paid jobs in the low-wage sector. For example, a relatively well-paid waitress working in an exclusive restaurant might benefit from her workplace's operating experience and reputation, while this might be less true for a waitress in a snack bar. This would imply that the higher the current wage of a low-wage worker, the higher her chances for future wage growth and remaining in higher-paid employment after having escaped the low-wage sector.

However, a contrary effect can be expected following search theory (e.g., Fitzenberger/Garloff 2007). Because the probability that a new wage offer will exceed the current wage of an individual declines with the level of his current wage, workers in higher wage quantiles are assumed to exhibit lower wage growth than workers in lower wage quantiles. One could expect a similar relationship when investigating only the wage growth of low-wage workers: on average, relatively well-paid low-wage workers should then experience a comparatively lower wage growth than relatively poorly-paid low-wage workers. As becomes clear from the two different lines of argument, the relationship between the wage level of a low-wage worker and her further career is not clear ex ante.

Turning to establishment characteristics, one factor that potentially influences the wage growth and career advancement of low-wage workers is firm size. First, firm size can be considered as a good proxy for the existence of an internal labour market in the firm. An internal labour market increases the chances for individuals to move up in the firm (e.g., Gürtzgen/Heinze 2010, Siebert/Addison 1991). Therefore, in large firms low-wage workers may have a higher probability of wage growth and career advancement. Second, compared to small firms, large firms in Germany more often provide on-the-job training (Gerner/Stegmaier 2009). Besides increasing upward mobility within the firm, on-the-job training might also provide employees with general human capital that (at least in part) is transferable to other employers. When changing firms, this transferable human capital could then help a low-wage worker to obtain a higher wage at his new job. Overall, this implies that firm size is positively associated with wage growth and the career prospects of low-wage workers, irrespective of whether they stay with the firm or change employers.

The composition of the workforce in the firm might also be relevant for the wage growth and the career prospects of low-wage workers. For example, a high percentage of highly-qualified workers may characterise a firm where the accumulation of general and firm-specific human capital is easier, for example, due to knowledge spill-overs or on-the-job training. Furthermore, working for a firm with a high percentage of women or foreign workers could be detrimental for the wage growth and career advancement of low-wage workers. For example, workplace segregation or low-cost strategies in these firms may imply lower wage growth and fewer possibilities for human capital accumulation (Mosthaf/Schnabel/Stephani 2011). A

high share of older workers might characterise a firm in which moving up is more difficult, for example, due to less flexible internal structures (Nienhüser 1998).

Furthermore, labour market segmentation may also hamper the wage growth and the career prospects of low-wage workers. In this context, Grün/Mahringer/Rhein (2011) point out that one might be able to identify firms that offer relatively poor promotion prospects for low-wage workers by looking at the average wage level in the firm. On average, firms that offer relatively poor promotion prospects may also have a lower wage level than firms that offer better promotion prospects. The reason for this could be that a firm that chooses a "high road" strategy, which also involves a higher prevalence of internal labour markets or on-the job training, may also be characterised by a comparatively higher wage level in the plant. On the one hand, such a "high road" strategy might have a positive effect on the careers of workers who stay with the firm (i.e., stayers), as the internal labour market may offer various career opportunities for them. On the other hand, workers who change their employer (i.e., movers) may benefit from the transferable part of the human capital that they accumulated with the previous ("high road") employer and his reputation, both in terms of wage growth and future career prospects. Therefore, I expect the median wage level in a firm to be positively related to the wage growth of low-wage workers and their probability of staying in higher-paid employment after an upward move.[6]

Finally, several other factors may be relevant for the wage growth and the careers of low-wage workers and therefore should be controlled for, although it is difficult to formulate clear-cut hypotheses about their effects. First, due to the high amount of heterogeneity between different industry sectors, one should control for industry affiliation. Second, due to the differing economic situations and relevance of institutions in East and West Germany (for instance regarding collective bargaining), it is also important to control for the location of the firm. Third, it would be interesting to see whether changing firms is associated with increased wage growth and better future career prospects of low-wage workers, as suggested by Andersson/Holzer/Lane (2005); however, some of these (voluntary) changes may of course be endogenous.

## 3  The data

I use a representative 2% random sample from the Integrated Employment Biographies (IEB) of the German Institute for Employment Research in Nuremberg (IAB) for the years 1992 to 2006 that has been augmented by the inclusion of employer information from the Establishment History Panel (BHP). The IEB contain information about all German employees who are liable to social security, benefit recipients, as well as individuals who are searching for employment, unemployed individuals and participants in measures of active labour market policy. For more information on a sample of the IEB which is available for scientific purposes, see Jacobebbinghaus/Seth (2007) as well as Oberschachtsiek et al. (2009). In contrast, the BHP is an establishment panel data set composed of yearly cross sections for both East and

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6    The average is more sensitive to extreme values than the median. In order to avoid bias, in this study, the median wage is used to describe the wage level in the firm.

West Germany. Each cross section of the BHP contains all German establishments that are covered by the Employee and Benefit Recipient History (BLH) on 30 June in that year (see Spengler 2009). A representative 2% sample of the IEB, as well as different versions of the BHP, is available to researchers at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) in Nuremberg.

By combining these two data sets, I create a linked employer-employee data set that enables me to investigate the impact of both individual and firm characteristics on the wage growth and the career of full-time low-wage workers in Germany. I use the commonly accepted low-wage threshold of 2/3 of the median daily gross wage of full-time employees, which has been computed separately for East and West Germany. By limiting the analysis to the low-wage workers who were full-time employed and liable to social security, I avoid potential biases that might arise from the fact that some part-time workers have voluntarily chosen part-time work, such as individuals engaged in childcare or elderly care. Furthermore, as precise information on working hours is not available in this data set, the accurate categorisation of part-time workers into low-paid or higher-paid individuals is not possible.

To focus on the core groups of the labour market, I limit the sample to the full-time employed workers aged 15 to 59 years (in 2001), and I exclude trainees, working students and retired individuals. In contrast to most of the previous studies, I further restrict the analysis to workers who were low-paid while being full-time employed in both starting years 2000 and 2001. By doing so, I ensure that the sample does not contain individuals who received a low wage once and for a short time; for example, this might be the case if a previously higher-paid worker temporarily has to take up a low-paid job after being laid off. For workers who have more than one job, I only use information about their main job, i.e., the employment relationship with the maximum daily wage.

Stemming from the social security records (i.e., administrative sources), both the IEB and the BHP can be regarded as highly reliable. Nevertheless, I exclude full-time employed workers with implausibly low wages from the analysis as well as individuals working in a high-skilled job while earning a wage below the low-wage threshold in both starting years 2000 and 2001.[7] Table 1 presents summary statistics of the sample.

(Table 1 about here)

In the remainder of the paper, I use this data set to analyse the real wage growth of the low-wage workers between 2001 and 2006 and their transitions between a low wage and a higher wage at three points in time: on 30 June in 2001, in 2004, and in 2006.[8]

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[7] I exclude full-time employed workers earning a daily wage of less than 20.1 € (21.5 €) in East (West) Germany in prices of 2006; this is equivalent to a monthly wage of about 602 € (645 €).The results of the analysis are not altered significantly by choosing a higher cut-off point. Furthermore, I also exclude individuals earning a wage below 2/3 of the median in both starting years 2000 and 2001 while working full-time in higher-paying jobs, such as technicians, engineers, managers or jobs belonging to the occupational group of the professions. Since the data set is highly reliable, this problem affects only about 5% of full-time employees.

[8] The nominal wages have been deflated using the consumer price index of the German Federal Statistical Office with 2006 = 100.

# 4 Descriptive evidence

## 4.1 The real wage growth of low-wage workers

As can be inferred from table 2, the full-time employed low-wage workers in the sample earned a real daily wage of about 43.4 € on average in 2001. Until 2006, they experienced a relative real wage growth of about 10.4%. Disaggregation by individual characteristics shows that women earned about 2.5 € less than men, while their amount of relative real wage growth was roughly half the amount of wage growth of men. Foreigners in the low-wage sector earned 2 € more than Germans, whereas there was hardly any difference between the two groups regarding wage growth.

(Table 2 about here)

Another interesting result can be seen when looking at the wage level of a full-time low-wage worker in 2001, which is measured by categorising the workers into three groups: those workers earning a wage below the $5^{th}$ percentile of the entire wage distribution, those earning a wage between the $5^{th}$ and the $10^{th}$ percentile, and those earning a wage between the $10^{th}$ percentile and the low-wage threshold.[9] As can be seen from the figures, the worst-paid workers in the low-wage sector experienced a much higher positive wage growth than the better-paid low-wage workers (23.5% versus 7.7% and 4.2%, respectively). However, only about 11% of the worst-paid low-wage workers were able to cross the low-wage threshold, whereas about 23.5% of the best-paid low-wage workers and about 12% of the wage group in between managed this career move (these figures are not shown in the table).

As the figures reflect both positive growth (wage increases) as well as negative growth (wage losses), the table shows that there has been a considerable degree of upward wage mobility in the low-wage sector. This mobility remains hidden if the analysis is narrowed to the low-wage workers who have crossed the low-wage threshold. After disaggregating these figures into workers who experienced wage increases and workers who experienced wage de-creases, I find some more interesting results. Overall, about 10,300 of the low-wage workers from 2000/01 experienced wage increases, whereas about 9,700 of them suffered wage de-creases (these figures are not shown in the table). This demonstrates that there is a consid-erable amount of downward wage mobility in the low-wage sector which is probably con-nected to the comparatively higher job instability and the higher unemployment risk of these workers. However, the relative magnitude of the average wage increases (31.1%) is almost three times the relative magnitude of the average wage decreases (-11.5%). This is the rea-son why in table 2, I observe a considerable extent of positive wage growth for low-wage workers on average, despite the fact that the frequencies of wage increases and wage decreases are quite close.

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[9] In 2001, the $5^{th}$ percentile of the daily wages of all full-time employees corresponded to a nominal daily wage of 30.5 € (38.0 €) in East (West) Germany; the $10^{th}$ percentile corresponded to a daily wage of 35.1 € (48.0 €); and the low-wage threshold corresponded to a daily wage of 43.5 € (59.4 €).

## 4.2 The career patterns of low-wage workers

While the previous section aimed at shedding light on the development of the wages of full-time employed low-wage workers, this section examines the career patterns of low-wage workers while also taking into account the transition out of full-time employment. In contrast to previous studies, I adopt a multi-period perspective by analysing the career patterns of the low-wage workers from 2000/01 that had reached higher-paid employment by the year 2004. Particularly, I would like to know how many of these workers were still in higher-paid employment in 2006.

Figure 1 gives information about the labour market status of the low-wage workers from 2000/01 in the years 2004 and 2006 by presenting the frequency of different career patterns in these two years.[10] While "N" characterises workers who were no longer full-time employed in the year 2004 or 2006, "L" represents the workers who were still full-time employed and still earning a low wage. Finally, "H" indicates that a low-wage worker from 2000/01 was still full-time employed but receiving a wage above the low-wage threshold. For example, in this context, the pattern "LH" indicates that a low-wage worker from 2000/01 was still low-paid in 2004 ("L") but had reached higher-paid employment in 2006 ("H").

(Figure 1 about here)

Figure 1 shows that more than 32% of the low-wage workers were no longer full-time employed in 2004 (see the sum of the frequencies for the first three career patterns on the left hand side: "NN", "NL" and "NH"). Interestingly, even two years later, most of these individuals (more than 25% of all low-wage workers from 2000/01, see career pattern "NN") had not returned to full-time employment. More than 35% of the low-wage workers from 2000/01 still received a low wage in 2004 and in 2006 while being full-time employed (see career pattern "LL"). The high persistence in low pay as well as the high number of transitions out of (full-time) low-paid employment has also been found by previous studies on the mobility of low-wage workers, for example, by Stewart (2007) for the UK and by Uhlendorff (2006) for Germany. In line with previous studies on low-wage mobility in Germany, I further find that about 15% of the low-wage workers had found higher-paid employment three years later ("HN", "HL", "HH"). However, more than 60% of these workers (i.e., about 9% of all low-wage workers) were still higher-paid in 2006 ("HH"), whereas about 4% of all low-wage workers were no longer full-time employed in 2006 after having moved to higher-paid employment by the year 2004 ("HN"). Only about 2% of all low-wage workers were again low-paid in 2006 after having reached a higher-paid position by 2004 ("HL"). In summary, despite the high persistence in low-paid employment and the considerable number of transitions out of full-time employment that accounts for an important part of the mobility in the low-wage sector, there also seems to be a certain amount of upward mobility of low-wage workers that results in long-lasting higher-paid jobs for about 9% of all low-wage workers in the sample.

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[10] See Bingley/Bjørn/Westergård-Nielsen (1995) for a similar analysis for Germany and Denmark for the years 1980-1990. Of course, even more could be learned by incorporating more years into this descriptive analysis; for example, one could try to identify low-wage workers who frequently switch between a low wage and a higher wage. However, due to the increased complexity that would result, this is not addressed in this paper.

Table 3 presents disaggregated information on the career patterns of the low-wage workers, focusing on the question of which of them were able to maintain higher-paid employment until 2006. For analytical reasons and for the purpose of clarity, I have built three aggregated groups out of the nine career patterns used in figure 1. The first group consists of the low-wage workers who were "low-paid in 2004 or not full-time employed in 2004" (this comprises about 85% of all low-wage workers from 2000/01)[11]; the second group contains the workers who were "higher-paid in 2004, low-paid or not full-time employed in 2006" ("HN" and "HL", about 6% of the low-wage workers), while the third group of workers was "higher-paid both in 2004 and 2006" ("HH", about 9%).

(Table 3 about here)

Women were more likely than men to be low-paid or to no longer be full-time employed in 2004, and at the same time, they were less likely to be higher-paid both in 2004 and in 2006; while about 13% of the male low-wage workers were higher-paid in 2004 and in 2006, only about 8% of the females had managed to achieve higher-paid employment. The differences between the figures for Germans and for foreigners are not particularly pronounced. Compared to relatively poorly paid low-wage workers, relatively well-paid low-wage workers more often managed to be higher-paid both in 2004 and 2006. Interestingly, in the third column, the figures for the workers earning less than the 5th percentile are quite close to the figures for the workers earning a wage between the 5th percentile and the 10th percentile, while the number of the previously best-paid low-wage workers from 2000/01 who were higher-paid both in 2004 and in 2006 is more than twice as high. This shows that the best-paid low-wage workers more often remain in higher-paid employment than the relatively poorly paid low-wage workers.

Using the descriptive results of this chapter as a starting point, it will be interesting to see which factors influence the real wage growth and the careers of the low-wage workers in the multivariate analysis.

# 5 Econometric analysis

## 5.1 The determinants of the real wage growth of low-wage workers

In the first part of the multivariate analysis, I investigate the determinants of the real wage growth of low-wage workers between 2001 and 2006 by estimating a Heckman selection model. In doing so, I correct for the selectivity of the sample by taking into account that the status of being a low-wage worker in 2000/01 and of still being full-time employed in 2006 might not be exogenous.[12]

Let $y_{i0}$ be a dummy variable which is 1 if a full-time employed individual from 2000/01 is low-paid in these two years:

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[11] These are: „NN", „NL", „NH", „LN", „LL" and „LH".

[12] The endogeneity of the initial state could result in the so-called initial conditions problem, see Heckman (1981) and Stewart/Swaffield (1999).

$$P(y_{i0} = 1) = P(y_{i0}^* = g(z_i \gamma^* + \varepsilon_{i0}) < \kappa) = \Phi_1(z_i \gamma) \tag{1}$$

where $y_{i0}^*$ is the underlying latent variable and $\kappa$ is the low-wage threshold. $\Phi_1$ denotes the cumulative standard normal distribution.

Let $\Delta lnw_i$ be the difference of the logarithms of an individual's real wages in 2006 and 2001, which is observed only if the individual was low-paid in 2000/01:

$$\Delta lnw_i = x_i \beta + \varepsilon_{i1} , \tag{2}$$

where $x_i$ is the vector of variables determining wage growth. Assuming that the error terms $\varepsilon_{i0}$ and $\varepsilon_{i1}$ have a bivariate normal distribution with zero means, standard deviation $\sigma_{\varepsilon 0}$ and $\sigma_{\varepsilon 1}$ and correlation $\rho$, then

$$E(\Delta lnw_i \mid y_{i0} = 1) = (x_i \beta + \beta_\lambda \frac{\phi_2(z_i \gamma^* / \sigma_{\varepsilon 0})}{\Phi_1(z_i \gamma^* / \sigma_{\varepsilon 0})} , \tag{3}$$

where $\phi_2$ is the standard normal density function and $\frac{\phi_2(z_i \gamma^* / \sigma_{\varepsilon 0})}{\Phi_1(z_i \gamma^* / \sigma_{\varepsilon 0})}$ is the inverse Mills Ratio. Following the theoretical considerations discussed earlier, I include a number of explanatory variables in the model. Explanatory variables that enter both $z_i$ and $x_i$ are individual characteristics (gender, age, level of education and (non-German) nationality), seven dummy variables indicating the occupational group of the worker and a number of establishment characteristics. The latter are dummy variables describing plant size and a number of variables describing the composition of the workforce in the plant, including the percentage of women, the percentage of foreigners, the percentage of highly-skilled workers, the median age and the median daily wage of all full-time workers in the plant. To control for industry affiliation, 18 industry dummy variables have also been included.[13] In addition, $x_i$ also contains three dummy variables describing the wage level of the worker in 2001 which has been discussed in the descriptive part of the paper, four variables describing the amount of individual labour market experience and tenure between 1992 and 2006[14] and one dummy control variable indicating that a worker changed plants between 2001 and 2006. In contrast, $z_i$ contains a variable that is not included in the wage growth equation. This variable measures the difference between the logarithm of the East (West) German low-wage threshold (2/3 of the median wage in the respective part of the country) and the logarithm of 2/3 of the median wage calculated at the level of the district in which an individual was employed[15]. The higher the difference between these two wage levels in 2001, the more likely it is that an individual working in the respective district in 2001 received a wage below the East (West) German low-wage threshold of 2/3 of the median wage. Therefore, I expect this variable to influence the selection of a full-time employed worker from 2000/01 into the group of the low-paid in these two years. However, this variable is a highly aggregated one because it has been cal-

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[13] All explanatory variables mentioned so far are measured in the year 2001.
[14] Labour market experience and tenure enter the equation in linear and squared form. The tenure variable refers to the firm at which a worker was employed in the year 2006.
[15] Germany is organised into 429 administrative districts.

culated by aggregating the wages of more than 950 full-time employees per district on average. Therefore, it is not likely to have a significant impact on the wage growth of an individual low-wage worker between 2001 and 2006. For this reason, I use this variable as an exclusion restriction.

The first column of table 4 presents the estimates of the determinants of the log wage growth of low-wage workers.[16] The correlation coefficient of the error terms $\rho$ is statistically highly significant, indicating that the use of a simple OLS regression instead of the Heckman procedure would result in biased estimates. Following the approach of Stewart/Swaffield (1999) and Gürtzgen/Heinze (2010) for testing the validity of the exclusion restriction, I find that the exclusion restriction that I use proves to be highly significant when included in the selection equation; however, it can be excluded from the wage growth equation as it is not significant there (see table 5 for the results of the diagnostic tests).

(Table 4 about here)

As expected, women, older workers and low-skilled workers have a comparatively lower real wage growth than men, younger workers and higher-skilled workers. Furthermore, I find that labour market experience and tenure are positively related to the wage growth of low-wage workers, at decreasing rates. However, the effect of labour market experience is only significant at the 10%-level.

(Table 5 about here)

The two dummy variables describing the wage level of a low-wage worker have a significant impact on the individual real wage growth: compared to the reference group of workers who earned a wage between the 10th percentile and the low-wage threshold of 2/3 of the median wage, the worst-paid workers in the low-wage sector had a higher real wage growth by 14.6%. The workers earning a wage between the 5th and the 10th percentile had a higher wage growth than the reference group by roughly 4%. Overall, these results seem to support the search theory hypothesis discussed in the theoretical part of the paper: the higher the wage of a low-wage worker, the lower his relative wage growth.

With respect to the establishment characteristics, as expected, I find a positive effect of plant size on the wage growth of low-wage workers. In contrast, the variables describing the composition of the workforce in the plant are not always statistically significant. Interestingly, even after controlling for a number of individual and plant characteristics, there is a positive and highly significant effect of the median daily wage in the plant. Considering all explanatory variables at their mean value, a higher median daily wage in the plant by 10 € is associated with a 2% higher individual wage growth of the low-wage workers who were employed there in 2001. As discussed in the theoretical part of the paper, this result suggests that there might be a considerable extent of inter-firm heterogeneity, which is relevant for the wage

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[16] Due to the non-comparability of the daily wages of the full-time and part-time workers in this administrative data set, and because of the non-existence of wage estimates for the low-wage workers who left employment, in this part of the paper, I am not able to control for the transition of low-wage workers out of (full-time) employment.

growth of low-wage workers and which is not captured by the other firm variables integrated in the regression. Last but not least, it is also worth noting that low-wage workers in East Germany had a more than 6% higher real wage growth than low-wage workers in West Germany, which might reflect a catch-up process due to the initially lower wage level in the eastern part of the country.

To account for the fact that low pay often constitutes a "special affliction" of women (Asplund/Persson 2000), the second and third column of table 4 present separate estimations by gender. In this way, I try to control for deeper gender-specific differences that might not be captured by the gender dummy variable used in the previous regression. The results reveal a number of interesting differences between male and female low-wage workers.

For example, the amount of labour market experience does not have an influence on the wage growth of women in the low-wage sector, while the effect of this variable on the wage growth of men is now highly significant at the 1%-level. Another interesting result is that although the sign of the effect of the individual wage level is the same for women and for men, the effects of these variables are about two times higher for men than for women. For women, I also find a positive impact of the plant size dummy variables compared to the reference group; for men, no significant difference between the effects of these dummy variables can be identified. Furthermore, the positive effect of the median daily wage in the plant is four times bigger for men than for women. Overall, these results might reflect systematic job or workplace differences between the sexes that are not captured by the variables included in the regressions.

Last but not least, in all estimations, I find a highly significant positive effect of the dummy variable that describes a change of the plant. Of course, one should keep in mind the potential endogeneity of this variable when interpreting it. Nevertheless, changing plants seems to be a relevant element of the wage growth of low-wage workers.

## 5.2 The determinants of the career patterns of low-wage workers

As stated earlier, in contrast to previous studies, I now adopt a multi-period perspective and investigate the development of the careers of low-wage workers after they have moved to higher-paid employment. To be able to analyse the career development of low-wage workers from 2000/01 that have reached higher-paid employment by the year 2004, in the second part of the multivariate analysis, I estimate an ordered probit model with Heckman selection correction (for an extended review of this model, see Greene/Hensher 2010). According to the aggregation of the labour market states into the three broad categories presented earlier in table 3, an ordered dependent variable $y_{ord}$ that characterises the career of a low-wage worker can take three values, indicating temporary or permanent status improvements:

$y_{ord} = 1$         if a low-wage worker from 2000/01 was low-paid or not full-time employed in 2004,

$y_{ord} = 2$         if a low-wage worker from 2000/01 was higher-paid in 2004, and low-paid or not full-time employed in 2006,

$y_{ord} = 3$         if a low-wage worker from 2000/01 was higher-paid both in 2004 and 2006.

According to Long/Freese (2006), Williams (2006) and Gerner (2009), an ordered probit model can be regarded as equivalent to a sequence of related binary probit models. Although, in some cases, these related binary probit models might be less efficient than the "conventional" ordered probit model, this so-called "generalised" ordered probit model is consistent. Furthermore, it allows for a relaxation of the parallel lines assumption that is inherent to the conventional model, and which might be violated in certain cases. By estimating two related binary probit models with sample selection in Stata using maximum likelihood, I am therefore able to mimic the estimation of a generalised ordered probit model with sample selection, which would be computationally more burdensome when estimated directly.

When doing so, the procedure of defining the values of the two binary dependent variables in the career pattern equations of the two related binary probit models with sample selection is crucial: one needs to make sure to choose their respective values in a way that these two models together indeed mimic a "conventional" ordered probit model with sample selection. Table 6 illustrates the recoding of the ordered outcome variable $y_{ord}$ into the dummy outcome variables of the two related binary probit models with sample selection.

(Table 6 about here)

As in the analysis of the determinants of wage growth, I correct for the selectivity of the sample. The two selection equations for the two related binary probit models with sample selection are identical. In each of these probit selection equations, $y_{i0}$ is a dummy variable which is 1 if a full-time employed individual from 2000/01 is low-paid in these two years:

$$P(y_{i0} = 1) = P(y_{i0}^* = g(z_i\gamma^* + \varepsilon_{i0}) < \kappa) = \Phi_1(z_i\gamma) , \qquad (4)$$

where $y_{i0}^*$ is the underlying latent variable and $\kappa$ is the low-wage threshold. Again, $\phi_1$ denotes the cumulative standard normal distribution.

In the first of the two related binary probit models with sample selection, let $y_{i1a}$ be a dummy variable which takes the value "0" if a low-wage worker from 2000/01 was low-paid or not full-time employed in 2004 (i.e., $y_{ord} = 1$), and "1" if in 2004, he was receiving a wage above the low-wage threshold (i.e., $y_{ord} \geq 2$). This yields a probit model for the probability of a low-wage worker being higher-paid in 2004:

$$P(y_{i1a} = 1) = P(y_{i1a}^* = f(x_i\beta_a^* + \varepsilon_{i1a}) > \kappa) = \Phi_{1a}(x_i\beta_a) . \qquad (5)$$

In the second of the two related binary probit models with sample selection, I estimate the probability of a low-wage worker being higher-paid both in 2004 and in 2006. For this second model, let $y_{i1b}$ be a dummy variable which takes the value "0" if a low-wage worker was low-paid or not full-time employed in 2004; or if he has been higher-paid in 2004 but returned to low pay or exited full-time employment in 2006 (i.e., $y_{ord} \leq 2$). Accordingly, $y_{i1b}$ takes the value "1" if a low-wage worker was higher-paid in both 2004 and 2006 (i.e., $y_{ord} = 3$). The probability of a low-wage worker being higher-paid in both 2004 and 2006 is then given by:

$$P(y_{i1b} = 1) = P(y_{i1b}^* = f(x_i\beta_b^* + \varepsilon_{i1b}) > \kappa) = \Phi_{1b}(x_i\beta_b) . \tag{6}$$

The error terms $(\varepsilon_{i0}, \varepsilon_{i1a})$ and $(\varepsilon_{i0}, \varepsilon_{i1b})$ are assumed to follow a bivariate standard normal distribution with correlation $\rho_a$ and $\rho_b$, respectively. Therefore, the conditional probability that a low-wage worker was higher-paid in 2004 is

$$P(y_{i1a} = 1 \mid y_{i0} = 1) = \frac{\Phi_{2a}(x_i\beta_a, z_i\gamma, \rho_a)}{\Phi_1(z_i\gamma)} , \tag{7}$$

and the conditional probability that a low-wage worker was higher-paid both in 2004 and in 2006 is

$$P(y_{i1b} = 1 \mid y_{i0} = 1) = \frac{\Phi_{2b}(x_i\beta_b, z_i\gamma, \rho_b)}{\Phi_1(z_i\gamma)} , \tag{8}$$

where $\Phi_{2a}$ and $\Phi_{2b}$ are the cumulative bivariate standard normal distributions. $\Phi_{2a}$ is derived from equations (4) and (5), $\Phi_{2b}$ from equations (4) and (6).

The variables included in $x_i$ are largely the same as the ones used in the wage growth equation in the analysis of the real wage growth of low-wage workers in the previous chapter. However, because in this chapter I also take into account transitions out of employment, $x_i$ contains neither the tenure variables nor the dummy variable indicating a change of plant.

The selection equations in both models are supposed to correct for the fact that the probability of a full-time employed worker from 2000/01 being low-paid in these two years might not be exogenous. The set of explanatory variables included in $z_i$ is the same as those used in the selection equation for the estimation of the real wage growth in the previous chapter. However, as an identifying restriction, I now use a dummy variable indicating whether or not a full-time employed worker from 2000/01 was low-paid in 1999.

Table 7 presents the results of this generalised ordered probit model with sample selection. The exclusion restriction I use in this analysis proves to be highly significant when included in the selection equation; at the same time, it can be excluded from the career pattern equations, as it is not significant there (see table 5 for details about the diagnostic tests). Note that in contrast to the analysis of the wage growth in the previous chapter, I now control for the

transition out of full-time employment, which is a relevant phenomenon in the low-wage sector.[17]

(Table 7 about here)

First, one can see that compared to men, women exhibit a lower probability of reaching higher-paid employment and also a lower probability of remaining in higher-paid employment after an upward move. Compared to men, their probability of reaching higher-paid employment is more than 11 percentage points lower (see marginal effect in the first column), while their probability of *staying* in higher-paid employment after an upward move is more than 13 percentage points lower than the corresponding probability for men (see marginal effect in the second column).

Regarding the occupational groups, I find that compared to the reference category of skilled commercial and administrative occupations, all occupational groups except the semi-professions have a lower probability of reaching higher-paid employment and of staying in higher-paid employment afterwards.

Labour market experience has a strong positive effect at a decreasing rate both on the probability of a low-wage worker reaching higher-paid employment and on his probability of remaining in higher-paid employment afterwards. This points to the importance of work experience for the career advancement of low-wage workers.

The marginal effects of the variables describing the wage level of a low-wage worker in 2001 show that the worst-paid workers in the low-wage sector have a significantly lower probability of crossing the low-wage threshold than the reference group of the best-paid low-wage workers. Compared to the reference group of workers who earned a wage between the 10th percentile and 2/3 of the median wage, the worst-paid workers had a more than 13.5 percentage points lower probability of reaching higher-paid employment by the year 2004 and a more than 11 percentage points lower probability of staying in higher-paid employment after an upward move. Interestingly, the career prospects of medium-paid low-wage workers (i.e., the group of workers earning a wage between the 5th percentile and the 10th percentile) were worse than the career prospects of the worst-paid low-wage workers.

Regarding the effects of establishment characteristics, similar to the analysis of the determinants of wage growth, I find a positive effect of firm size. Furthermore, there is a highly significant positive effect of the median daily wage in the plant. Again, the latter effect can be interpreted as a proxy for firm heterogeneity in the low-wage sector, which is not captured by the firm variables in the regressions. A higher median daily wage in the plant by 10 € increases the probability of a low-wage worker reaching higher-paid employment by the year 2004 by 2 percentage points; the probability of staying in higher-paid employment after moving up is higher by 2 percentage points as well.

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[17]   I control for the transition from full-time employment into part-time employment and into the status of no longer being employed by incorporating these two labour market states into the value "0" of the dependent variable of the mobility equations.

Separate regressions by gender qualitatively confirm most of the results discussed above, with the marginal effects for men often being more pronounced than for women (results available on request). I find that the percentage of women in the firm has a statistically significant negative impact on the careers of women, while there is no such effect for men. As discussed earlier, this result could point to the relevance of labour market segregation in the low-wage sector.

# 6   Conclusions

Using administrative linked employer-employee data from Germany, this paper has provided several new insights on the real wage growth and career patterns of full-time employed low-wage workers between 2001 and 2006.

First, there is a significant extent of upward and downward real wage mobility in the low-wage sector, as the number of low-wage workers experiencing real wage increases is only slightly higher than the number of low-wage workers experiencing real wage losses. However, even the worst-paid workers in the low-wage sector, i.e., the workers who earned a wage below the $5^{th}$ percentile, experienced a considerable extent of upward wage mobility: on average, their real wages increased more than 23% between 2001 and 2006. Thus, the relative wage growth of the worst-paid low-wage workers was considerably higher than the wage growth of the better-paid low-wage workers.

Second, in line with previous studies, I find that only about 15% of all low-wage workers managed to move up to higher-paid employment within three years. In addition, I go beyond the previous studies by analysing the careers of these workers after their upward move. I find that more than 60% of these workers were still higher-paid two years later. This result shows that the upward wage mobility of low-wage workers is not a merely transitory phenomenon, but can lead to longer-lasting higher wage levels for low-wage workers.

Third, the multivariate analysis shows the relevance of individual, job and firm characteristics for the wage growth and the career advancement of low-wage workers. Notably, I find a highly significant positive effect of the median daily wage in the plant. This variable can be interpreted as a proxy for firm heterogeneity. Therefore, the results point to the existence of firms in the low-wage sector that choose a "high road" strategy. Besides higher wage growth, such a strategy might also involve better prospects and career opportunities for low-wage workers.

For the U.S., studies have shown that employers indeed play an important role in the earnings and the employment outcomes of low-wage workers (see Holzer 2005 for a discussion). Therefore, future researchers might be able to identify potential career firms for German low-wage workers by addressing the aspect of firm heterogeneity in the low-wage sector in more detail. In doing so, qualitative approaches should also be considered. As Lane (2009) points out, case studies might constitute a particularly helpful tool for understanding the relationship between employers and wage inequality.

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**Table 1: Summary statistics of variables in the sample**

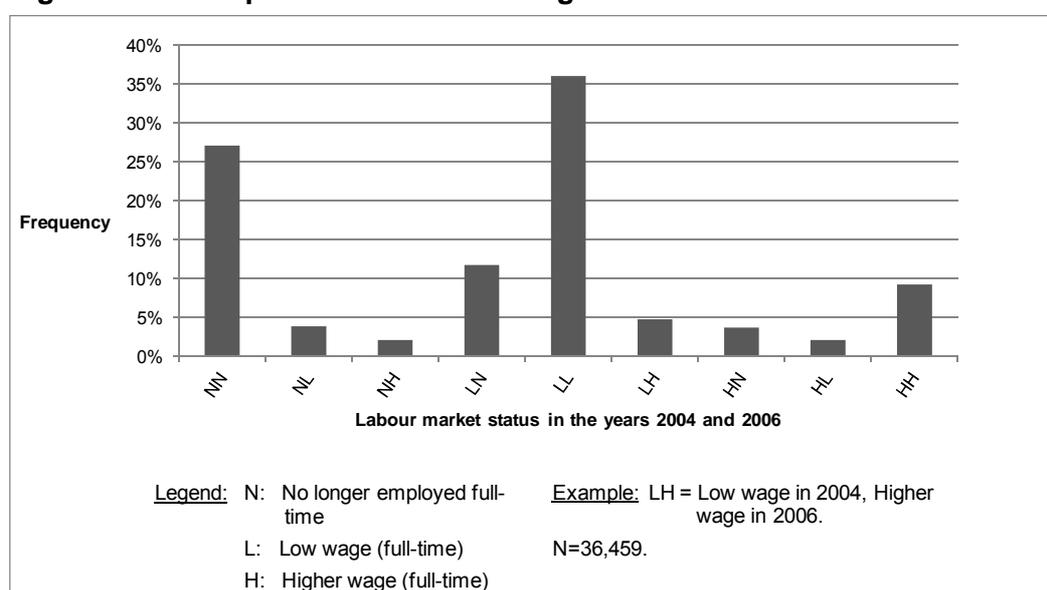| Variable | Observa-tions | Mean | Std. Deviation |
|---|---|---|---|
| **Full-time employed workers with low wage in both 2000 and 2001** | | | |
| Female (1=yes) | 36,459 | 0.695 | 0.460 |
| Foreigner (1=yes) | 36,456 | 0.104 | 0.305 |
| Age 15-24 (1=yes) | 36,459 | 0.123 | 0.329 |
| Age 25-34 (1=yes) | 36,459 | 0.253 | 0.434 |
| Age 35-49 (1=yes) | 36,459 | 0.562 | 0.496 |
| Age 50-57 (1=yes) | 36,459 | 0.062 | 0.241 |
| School leaving certificate without vocational training (1=yes) | 36,459 | 0.183 | 0.387 |
| School leaving certificate with vocational training (1=yes) | 36,459 | 0.576 | 0.494 |
| High school certificate or university degree (1=yes) | 36,459 | 0.005 | 0.070 |
| Education unknown (1=yes) | 36,459 | 0.139 | 0.117 |
| Unskilled manual occupations (1=yes) | 36,459 | 0.191 | 0.393 |
| Skilled manual occupations (1=yes) | 36,459 | 0.128 | 0.334 |
| Unskilled service occupations (1=yes) | 36,459 | 0.223 | 0.416 |
| Skilled service occupations (1=yes) | 36,459 | 0.122 | 0.327 |
| Unskilled commercial and administrative occupations (1=yes) | 36,459 | 0.146 | 0.353 |
| Skilled commercial and administrative occupations (1=yes) | 36,459 | 0.158 | 0.365 |
| Semi-professions (1=yes) | 36,456 | 0.025 | 0.156 |
| Occupation unknown (1=yes) | 36,459 | 0.007 | 0.086 |
| Labour market experience 1992-2006 | 34,580 | 10.903 | 3.207 |
| … squared | 34,580 | 129.158 | 65.517 |
| Tenure 1992-2006 | 34,580 | 5.205 | 5.006 |
| … squared | 34,580 | 52.154 | 70.958 |
| Wage < $5^{th}$ percentile in 2001 (1=yes) | 36,459 | 0.311 | 0.463 |
| $5^{th}$ percentile < wage < $10^{th}$ percentile in 2001 (1=yes) | 36,459 | 0.321 | 0.467 |
| $10^{th}$ percentile < wage < 2/3 of the median wage in 2001 (1=yes) | 36,459 | 0.369 | 0.482 |
| 1-20 employees (1=yes) | 36,459 | 0.535 | 0.499 |
| 21-100 employees (1=yes) | 36,459 | 0.272 | 0.445 |
| 101-500 employees (1=yes) | 36,459 | 0.156 | 0.363 |
| More than 500 employees (1=yes) | 36,459 | 0.037 | 0.189 |
| Median age of the full-time workers in the plant | 36,398 | 37.821 | 7.034 |
| Percentage of women in the plant | 36,459 | 59.075 | 31.445 |
| Median daily wage in the plant | 36,398 | 53.324 | 18.984 |
| Percentage of foreigners in the plant | 36,459 | 9.373 | 18.104 |
| Percentage of highly-qualified workers in the plant | 36,459 | 1.972 | 6.549 |
| East Germany (1=yes) | 36,459 | 0.214 | 0.410 |
| Change of plant (1=yes) | 26,590 | 0.447 | 0.497 |
| **All full-time employed workers from 2000/01** | | | |
| Difference between the log of 2/3 of the East (West) German median wage and the log of 2/3 of the median wage in the district | 344,893 | -0.128 | 0.116 |
| Low-wage employed in 1999 (1=yes) | 344,961 | 0.100 | 0.300 |

Notes: own calculations based on IEB and BHP. The personal and plant-level characteristics are measured in 2001.

**Table 2: Real daily wages and wage growth of the low-wage workers from 2000/01 in the years 2001-2006, disaggregated by individual characteristics**

| | Mean wage in 2001 | Δ wage (2001 - 2006) | N (N full-time employed in 2006) |
|---|---|---|---|
| Men | 45.1 € | 16.5% | 11,113 (6,228) |
| Women | 42.7 € | 7.7% | 25,346 (13,708) |
| Germans | 43.2 € | 10.4% | 32,662 (18,158) |
| Foreigners | 45.2 € | 10.6% | 3,794 (1,778) |
| Secondary school certificate without vocational training | 44.9 € | 10.2% | 6,707 (3,612) |
| Secondary school certificate with vocational training | 43.3 € | 9.2% | 21,005 (11,800) |
| High school certificate or university degree | 43.5 € | 38.9% | 946 (495) |
| Education unknown | 42.6 € | 10.7% | 7,801 (4029) |
| Wage 2001 < 5$^{th}$ perc. | 31.7 € | 23.5% | 11,331 (5,306) |
| 5$^{th}$ perc. < wage 2001 < 10$^{th}$ perc. | 44.6 € | 7.7% | 11,688 (6,335) |
| 10$^{th}$ perc. < wage 2001 < 2/3 median wage | 52.3 € | 4.2% | 13,440 (8,295) |
| 1-20 employees | 41.7 € | 10.6% | 19,495 (10,386) |
| 21-100 employees | 44.7 € | 8.8% | 9,929 (5,654) |
| 101-500 employees | 46.4 € | 10.4% | 5,679 (3,207) |
| More than 500 employees | 47 € | 21.8% | 1,356 (689) |
| No change of plant | 44.5 €* | 3.5% | - (12,141) |
| Change of plant | 44.8 €* | 21.2% | - (7,795) |
| Employed in East Germany | 35.4 € | 9.1% | 7,798 (4,327) |
| Employed in West Germany | 45.6 € | 10.8% | 28,661 (15,609) |
| **Overall** | **43.4 €** | **10.4%** | **36,459 (19,936)** |

Source: own calculations based on IEB and BHP. * only workers who were full-time employed in 2001 and 2006.

**Figure 1: Career patterns of the low-wage workers from 2000/01 in 2004 and 2006**



Legend:  N:  No longer employed full-time
         L:  Low wage (full-time)
         H:  Higher wage (full-time)

Example: LH = Low wage in 2004, Higher wage in 2006.
N=36,459.

Source: own calculations based on IEB and BHP

**Table 3: Aggregated career patterns of the low-wage workers from 2000/01 in 2004 and 2006, disaggregated by individual characteristics**

| | Low-paid or not full-time employed in 2004 | Higher-paid in 2004; low-paid or not full-time employed in 2006 | Higher-paid both in 2004 and in 2006 |
|---|---|---|---|
| | (1) | (2) | (3) |
| Men | 81.5% | 5.9% | 12.7% |
| Women | 86.7% | 5.7% | 7.7% |
| Germans | 85.0% | 5.7% | 9.3% |
| Foreigners | 86.1% | 6.0% | 7.9% |
| Secondary school certificate without vocational training | 87.1% | 4.6% | 8.4% |
| Secondary school certificate with vocational training | 84.3% | 6.1% | 9.6% |
| High school certificate or university degree | 78.0% | 6.7% | 15.3% |
| Education unknown | 86.5% | 5.6% | 7.9% |
| Wage 2001 < $5^{th}$ perc. | 90.0% | 4.4% | 5.6% |
| $5^{th}$ perc. < wage 2001 < $10^{th}$ perc. | 89.6% | 4.4% | 6.0% |
| $10^{th}$ perc. < wage 2001 < 2/3 median wage | 77.1% | 8.0% | 14.9% |
| 1-20 employees | 85.7% | 5.9% | 8.4% |
| 21-100 employees | 85.4% | 5.3% | 9.2% |
| 101-500 employees | 83.7% | 5.5% | 10.8% |
| More than 500 employees | 79.7% | 7.3% | 13.0% |
| Employed in East Germany | 87.3% | 4.9% | 7.9% |
| Employed in West Germany | 84.5% | 6.0% | 9.5% |
| Employed in East Germany | 87.3% | 4.9% | 7.9% |
| **Overall** | **85.1%** | **5.7%** | **9.2%** |
| **Observations** | **31,030** | **2,091** | **3,338** |

Notes: own calculations based on IEB and BHP. The aggregated pattern (1) contains the career patterns „NN", „NL", „NH", „LN", „LL" and „LH"; (2) contains "HN" and "HL"; (3) contains "HH".

**Table 4: Determinants of the log real wage growth of the low-wage workers from 2000/01 between 2001 and 2006, Heckman selection models**

| | All workers | Women | Men |
|---|---|---|---|
| **Wage growth equation** | | | |
| Female (1=yes) | -0.083*** | - | - |
| | (0.006) | | |
| Foreigner (1=yes) | -0.022*** | 4.9e-04 | -0.041*** |
| | (0.008) | (0.010) | (0.013) |
| Age 25-34 (1=yes) | -0.039*** | -0.038*** | -0.032*** |
| | (0.007) | (0.009) | (0.012) |
| Age 35-49 (1=yes) | -0.090*** | -0.083*** | -0.084*** |
| | (0.007) | (0.008) | (0.012) |
| Age 50-57 (1=yes) | -0.094*** | -0.094*** | -0.083*** |
| | (0.011) | (0.012) | (0.023) |
| School leaving certificate with vocational training (1=yes) | 2.0e-04 | -0.003 | 0.013* |
| | (0.004) | (0.005) | (0.008) |
| High school certificate or university degree (1=yes) | 0.176*** | 0.153*** | 0.164*** |
| | (0.040) | (0.050) | (0.057) |
| Education unknown (1=yes) | 0.053*** | 0.031* | 0.075 |
| | (0.018) | (0.018) | (0.048) |
| Unskilled manual occupations (1=yes) | -0.035*** | -0.034*** | -0.070*** |
| | (0.007) | (0.008) | (0.019) |
| Skilled manual occupations (1=yes) | -0.036*** | -0.040*** | -0.069*** |
| | (0.008) | (0.009) | (0.018) |
| Unskilled service occupations (1=yes) | -0.063*** | -0.060*** | -0.091*** |
| | (0.007) | (0.008) | (0.017) |
| Skilled service occupations (1=yes) | -0.046*** | -0.048*** | -0.072** |
| | (0.009) | (0.010) | (0.035) |
| Unskilled commercial and administrative occupations (1=yes) | -0.038*** | -0.038*** | -0.063*** |
| | (0.007) | (0.008) | (0.023) |
| Semi-professions (1=yes) | 0.025 | -0.001 | 0.124*** |
| | (0.016) | (0.017) | (0.048) |
| Occupation unknown (1=yes) | -0.048** | -0.048* | -0.076* |
| | (0.022) | (0.028) | (0.041) |
| Labour market experience 1992-2006 | 0.011* | -0.003 | 0.031*** |
| | (0.006) | (0.009) | (0.009) |
| … squared | -0.001** | 8.9e-05 | -0.001*** |
| | (2.8e-04) | (3.8e-04) | (4.3e-04) |
| Tenure 1992-2006 | 0.041*** | 0.034*** | 0.053*** |
| | (0.003) | (0.003) | (0.004) |
| … squared | -0.002*** | -0.002*** | -0.003*** |
| | (1.3e-04) | (1.7e-04) | (2.3e-04) |
| Wage < 5th percentile in 2001 (1=yes) | 0.146*** | 0.119*** | 0.220*** |
| | (0.006) | (0.006) | (0.015) |
| 5th percentile < wage < 10th percentile in 2001 (1=yes) | 0.041*** | 0.031*** | 0.064*** |
| | (0.004) | (0.005) | (0.008) |
| 21-100 employees (1=yes) | -0.003 | 1.0e-04 | -0.009 |
| | (0.004) | (0.005) | (0.008) |
| 101-500 employees (1=yes) | 0.016*** | 0.023*** | -0.004 |
| | (0.006) | (0.007) | (0.011) |
| More than 500 employees (1=yes) | 0.039*** | 0.058*** | -0.002 |
| | (0.012) | (0.014) | (0.021) |
| Median age of the full-time workers in in the plant | -0.001*** | -0.001*** | -0.002*** |
| | (3.0e-04) | (3.5e-04) | (0.001) |
| Percentage of women in the plant | -2.4e-05 | -2.0e-04* | 4.4e-05 |
| | (9.0e-05) | (1.2e-04) | (1.6e-04) |
| Median daily wage in the plant (full-time) | 0.002*** | 0.001*** | 0.004*** |
| | (1.7e-04) | (1.8e-04) | (4.1e-04) |

**Table 4 (cont.): Determinants of the log real wage growth of the low-wage workers from 2000/01 between 2001 and 2006, Heckman selection models**

| | All workers | Women | Men |
|---|---|---|---|
| Percentage of foreigners in the plant | 2.2e-04 | 9.85e-06 | 0.001** |
| | (1.5e-04) | (1.9e-04) | (2.3e-04) |
| Percentage of highly-qualified workers in the plant | 0.001** | 0.001* | 0.002* |
| | (3.7e-04) | (3.9e-04) | (0.001) |
| East Germany (1=yes) | 0.061*** | 0.039*** | 0.102*** |
| | (0.005) | (0.006) | (0.011) |
| Change of plant (1=yes) | 0.161*** | 0.132*** | 0.204*** |
| | (0.009) | (0.011) | (0.015) |
| Joint significance of dummy variable groups | Age***, level of education***, type of occupation***, wage level in 2001***, plant size***, industry*** | Age***, level of education***, type of occupation***, wage level in 2001***, plant size***, industry*** | Age***, level of education***, type of occupation***, wage level in 2001***, plant size***, industry*** |
| Observations | 19,918 | 13,694 | 6,224 |
| **Selection equation** | | | |
| Difference between the log of 2/3 of the East (West) German median wage and 2/3 of the log of the median wage in the district | 0.008*** | 0.041*** | 0.001*** |
| | (9.4e-04) | (0.005) | (2.9e-04) |
| ρ (correlation of the error terms) | 0.848*** | 0.838*** | 0.869*** |
| Significance of model | $\chi^2(48) =$ 3285.08*** | $\chi^2(47) =$ 1743.45*** | $\chi^2(47) =$ 1938.01*** |
| Total observations | 344,766 | 116,077 | 228,689 |

Notes: own calculations based on IEB and BHP. Standard errors in parentheses (clustered at plant level). 17 industry dummies suppressed in the table. Reference group of the dummy variable groups: age 15-24; secondary school certificate without vocational training; skilled commercial and administrative occupations; wage between the 10th percentile and 2/3 of the median wage; 1-20 employees. Significance levels: ∗ p<0.1, ∗∗ p<0.05, ∗∗∗ p<0.01; n.s. denotes statistical insignificance.

**Table 5: Diagnostic tests**

| Analysis of the wage growth of low-wage workers (see table 4) | | | | | | |
|---|---|---|---|---|---|---|
| | All full-time employed workers | | Females | | Males | |
| | $\chi^2$ | p-value | $\chi^2$ | p-value | $\chi^2$ | p-value |
| Exclusion of instrument 1 from wage growth equation | 0.63 | 0.427 | 1.09 | 0.297 | 2.05 | 0.152 |
| Inclusion of instrument 1 in selection equation | 66.44 | 0.000 | 75.87 | 0.000 | 15.89 | 0.000 |

**Analysis of the career patterns of low-wage workers (see table 7)**

| | Regression 1 | |
|---|---|---|
| | $\chi^2$ | p-value |
| Exclusion of instrument 2 from career pattern equation | 0.81 | 0.369 |
| Inclusion of instrument 2 in selection equation | 20000.13 | 0.000 |
| | **Regression 2** | |
| | $\chi^2$ | p-value |
| Exclusion of instrument 2 from career pattern equation | 0.06 | 0.813 |
| Inclusion of instrument 2 in selection equation | 20023.92 | 0.000 |

Notes: As discussed earlier, instrument 1 (used in table 4) is the difference between the log of the East (West) German low-wage threshold (2/3 of the German median wage) and the log of 2/3 of the median wage calculated at the level of the district in which an individual was employed. Instrument 2 (used in table 7) is a dummy variable indicating whether a full-time employed worker from 2000/01 was low-paid in 1999 or not.

**Table 6: Recoding of the ordered outcome variable $y_{ord}$ into the dummy outcome variables of the related binary probit models with sample selection ($y_{i1a}$ and $y_{i1b}$)**

| Ordered dependent variable $y_{ord}$: | "Low-paid or not full-time employed in 2004" | "Higher-paid in 2004; low-paid or not full-time employed in 2006" | "Higher-paid both in 2004 and in 2006" |
|---|---|---|---|
| | (1) | (2) | (3) |
| Coded into | | | |
| **Two related binary dependent variables:** | | | |
| $y_{i1a} =$ | 0 | 1 | |
| $y_{i1b} =$ | 0 | | 1 |
| Corresponding to the probability of a low-wage worker being… | "Low-paid in 2004 or no longer full-time employed in 2004" | "Higher-paid at least in 2004" (1) vs. (2) & (3) | "Higher-paid both in 2004 and 2006" (1) & (2) vs. (3) |

Notes: $y_{ord}$ = 1 contains the career patterns „NN", „NL", „NH", „LN", „LL" and „LH"; $y_{ord}$ = 2 contains "HN" and "HL"; $y_{ord}$ = 3 contains "HH".

**Table 7: Determinants of the career patterns of low-wage workers, generalised ordered probit model with selection correction estimated by two related probit regressions with selection correction; marginal effects**

| | Regression 1 | Regression 2 |
|---|---|---|
| **Values of the binary outcome variable** | $y_{i1a}$ | $y_{i1b}$ |
| | **0 =** „Low-paid or not full-time employed in 2004" | **0 =** "Low-paid or not full-time employed in 2004" or „Higher-paid in 2004; "low-paid or not full-time employed in 2006" |
| | **1 =** „Higher-paid in 2004" | **1 =** "Higher-paid both in 2004 and in 2006" |
| **Estimating the probability of a low-wage worker being…** | "Higher-paid at least in 2004" | "Higher-paid in 2004 and 2006" |
| **Career pattern equation** | | |
| Female (1=yes) | -0.117*** (0.010) | -0.135*** (0.011) |
| Foreigner (1=yes) | 0.026* (0.014) | 0.021 (0.016) |
| Age 25-34 (1=yes) | -0.064*** (0.010) | -0.080*** (0.010) |
| Age 35-49 (1=yes) | -0.158*** (0.011) | -0.167*** (0.012) |
| Age 50-57 (1=yes) | -0.226*** (0.013) | -0.227*** (0.012) |
| School leaving certificate with vocational training (1=yes) | 0.005 (0.008) | -0.009 (0.008) |
| High school certificate or university degree (1=yes) | 0.101** (0.044) | 0.152*** (0.046) |
| Education unknown (1=yes) | 0.044 (0.027) | 0.035 (0.028) |
| Unskilled manual occupations (1=yes) | -0.081*** (0.013) | -0.078*** (0.013) |
| Skilled manual occupations (1=yes) | -0.079*** (0.013) | -0.085*** (0.013) |
| Unskilled service occupations (1=yes) | -0.096*** (0.012) | -0.106*** (0.011) |
| Skilled service occupations (1=yes) | -0.012 (0.018) | -0.056*** (0.017) |
| Unskilled commercial and administrative occupations (1=yes) | -0.052*** (0.012) | -0.070*** (0.012) |
| Semi-professions (1=yes) | 0.005 (0.024) | -0.002 (0.025) |
| Occupation unknown (1=yes) | -0.097** (0.038) | -0.095** (0.037) |
| Labour market experience 1992-2006 | 0.133*** (0.007) | 0.140*** (0.008) |
| … squared | -0.005*** (3.4e-04) | -0.005*** (3.7e-04) |
| Wage < 5$^{th}$ percentile in 2001 (1=yes) | -0.135*** (0.008) | -0.111*** (0.008) |
| 5$^{th}$ percentile < wage < 10$^{th}$ percentile in 2001 (1=yes) | -0.156*** (0.007) | -0.131*** (0.007) |
| 21-100 employees (1=yes) | 0.004 (0.008) | 0.011 (0.009) |
| 101-500 employees (1=yes) | 0.026** (0.011) | 0.040*** (0.011) |

**Table 7 (cont.): Determinants of the career patterns of low-wage workers, generalised ordered probit model with selection correction estimated by two related probit regressions with selection correction; marginal effects**

| | Regression 1 | Regression 2 |
|---|---|---|
| **Values of the binary outcome variable** | $y_{i1a}$ | $y_{i1b}$ |
| | **0 =** „Low-paid or not full-time employed in 2004" | **0 =** "Low-paid or not full-time employed in 2004" or „Higher-paid in 2004; "low-paid or not full-time employed in 2006" |
| | **1 =** „Higher-paid in 2004" | **1 =** "Higher-paid both in 2004 and in 2006" |
| **Estimating the probability of a low-wage worker being…** | "Higher-paid at least in 2004" | "Higher-paid in 2004 and 2006" |
| More than 500 employees (1=yes) | 0.057*** (0.020) | 0.052** (0.020) |
| Median age of the full-time workers in the plant | -0.003*** (0.001) | -0.002*** (0.001) |
| Percentage of women in the plant | -2.4e-04 (1.6e-04) | -2.1e-04 (1.7e-04) |
| Median daily wage in the plant (full-time) | 0.002*** (2.8e-04) | 0.002*** (3.0e-04) |
| Percentage of foreigners in the plant | -3.6e-04 (2.7e-04) | -0.001** (2.9e-04) |
| Percentage of highly-qualified workers in the plant | 2.5e-04 (0.001) | 2.8e-04 (0.001) |
| East Germany (1=yes) | -0.001 (0.010) | 0.002 (0.010) |
| Joint significance of dummy variable groups | Age***, level of education**, type of occupation***, wage level in 2001***, plant size*, industry*** | Age***, level of education***, type of occupation***, wage level in 2001***, plant size*, industry*** |
| Observations | 34,522 | 34,522 |
| **Selection equation** | | |
| Low-wage employed in 1999 (1=yes) | 0.148*** (0.004) | 0.148*** (0.004) |
| ρ (correlation of the error terms) | 0.210*** | 0.218*** |
| Significance of model | $\chi^2(45) = 1897.41$*** | $\chi^2(45) = 1630.27$*** |
| Total observations | 342,893 | 342,893 |

Notes: own calculations based on IEB and BHP. Standard errors in parentheses (clustered at plant level). 17 industry dummies suppressed in the table. Reference group of the dummy variable groups: age 15-24; secondary school certificate without vocational training; skilled commercial and administrative occupations; wage between the 10th percentile and 2/3 of the median wage; 1-20 employees. Significance levels: ∗ $p<0.1$, ∗∗ $p<0.05$, ∗∗∗ $p<0.01$; n.s. denotes statistical insignificance.

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