# Why do worker-firm matches dissolve?

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**Abstract**

In a dynamic labor market worker-firm matches dissolve frequently and workers separate. This paper studies worker separations using matched worker-firm data from The Netherlands. The main findings are fourfold. First, separations are less likely from high quality matches. Second, wage renegotiations to prevent separations occur; workers with a high propensity to quit are offered higher wages, while workers with a high layoff probability give up some of their wage. Third, despite these wage renegotiations some inefficiency in separations remains. Fourth, whereas inefficient quits are rare, presumably because of downward wage rigidity a substantial part of the layoffs is inefficient.

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# 1 Introduction

In a dynamic labor market worker-firm matches dissolve frequently causing workers to separate from firms through quits or layoffs. In this paper we investigate the nature of these separations. We are particularly interested in analyzing how the match-specific surplus and wage renegotiations affect quits and layoffs to determine whether or not separations are efficient from an economic point of view.

Although the focus of the paper is empirical we start with a simple theoretical model from which we derive three predictions. First, separations are less likely to occur if the joint match specific surplus is high. Second, some separations are inefficient because they occur when there is still a positive match-specific surplus. Third, some of the inefficient separations may be avoided through wage renegotiations. In our empirical analysis we investigate to what extent we can find evidence for these theoretical findings. For this we use matched worker-firm data from the Netherlands collected over a period of 10 years, set-up as repeated cross-sections with a limited panel dimension (2 years). Our empirical strategy consists of four parts (see Box 1 for a stylized representation). First, we estimate a wage equation to obtain a measure for the match-specific surplus, which we define as the sum of the firm-fixed effect, the tenure effect and the residual from the wage regression. So, the match surplus is what the worker would loose when she would quit and accept the market wage, starting at zero tenure in a new firm.

Second, the match-specific surplus measure is used as one of the explanatory variables in separation estimations, distinguishing between quits ($q$) and layoffs ($l$). Indeed, we find that both quits and layoffs are less likely to occur when the match surplus is high.

Third, we investigate whether wages are being renegotiated in response to predicted quit ($\widehat{P}_{q,ij}$) and layoff ($\widehat{P}_{l,ij}$) probabilities. We find that the wage growth of a worker that stays in the firm is larger if that worker had a high quit probability and smaller when that worker had a high layoff probability. From this we derive that indeed some wage renegotiation occurs.

Finally, we calculate the average wage growth for each firm and use this with the predicted wage growth for the workers that separated to establish whether the separations were efficient or inefficient.

Part of our empirical analysis is well-known. Several studies used residuals from wage regressions as an indicator for match quality, estimated quit and layoff probabilities and investigated the wage effects of quits and layoffs. Nevertheless, our analysis also contains new elements. Our contribution to the literature is twofold. First, we focus on the ex-ante effect of separations on wages, while previous studies analyzed the wage effect of separations after they occurred. Second, we provide an indication of inefficiency in worker separations. This issue is important to determine to what extent worker separations are associated with an efficient relocation of resources and skills. We use a unique matched worker-firm dataset from the Netherlands, which provides us with information on both workers and firms covering the period 1993-2002. The data allow us to distinguish between worker-initiated (quit) and firm-initiated (layoff) separations. The panel character is limited but we are able to investigate labor and wage dynamics because some information is available for two consecutive years within each cross-section.

The set-up of this paper is as follows. In section 2 we present a theoretical model about efficient and inefficient separations. In section 3 we give a brief review of previous literature. Section 4 describes the dataset we use and presents some stylized facts. In section 5 the results of our empirical analysis are presented. Finally, section 6 concludes.

# 2 Theoretical model

When a worker and a firm start an employment relationship they expect it to yield a certain surplus which will depend on the characteristics of both the worker and the firm. This match-specific surplus is split-up between the worker and the firm through wage negotiations. The surplus may be affected by external shocks and change over time. Therefore, the employment relationship is continuously reevaluated. A relationship may be terminated if the value of the match for either one or both parties falls below the value of an outside option. As a result, a separation may be initiated by the worker in which case the worker quits, by the firm in which case the worker is fired, or result from a joint decision in which case the nature of the separation is not clear but most likely – due to the voluntary nature of the separation – will be considered as a quit. In the following section we will present our theoretical model which focuses on this process of match dissolution.

## 2.1 Worker-firm separations

Our theoretical model is based on Farber (1999). We assume that the employment relationship between worker $i$ and firm $j$ at time $t$ generates a surplus. For the firm the match generates a surplus which is equal to the difference between the match-specific revenue $V_{ijt}$ and the wage of the worker $W_{ijt}$:

$$S_{ijt}^{F} = V_{ijt} - W_{ijt} \tag{1}$$

For the worker the match generates a surplus which is equal to the difference between the wage and the alternative earnings $A_t$:

$$S_{ijt}^{W} = W_{ijt} - A_t \tag{2}$$

The alternative earnings $A_t$ represent the market wage the worker could earn outside firm $j$. The match-specific surplus is equal to the sum of the workers' surplus and the firm surplus:

$$S_{ijt} = S_{ijt}^{F} + S_{ijt}^{W} = V_{ijt} - A_t \tag{3}$$

Or, in other words, the match-specific surplus is equal to the difference between the value of the production and the alternative earnings of the worker. The surplus is divided between worker and firm through wage negotiations that divide the surplus through a sharing rule such that firms receive a share $\beta_{ijt}$ and workers receive a share $(1 - \beta_{ijt})$, with $0 \leq \beta \leq 1$. The wage is equal to the alternative earnings plus the workers' share of the match-specific surplus:

$$W_{ijt} = A_t + (1 - \beta_{ijt})S_{ijt} \tag{4}$$

Now consider what happens if we introduce labor market dynamics through two types of shocks to the surplus. First, there may be a shock to the alternative earnings:

$$A_{t+1} = A_t + \theta_{t+1} \tag{5}$$

where $\theta$ is a random and external shock, drawn from the distribution function $g(\theta)$ with mean zero. If no wage renegotiations occur, a worker quits if the alternative income exceeds the wage

he receives in the firm:[1]

$$A_{t+1} > W_{ijt}$$
$$\theta_{t+1} > (1 - \beta_{ijt})S_{ijt} \tag{6}$$

Equation (6) shows that the worker is less likely to quit when the value of the workers' surplus is larger.

Second, some match-specific shock may affect the value of production of the worker in the firm:

$$V_{ij,t+1} = V_{ijt} + \phi_{t+1} \tag{7}$$

where $\phi$ is a random variable drawn from the distribution function $f(\phi)$ with mean zero. The firm will layoff the worker if the firm' surplus falls below zero:

$$V_{ij,t+1} < W_{ijt}$$
$$\phi_{t+1} < -\beta_{ijt}S_{ijt} \tag{8}$$

Equation (8) indicates that the worker is laid off if the negative shock is sufficiently large to outweigh the firm's share of the surplus. So the two types of shocks may cause different separations. Shocks to alternative earnings may lead to quits, match-specific shocks may cause layoffs.

## 2.2 Efficiency

A separation is denoted inefficient if it would have been economically rational to prevent it through wage renegotiation. If a worker is about to leave a firm because of a higher outside wage, the firm might prevent this by offering a higher wage too. That reduces the firm's part of the match surplus but may still be profitable if the remaining match surplus is positive.[2] Similarly, the firing of a worker is inefficient if a wage reduction would have prevented the dismissal making the worker better off if the reduced wage is still higher than the outside

[1]Hiring and firing costs for the firm and separation costs for the worker are assumed to be zero for computational simplicity. However, introducing positive hiring and firing costs and separation costs does not change the predictions of the model.

[2]Note that in our model a firm can always hire a new worker at wage $A_t$ and produce $V_{jt}$=$A_t$. So, in expectation, a newly hired workers generates no match surplus.

wage. A separation is efficient if the match surplus after the shock is negative or too small for compensation, i.e. insufficient to compensate the worker who wants to leave or the firm that wants to fire a worker.

In our model we can identify both efficient and inefficient separations. An efficient separation (ES) occurs if the joint surplus of the match falls below zero after the shocks occurred, i.e. a separation is efficient if the positive shock to the alternative wage and the negative match-specific shock are sufficiently large to offset the value of surplus:

$$\begin{aligned} S_{ij,t+1} &< 0 \\ S_{ijt} &< \theta_{t+1} - \phi_{t+1} \end{aligned} \tag{9}$$

Note that efficient separations are independent of the firm's share of the joint match surplus. The distinction between quits and layoffs is related to wage rigidity, i.e. either the worker or the firm is not willing or able to renegotiate the sharing rule governing the costs and returns to firm-specific human capital (Becker (1962) and Parsons (1972)). If wages are fully flexible a separation is always efficient and the distinction between quits and layoffs is irrelevant (Burdett (1978), Jovanovic (1979), Mortensen (1988)). However, McLaughlin (1991) has shown that even in the case of efficient separations, there can be a meaningful distinction between quits and layoffs, which is based on who initiates the separation by demanding a wage revision. Then, quits are worker-initiated separations that result from censored wage increases, while layoffs are firm-initiated separations that result from censored wage cuts. Nevertheless, in the case of fully flexible wages the separation is most likely classified as a quit because a layoff would require a formal action by the employer and is often a costly event due to employment protection legislation. An efficient quit (EQ) occurs if the external shock $\theta$ exceeds the value of the worker surplus and if the sum of both shocks exceeds the joint match surplus, i.e.,

$$S_{ijt} < \theta_{t+1} - \phi_{t+1} \qquad \text{and} \qquad \theta_{t+1} > (1 - \beta_{ijt}) S_{ijt} \tag{10}$$

Since the sum of both the external and the match-specific shock is larger than the initial match surplus, the joint match surplus in the next period falls below zero. Hence, there is no renegotiation possible such that the worker can be compensated for the external shock to

alternative earnings. Similarly, an efficient layoff (EL) occurs if the value of the match-specific shock exceeds the firm surplus and if the sum of both shocks exceeds the joint match surplus, i.e.,

$$S_{ijt} < \theta_{t+1} - \phi_{t+1} \qquad \text{and} \qquad \phi_{t+1} < -\beta_{ijt} S_{ijt} \tag{11}$$

Such a layoff is efficient because the sum of both shocks is too large to compensate the firm through lower wages.

A separation is inefficient if the match surplus is still positive after the shocks occurred. If the shock to the alternative earnings is sufficiently large it will be profitable for the worker to quit, but it may also be profitable for the firm to prevent it. Similarly, if the match-specific shock is sufficiently negative if will be profitable for the employer to fire the worker, but it may also be profitable for the worker to accept a lower wage and stay with the firm. Hence, inefficient quits (IQ) occur if

$$(1 - \beta_{ijt}) S_{ijt} < \theta_{t+1} < S_{ijt} + \phi_{t+1} \tag{12}$$

Similarly, inefficient layoffs (IL) occur if

$$\theta_{t+1} - S_{ijt} < \phi_{t+1} < -\beta_{ijt} S_{ijt} \tag{13}$$

Renegotiation of the wage may prevent inefficient quits and layoffs. If the sum of both shocks is smaller than the joint match surplus, renegotiations may occur and quits and layoffs will be reduced.[3]

A graphical illustration of efficient and inefficient separations is given in Figure 1.[4] Here, $X$ denotes the original match and the match-specific ($\phi$) and external ($\theta$) shock are presented on the axes. If the shocks are smaller than the current match surplus for each party ($\beta_{ijt} S_{ijt}$ for the firm and $(1-\beta_{ijt}) S_{ijt}$ for the worker), the match is maintained. If at least one of the shocks is larger, redistribution of the surplus is necessary to avoid a match dissolution. The diagonal line between $-S_{ijt}$ and $S_{ijt}$ represents the combinations of $S^W_{ijt}$ and $S^F_{ijt}$ that can be reached through renegotiations. North-west of this diagonal are efficient separations, since no successful

[3] Indeed, Hall and Lazear (1984) show that an ex ante fixed surplus sharing rule will lead to excess separations.

[4] 'ST' represents a stay, 'EQ' and 'IQ' an efficient and inefficient quit, 'EL' and 'IL' an efficient and inefficient layoff, and 'ES' indicates an efficient separation.

renegotiations are possible to prevent the match from splitting up. Note that a positive match-specific shock does not lead to wage renegotiations, since it does not lead to a negative surplus for either party, therefore neither party has an incentive to initiate a separation. A similar argument goes for a negative alternative earnings shock.

Overall, the main message of the theoretical model is threefold. First, separations are less likely to occur if the joint surplus is high. Second, some separations may be inefficient because they occur after shocks which still left a positive match-specific surplus. Third, inefficient separations may be avoided through renegotiations. In the analysis below we will investigate to what extent we find empirical evidence to support these theoretical findings. Before presenting the results from our empirical analysis we first give a brief review of previous literature. In the review we relate findings from our theoretical model to earlier research.

# 3 Previous literature

When individual wages are regressed on worker and firm characteristics the wage residuals measure the difference between the current wage and the wage that could be obtained in a similar job given the worker and firm characteristics. Job matching theory, as well as human capital theory and job search theory, predict that matches with high wage residuals are less likely to be dissolved. This prediction is empirically confirmed by Altonji and Shakotko (1987), Borland and Lye (1996), Barth and Dale-Olsen (1999) and Yamaguchi (2003). Not only individual worker effects, but also firm effects that can make up part of the wage residual appear to affect worker separations. In general, high-wage firms seem to have lower worker turnover than low-wage firms (Powell et al. (1994), Abowd and Finer (1997), Galizzi and Lang (1998), Haltiwanger and Vodopivec (2003) and Dale-Olsen (2006)). Though the matching model (Jovanovic (1979)) states that especially the bad matches with negative wage residuals dissolve, Lazear's raiding model (Lazear (1986)) predicts the opposite. In this model rival firms will spot high productivity workers and 'raid' them. Hence, especially good matches dissolve, through quits. Indeed, Garen (1989) finds a negative correlation between tenure and the unobserved job-match effect in a wage estimation. The matching theory would predict a positive correlation and hence the estimated tenure effect to be overstated rather than to be understated.

While most studies focus on separations in general, some studies distinguish between quits and layoffs in order to examine the (different) effect of the wage residual on worker- and firm-initiated separations. Our theoretical model predicts that the wage residual affects both quits and layoffs in a similar way, because the match surplus is shared between the worker and the firm. This prediction is confirmed by Altonji and Shakotko (1987) who find that the wage residual has a negative effect on both quits and layoffs. Also, Pfann (2006) finds that workers with low wage residuals are more likely to be laid off. However, a more recent study by Perticara (2004) shows that workers with a strongly negative wage residual are more likely to quit, while workers with strongly positive wage residuals are more likely to be laid off by the firm. This indicates that a high wage residual is not always an indicator of a large surplus but could also be an indicator of workers being overpaid.

Our theoretical model predicts that workers and firms may want to renegotiate the wage when a separation is imminent in order to avoid inefficient match dissolutions.[5] As a result of this renegotiation, wages will change. Several studies analyzed wage dynamics resulting from separations. Many studies find that compared to workers who stay, quitting workers experience wage gains (e.g. Perez and Rebollo (2005); Light (2005)) while dismissed workers experience wage losses (see Farber (1999) for an overview). However, few studies have investigated how wages are affected by the ex-ante separation probability. Some studies investigated how the risk of firm closures affects wages. In theory, the risk of firm closure may have positive or negative wage effects. On the one hand, workers may agree to lower wages in order to avoid displacement. On the other hand, in the face of firm closing workers may claim higher wages to compensate for the layoff risk. According to Hamermesh (1988, 1991) accepting only small wage cuts is unlikely to be successful in avoiding firm closure. This might explain workers resistance to wage concessions. Nevertheless, Blanchflower (1991) does find that workers in unionized workplaces who expect to be made redundant earn 9% less than workers who do not face this risk. A more recent paper by Carneiro and Portugal (2006) estimates a simultaneous-equations model of firm closing and wages using Portuguese data to analyze how wages are adjusted to

[5]Malcomson (1999) provides an overview of types of contracts and renegotiation possibilities. The discussion also includes an overview of the (adverse) effects renegotiation may have on individual worker decisions, such as investing in human capital.

adverse economic shocks that increase the layoff probability. They also find that the fear of job loss generates lower wages rather than higher wages. All in all, it seems that workers are willing to accept wage concessions in order to prevent job loss. Similarly, if a worker is offered attractive contracts by alternative employers, the current employer may be willing to pay the worker a higher wage in order to retain him. After making a decomposition of wage growth Yamaguchi (2005) finds that employers are indeed willing to renegotiate the workers' wage: 20% of wage growth for young workers is due to an improved bargaining position of the worker. We are not aware of any other study investigating firms' willingness to renegotiate the wage in order to prevent a worker from quitting. Below we investigate this issue in more detail, when we investigate how expected quit and layoff probabilities affect wages.

When firms are unable to renegotiate the wage, inefficient separations may occur (Hashimoto and Yu (1980) and Hall and Lazear (1984)). However, even with flexible wages, inefficiency in separations can remain (Ramey and Watson (1997)). Note that efficient separations only occur when the highest wage the firm is willing to pay is lower than the lowest wage the worker is willing to accept. Hence, efficient separations are independent of the current wage. However, due to asymmetric information, the firm does not always know the outside option of the worker, and the worker does not always know at what wage the firm will decide to replace him. In the presence of asymmetric information renegotiation can no longer guarantee that only efficient separations occur (Hall and Lazear (1984); Haltiwanger (1984)). A recent paper by Hall (2005) studies inefficiency in separations concluding that the sticky-wage inefficient-separations model does not describe the modern U.S. labor market; modern employment relationships are generally terminated in the joint interest of the worker and the firm and hence, inefficient separations are not an important phenomenon in the U.S.[6] We are not aware of any other study investigating the extent of inefficiency in separations. Our paper adds to this small literature by using wage growth information from individual workers and firms to determine which separations are efficient and which are not.

[6]However, Shimer (2005) discerns from this conclusion by stating that in the analysis no attention is paid to separations which are privately inefficient.

# 4 Data and stylized facts

## 4.1 Data

We use administrative information about workers and firms in the Netherlands over the period 1993-2002.[7] The dataset has a repeated cross-section set-up where each cross-section contains information at two points in time, one year apart. Every year about 1900 firms and 44,000 workers are sampled.[8]

The data are obtained by means of a two stage sampling procedure. In the first stage, a sample of firms is drawn from the Department of Social Affairs internal firm register that is roughly similar to the firm register of the Dutch statistical office. The sample is drawn using a stratified design – by economic sector and firm size. In the second stage, a sample of workers is drawn from each firm. Information is collected from the wage administration of the firm for two distinct moments in time: October of the year of the survey (denoted by $t$) and October of the previous year (denoted by *t-1*). A distinction is made between workers working at the firm at both moments in time ('stayers'), workers working at the firm only at time $t$ ('entrants'), and workers working at the firm only at time *t-1* ('leavers').[9] The share of sampled workers within a firm decreases with firm size and depends on several workers categories (covered by collective bargaining contract or not; stayer/leaver/entrant). The sample size was increased if certain conditions were not met.[10] Because of this sampling design, some worker categories

[7]These are the AVO data; "AVO" is in Dutch: "Arbeidsvoorwaardenontwikkeling" (see Arbeidsinspectie (2003). The data are from the Working Conditions Survey of the Dutch Ministry of Social Affairs and Employment. Unless otherwise indicated the graphs and tables in this paper are based on the AVO data. In the analysis information from 1999 is not used since in this year no distinction is made between quits and layoffs.

[8]See Gielen and van Ours (2005, 2006) for a Table with AVO means for several variables and Arbeidsinspectie (2003) for a detailed variable description and more information about the sample design. The dataset does not contain financial information about the firms such as value added, output, profits, capital and investment. This is due to the fact that the data were designed to study changes in wages and therefore only information from the wage administration of firms was obtained. Since the 1993 sample contains no information on public sector workers, we excluded firms from this sector in other years as well. Firms from the service sector and semi-public sectors were included in all samples.

[9]Note that since workers are observed at two moments in time, we do not know the number nor the characteristics of the workers who were hired after October of year $t-1$ and left the firm before October of year $t$.

[10]At least 10 employees had to be covered by a collective bargaining agreement and 10 not; the minimal number of stayers, entrants and leavers had to be at least 8. This sampling design results at the firm level in random samples from subgroups of workers discerned by working in the firm in October of year $t$ or *t-1*, or both, and covered by collective bargaining (or not).

were underrepresented in the sample.

The reason for a separation is reported by the firm. A separation is denoted a quit if the worker has started a job in another firm, if he has become self-employed or if he has resigned himself. Similarly, a separation is denoted a layoff if the worker is dismissed or left the firm because of being disabled.[11] We focus on prime-age workers, aged between 30 and 50, in order to abstract from other separations such as retirements or students leaving a holiday job.[12]

### 4.2 Stylized facts

Table 1 shows some stylized facts concerning the separate exit routes. For comparison, some stylized facts for stayers are presented in the first column. Many workers appear to have stable employment relationships. Separations are a decreasing function of tenure. Quits occur more often among low experience workers in small firms. Layoffs are more prevalent among low educated workers in low complexity jobs. Finally, quits seem to behave procyclical, whereas layoffs do not show a clear cyclical pattern.

Figure 2 illustrates the average gross hourly wage for workers who stay with the firm and workers who leave. It appears that workers who quit earn relatively low hourly wages. There does not seem to be a difference in the average hourly wage earned by workers who stay with the firm compared to workers who are laid off.

## 5 Empirical analysis

In this section we investigate in more detail which worker-firm matches most likely dissolve. We distinguish between worker and firm initiated separations. First, we estimate a wage-equation in order to obtain wage residuals that are used to generate a measure for match quality. Then, we include this measure in a separations equation in order to determine the effect of match quality on worker-firm separations. Furthermore, we investigate whether wages

[11] The latter is included as in the Netherlands disabled remain employed in the firm while in disability insurance. Hence, if the firm reports someone with a disability as having left the firm, this clearly indicates a layoff.

[12] For example, young workers may enter and leave the workforce randomly, because they work few hours next to their educational obligations. Similarly, old workers may leave the workforce because of retirement or health considerations, which need not be influenced by financial reasons.

are renegotiated in order to prevent the dissolution of valuable worker-firm matches. Finally, expected wage changes of separated workers are compared with wage growth at the firm level to establish whether or not separations are efficient.

## 5.1 Wage residuals

We estimate a Mincerian wage equation for prime-age workers where the log of the gross hourly wage ($w_{ij}$) denoted in 1993 Dutch guilders is explained by worker, job and firm characteristics.[13] Since the panel element of our dataset is limited, we cannot include individual fixed effects in the wage equation. Therefore, the wage residual includes both individual ability and match quality information.[14]

$$w_{ij} = X_{ij}\pi + \nu_j + \gamma T_{ij} + \varepsilon_{ij} \tag{14}$$

where $X_{ij}$ is a vector of personal ($i$) and job characteristics ($j$), $\nu_j$ are firm fixed effects, $T_{ij}$ represents job tenure and $\varepsilon_{ij}$ is an error term.

The results of the wage estimation are presented in the first column of Table 2.[15] We find that wages are lower for females, part-time workers and low educated workers. Moreover, it appears that tenure and potential experience have a positive but nonlinear effect on wages. According to previous studies, general human capital accounts for a larger part of wage growth than specific human capital. In order to correct for potential endogeneity of tenure and experience we re-estimate the wage equation using an instrumental variables (IV) approach, where tenure and experience are instrumented by deviations of the means for the observations in a given occupation-job complexity level-education level combination.[16] From the parameter es-

[13]The gross hourly wage is corrected for inflation. 1 guilder equals approximately 0.454 euro. Note that $w_{ij} = ln(W_{ij})$, where $W_{ij}$ is the gross hourly wage.

[14]Actually, having ability and match quality in one measure is appropriate, since it avoids having zero match quality for workers who never changed jobs.

[15]We exclude cases with tenure and experience of one year or less in order to make sure the estimates are not affected by temporary contracts. Sensitivity analysis show that the exclusion of these cases does not affect the results. Potential experience is computed as the worker's age minus the years of schooling attended minus 6. Note: year dummies drop out because of the firm fixed effect.

[16]This approach is based on Altonji and Shakotko (1987), who provide a clear overview of the nature of the bias. This method is also the preferred method of Dustmann and Pereira (2005) who compare several IV methods in order to avoid estimation biases in wage estimations. Since we do not have a panel dataset, we cannot take individual means of tenure and experience. Therefore, we construct a given job type, based on occupation, job complexity level and education, and compute average tenure and experience for this "job".

timates for tenure and experience from the IV-estimation, it appears that the OLS-estimates indeed suffer from an estimation bias. Hence, hereafter we will only use the IV-parameter estimates.[17]

The wage residual that is assumed to represent the workers' surplus is obtained by comparing the current wage in the firm to the market wage obtained from the wage equation evaluated at zero tenure. This is done because tenure at the current firm is not rewarded by outside firms.[18] As a result, the augmented wage residual consists of the tenure effect ($\gamma T_{ij}$) and the unobserved individual match effect ($\mu_{ij}$) which we assume to be equal to the sum of the individual wage residual and the firm fixed effect:

$$\widehat{\varepsilon}^*_{ij} = \widehat{\nu}_j + \widehat{\varepsilon}_{ij} + \widehat{\gamma} T_{ij} = \widehat{\mu}_{ij} + \widehat{\gamma} T_{ij} \tag{15}$$

Table 3 illustrates how the wage residual is spread over the different demographic groups by showing the percentage of the workforce that belongs to a certain residual interval. It appears that on average the wage residual is higher for high-experience and high-tenure workers in large firms. This is due to the firm fixed effect which increases with firm size and the tenure effect which increases with tenure. Moreover, high-residual workers seem to be more likely to stay with the firm, while low-residual workers are more likely to separate. This provides preliminary evidence in favor of the predictions from the theoretical model.

Obtaining an approximation of the firm surplus is a more difficult task, because information about individual worker productivity is absent in a lot of datasets.[19] However, the theoretical model predicts that total match surplus is shared between the worker and the firm, and therefore a larger worker surplus also implies a larger firm surplus. Hence, in the remainder of the paper, we also use $\widehat{\varepsilon}^*_{ij}$ as an indicator for the firm surplus.

[17] We do not take into account potential endogeneity of the part-time work dummy variable. According to traditional labor supply theory, part-time work is considered endogenous since the wage level determines the number of hours worked. However, in practice, the opposite may be more likely: people choose to work either part-time of fulltime and then investigate what wage is available for them. Therefore, we do not instrument the variable for part-time work.

[18] Despite of this intuition, the inclusion of returns to tenure in the residual has not been done previously in the literature except for Perticara (2004). However, as we will show later in the separations estimation, the results remain unchanged when we consider the effect of the residual excluding the tenure effect.

[19] Note that even the presence of firm profitability would not be sufficient to determine the individual workers' contribution to the profit.

## 5.2 Worker separations

In this section we investigate which worker-firm matches dissolve. In particular, we analyze how separations are affected by the augmented wage residual. Figure 3 shows how the match surplus affects worker-firm separations. It appears that workers with low wage residuals are more likely to quit or to be laid off. For layoffs this is mainly due to the tenure effect. The effect of the unobserved individual match effect on quits is U-shaped: quits are more likely to occur for workers at both ends of the distribution.

In order to investigate the effect of the match surplus we estimate logit models for separations, quits and layoffs including the wage residual in the set of regressors. The effect of the total – augmented – wage residual ($\widehat{\varepsilon}^*_{ij}$) is presented in panel A of Table 4.[20] Linear effects (panel A.1.) are only significantly in the layoff equation. When asymmetry is allowed for (panel A.2.), we find the effect of the residual on separations to be U-shaped: workers at both ends of the distribution are most likely to quit. Lower end workers may be more likely to search for another job since they are underpaid. This underpayment may be due to a bad worker-firm match (Jovanovic (1979)). Also, the high quit propensity for low-residual workers may be due to a low firm fixed effect, which may be an indicator for future wage growth (Galizzi and Lang (1998)). The effects for workers at the top end of the distribution provide evidence for the raiding model (Lazear (1986)): high residual workers are more likely to quit since firms will spot the high ability of these workers and raid them. This U-pattern is not found for layoffs, which occur mainly among workers with negative wage residuals. This suggests that rather than representing overpayment of the worker the match surplus is indeed shared between worker and firm. A LR-test indicates that introducing quadratic effects (panel A.3.) does not improve the model. In panel B of the table, the separate effects of each of the components of the wage residual are investigated. Tenure effects appear to reduce all separations, as predicted by Parsons (1972), while larger match effects ($\widehat{\mu}_{ij}$) only reduce layoffs (panel B.1.). When asymmetry in the separate effects is allowed for (panel B.2.), we find that the U-shaped effect

[20] We compute robust standard errors, where we correct for correlation of the error terms within firms. Moreover, since we use a generated regressor, i.e. the wage residual, in the analysis, we adjust the asymptotic covariance matrix along the lines of Murphy and Topel (1985).

of the residual on quits and separations (from panel A.2.) is due to a U-shaped pattern in the match effect. However, the layoff probability is only affected by negative match values. This is in line with Bishop (1990), who finds that layoff rates are negatively related to match quality measures. Again, introducing quadratic effects (panel B.3.) does not improve the model.

The parameter estimates in Table 4 show that separations are not a linear function of the wage residual. In order to identify the separation pattern in more detail we estimate a logit model for quits and layoffs separately, using a flexible spline specification of the wage residual. The results are used to predict quit and layoff probabilities. Figure 4 illustrates the relationship between the wage residual and both quits and layoffs. Again we find the U-shaped pattern for quits. Although we find some significant effects for the wage residual on layoffs, the overall layoff probability is small. The average predicted layoff probability is 1.2%, while the average predicted quit probability is 6.2%. Consequently, the effects of the wage residual on the layoff probability are very small. Moreover, there does not seem to be a relation between the quit probability and the layoff probability.

## 5.3 Wage renegotiations

We are interested in whether firms and workers respond to estimated quit and layoff probabilities by renegotiating the match surplus. Our dataset contains two wage observations of workers that are present in the firm at both the first date ($t$) and the second date ($t+1$). Assuming that the wage at the first date is determined by a match-specific component ($\alpha_{ij}$)[21], the wage at the second date is determined by this match-specific component, a general effect representing national shocks ($\psi$) and individual-specific expected probabilities to quit ($\widehat{P_q}$) or to be laid-off ($\widehat{P_l}$). So, $w_{ijt} = \alpha_{ij}$ and $w_{ij,t+1} = \alpha_{ij} + \psi + \delta_1 \widehat{P}_{q,ij} + \delta_2 \widehat{P}_{l,ij}$.[22] Taking first differences we find

$$\Delta w_{ij} = \psi + \delta_1 \widehat{P}_{q,ij} + \delta_2 \widehat{P}_{l,ij} + \epsilon_{ij} \tag{16}$$

If wage renegotiations occur, this should be revealed by the parameters $\delta_1$ and $\delta_2$. A wage renegotiation to prevent a quit is likely if $\delta_1 > 0$, a wage renegotiation to prevent a lay-off is

[21] One can think of $\alpha_{ij} = f(A_t + (1 - \beta_{ijt})S_{ijt})$.

[22] Note that $w_{ij}$ represents the log of the gross hourly wage.

likely if $\delta_2 < 0$. A similar approach has been used in Royalty (1996) where predicted job-to-job and job-to-nonemployment were used to explain the incidence of training.[23]

The first estimate presented in Table 5 indeed shows that both $\delta$-parameters have the expected sign and are significantly different from zero. Apparently there are wage renegotiations to prevent separations.[24] Unfortunately, since the available wage information concerns a non-random selection of workers that stayed with the firm least squares estimates may be biased. As a sensitivity analysis we introduced the actual changes in employment in the firm ($\Delta E_j$) and the relevant industry ($\Delta E_s$). Both variables are also included in the estimated probabilities to quit or being laid-off but as the third row of Table 5 shows they have direct effects as well. Both an increase in the employment of the firm and an increase in the employment of the relevant industry have positive effects on the wage growth of the individuals. The first effect could be an indication that growing firms can afford paying higher wages. The second effect may indicate that employers are willing to pay their workers more if employment in the relevant industry is growing to prevent their workers from leaving the firm, over and above the effect of the predicted quit probability. As shown the sizes of the relevant parameters are affected by the introduction of the additional variables but the signs are still correct and both $\delta$-parameters are still significantly different from zero. As an alternative, the second column presents estimates for both $\delta$-parameters when total earnings growth is used as dependent variable. Total earnings include flexible wage components, such as profit sharing, individual bonuses, and commissions, and remaining additional payments. The results remain unchanged.

All in all, we conclude that firms and workers are apparently willing to renegotiate the division of the match surplus if it is profitable to do so.

[23] Though one can argue that the increased training raises the wage, the extent to which this does occur is not subject of investigation in Royalty (1996).

[24] Alternatively, one might argue that the wage effects are due to changes in training. A higher layoff probability reduces the payoff period of investments in training and hence decreases the probability of receiving training (Royalty (1996)). As a result, wages may be lower. However, this story does not hold for the quit probability, as we have found a positive coefficient. Hence, we conclude that our results provide evidence for the occurrence of wage renegotiations.

## 5.4 Are separations efficient?

Wages are renegotiated as a response to current separation probabilities in order to avoid valuable worker-firm matches to break up. However, this does not always occur. Sometimes a separation could have been prevented but is not, i.e. the separation is inefficient.[25]

According to equation (6) we expect to observe a quit if the new worker surplus falls below zero, i.e. $(1 - \beta_{ij,t+1})S_{ij,t+1} < 0$. Hence, we expect to observe a quit if the expected wage change, $\widehat{\Delta w}_{ij}$[26], was insufficient to compensate for the negative worker surplus ($\widehat{\varepsilon}^*_{ij}$), i.e. $\widehat{\Delta w}_{ij} + \widehat{\varepsilon}^*_{ij} < 0$. If the wage change is larger, the worker should have stayed in the firm. Similarly, equation (8) indicates we expect to observe a layoff if the new firm surplus falls below zero, i.e. $\beta_{ij,t+1}S_{ij,t+1} < 0$. So we expect to observe a layoff if the worker performs worse than the average worker, i.e. $\widehat{\Delta w}_{ij} - \overline{\Delta w}_j < 0$.[27] If the wage change is larger, the worker should have remained with the firm.

A comparison of actual separations with predicted separations is presented in Table 6. As the table shows predicting actual quits is not easy. Our predicted quit decision is correct for 41% of the workers that quit. This imprecision is due to unobserved determinants of quits. We have no information about external job offers individuals may have received or about non-monetary value the worker attaches to his or her job. A similar story holds for layoffs. Here the percentage of correct predicted layoffs is 58%. The imperfect prediction of layoffs may be due to the lack of information about worker productivity not reflected in the wage.[28]

According to equation (9) a separation is efficient if the sum of the shocks is larger than the former joint match surplus, or similarly, if the sum of the new worker and firm surpluses

[25] For this we use separations predicted by the theoretical model rather than actual separations. This way, we abstain from other separations that have occurred for reasons other than match quality considerations, such as leaving for a part-time job that allows the worker to combine work with raising a child.

[26] For this, we use the first estimate of the wage growth model from Table 5.

[27] Note that we approximate the new firm surplus by the difference between the predicted wage growth for the individual worker ($\widehat{\Delta w}_{ij}$) and the actual average wage growth that is paid by the firm to remaining workers ($\overline{\Delta w}_j$). This approximation provides an indicator for the worker quality compared to the average worker in the workforce.

[28] As part of sensitivity analysis, we redid our analysis using the *predicted* average wage growth among *all* workers rather than the actual wage growth among remaining workers, because due to selective worker outflow the former may be different from the latter. However, the results remain almost the same: the percentage correct predicted quits remains the same, while the percentage correct predicted layoffs increases to 59%.

falls below zero, i.e. $S^W_{ij,t+1} + S^F_{ij,t+1} < 0$. Hence, a separation is denoted efficient if $\left[\widehat{\varepsilon^*_{ij}} + \widehat{\Delta w_{ij}}\right] + \left[\widehat{\Delta w_{ij}} - \overline{\Delta w_j}\right] < 0$. If the new joint match surplus is larger than zero, the separation is denoted inefficient.

We use the category correctly predicted quits and layoffs to give an indication about the relative size of the inefficiency of separations. Table 7 shows that only 5% of correct predicted quits is inefficient, while 49% of correct predicted layoffs is inefficient.[29] The inefficiency among layoffs is much higher, which could be due to the fact that even though wage renegotiation would be possible and the worker would be better off with the new lower wage it does not occur because of wage rigidity. Introducing lower wages for some of the workers might harm labor relations within a firm to the extent that the lower wage would reduce labor productivity. Moreover, we investigate whether the wage rigidity is caused by limited renegotiation possibilities due to a binding minimum wage. However, the minimum wage appeared to be not binding, therefore this cannot explain the inefficiency in layoffs. Naturally, the large share of inefficient layoffs we find may also be caused by our imperfect measure of firm surplus. As part of sensitivity analysis, panel B of the table also presents the percentage of inefficient separations when using the predicted average wage growth among *all* workers in the firm ($\widehat{\overline{\Delta w_j}}$).[30] Even though the results for layoffs do not change much, inefficiency in quits is much lower. Apparently, the selection in worker outflow causes the actual average wage change among stayers to be lower than the predicted wage change among all workers. This indicates that, even though firms are willing to compensate workers with a high quit propensity by providing a larger wage growth, this is insufficient to persuade these workers to remain with the firm. In order to investigate whether worker characteristics influence the inefficiency in separations, we decompose separations for different types of workers, distinguished by gender, length of tenure, education level and whether or not the wage was collectively bargained.[31] The results are presented in panel C of Table 7.

[29] Note that inefficient layoffs may turn out to be efficient once we take into account the amount of severance pay the worker receives after being laid off. Unfortunately, we have no information on this in the data.

[30] The disadvantage of using the predicted average wage growth among all workers in the firm is that the results depend on the assumptions made in the model, while the actual average wage growth among stayers is observed, therefore independent of model assumptions.

[31] Here we use the actual average wage growth among remaining workers. When using the predicted average wage growth among all workers, inefficiency in quits disappears, while the inefficiency in layoffs is unchanged.

In general, inefficiency in layoffs is much more common than in quits for all types of workers. However, we can observe some small differences between the different types of workers. Women appear to have more inefficient quits, but less inefficient layoffs than men. The inefficiency in quits among women may be explained by women leaving the labor market for family care reasons. A possible explanation for the lower inefficiency in layoffs among women is that women may not only renegotiate over wages, but also over working hours. Since women are more likely to work part-time, they may be more willing to adjust working hours than their fulltime working male counterparts. This higher flexibility may reduce inefficiency in layoffs. However, we do not find an indication for this in the data. Workers with high tenure or a high education level experience less inefficiency in quits, but more inefficiency in layoffs. This may indicate that the information about the (high) quality of worker skills (either general or firm-specific) is asymmetric: workers are better able to value the quality of their skills, and hence of the match, than firms. Finally, inefficiency in layoffs is much higher in firms where wages are collectively bargained. All in all, the dominant outcome of our analysis is that only a small percentage of quits but a substantial part of layoffs are inefficient.

# 6 Conclusions

The current paper investigates why worker-firm matches dissolve and workers separate from firms. Based on an analysis of matched worker-firm data from the Netherlands we find that worker separations are a nonlinear function of the match surplus. While workers with low match surpluses are most likely to quit or to be laid off, also workers with very high match surpluses are likely to quit, possibly because firms compete with each other to attract high ability workers. Moreover, we find that wages are renegotiated when valuable employment relationships are likely to end. To persuade them to stay, firms increase wages for workers that have a high propensity to quit; in order to avoid layoff workers that are likely to be laid off are willing to sacrifice part of their earnings. As a share of all separations the inefficient ones are not very important. However, there is a clear difference between quits and layoffs. Whereas inefficient quits are rare, inefficient layoffs occur frequently. This may be related to downward wage rigidity. While it is easy to renegotiate higher wages to prevent quits it is much more

difficult to renegotiate lower wages to prevent layoffs even if that would overall be beneficial to the workers involved. To the extent that the laid-off workers have difficulties in finding a new job this inefficiency has a wider impact because unemployment – and thus unemployment benefits – increase. Government intervention aiming to remove this externality - for example by introducing wage costs subsidies for workers at risk of being laid-off inefficiently - could be Pareto efficient. However, implementing such a policy and distinguish between efficient and inefficient layoffs will not be easy.

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**Box 1: Identification strategy**

| **Empirical analysis**: | | **Derived from results**: |
|---|---|---|
| *1. Wage estimation*: $w_{ij} = X_{ij}\pi + \nu_j + \gamma T_{ij} + \varepsilon_{ij}$ | $\rightarrow$ | *Augmented wage residual* $\widehat{\varepsilon}^*_{ij} = \widehat{\nu}_i + \widehat{\gamma} T_{ij} + \widehat{\varepsilon}_{ij}$ |
| *2. Separations estimation*: $P(k_{ij} = 1) = \Lambda(Z_{ij}\pi_k, \widehat{\varepsilon}^*_{ij}) \quad k = (s, q, l)$ | $\rightarrow$ | *Quit and layoff probabilities* $\widehat{P}_{q,ij}, \widehat{P}_{l,ij}$ |
| *3. Wage growth estimation*: $\Delta w_{ij} = \psi + \delta_1 \widehat{P}_{q,ij} + \delta_2 \widehat{P}_{l,ij} + \epsilon_{ij}$ | $\rightarrow$ | *Individual and firm wage growth* $\widehat{\Delta w_{ij}}$ |
| *4. Efficiency*: $\left[\widehat{\varepsilon}^*_{ij} + \widehat{\Delta w_{ij}}\right] + \left[\widehat{\Delta w_{ij}} - \overline{\Delta w_j}\right] < 0$ | | |

| | |
|---|---|
| $w$ = log hourly wage | $\gamma, \pi, \pi_k, \delta_1, \delta_2$ = parameters |
| $X$ = personal characteristics | $\varepsilon, \epsilon$ = error terms |
| $T$ = tenure | $\psi$ = constant |
| $Z$ = personal characteristics | $\nu_j$ = firm fixed effect |
| $\Lambda$ = indicator logistic distribution | |
| $k$ = type of separation | $s, q, l$ = separation, quit or layoff |
| $i$ = individual | $j$ = firm |

**Table 1: Annual worker flows and exit routes (in % of the workforce)**

| | Stay | Separation | |
|---|---|---|---|
| | | Quit | Layoff |
| *Education level* | | | |
| Primary | 92.6 | 5.7 | 1.7 |
| Junior General | 92.2 | 6.6 | 1.2 |
| Pre-vocational | 93.7 | 4.9 | 1.5 |
| Senior General | 91.4 | 7.4 | 1.2 |
| Senior Vocational | 93.2 | 5.9 | 0.9 |
| Vocational College | 91.9 | 7.4 | 0.7 |
| University | 88.4 | 10.7 | 0.9 |
| *Wage contract* | | | |
| CAO | 93.5 | 5.4 | 1.1 |
| AVV | 91.5 | 7.1 | 1.4 |
| No collective wage agreement | 89.7 | 9.1 | 1.2 |
| *Experience (years)*[a] | | | |
| 0-1 | - | - | - |
| 2-5 | - | - | - |
| 6-10 | 87.2 | 11.6 | 1.1 |
| 11-15 | 90.5 | 8.5 | 1.0 |
| 16-20 | 91.7 | 7.3 | 1.0 |
| 21-30 | 94.1 | 4.7 | 1.2 |
| 30+ | 95.0 | 3.5 | 1.5 |
| *Tenure (years)*[b] | | | |
| 0-1 | - | - | - |
| 2-5 | 89.0 | 9.4 | 1.6 |
| 6-10 | 92.3 | 6.6 | 1.1 |
| 11-15 | 95.1 | 4.2 | 0.8 |
| 16-20 | 96.3 | 3.0 | 0.7 |
| 21-30 | 97.5 | 1.6 | 0.9 |
| 30+ | 98.6 | 1.2 | 0.2 |
| *Job Complexity Level* | | | |
| F1 | 91.5 | 6.7 | 1.8 |
| F2 | 92.5 | 5.9 | 1.6 |
| F3 | 93.1 | 5.5 | 1.4 |
| F4 | 92.5 | 6.5 | 1.0 |
| F5 | 92.3 | 7.0 | 0.7 |
| F6 | 91.2 | 8.1 | 0.7 |

Continued on next page

**Table 1 – continued from previous page**

| | Stay | Separation | |
|---|---|---|---|
| | | Quit | Layoff |
| *Sector* | | | |
| Agriculture | 93.3 | 5.8 | 0.9 |
| Industry | 94.8 | 3.9 | 1.3 |
| Construction | 93.0 | 5.4 | 1.6 |
| Trade, catering | 90.6 | 8.1 | 1.3 |
| Transport | 94.1 | 4.9 | 1.0 |
| Financial services | 90.6 | 8.5 | 0.9 |
| Health and other | 92.7 | 6.4 | 0.9 |
| *Firm size* | | | |
| 1-9 | 89.3 | 8.9 | 1.7 |
| 10-19 | 90.5 | 8.3 | 1.3 |
| 20-49 | 92.5 | 5.9 | 1.6 |
| 50-99 | 93.3 | 5.5 | 1.2 |
| 100-199 | 92.5 | 6.0 | 1.5 |
| 200-499 | 93.1 | 5.8 | 1.1 |
| 500+ | 93.7 | 5.6 | 0.7 |
| *Year* | | | |
| 1993 | 94.3 | 4.3 | 1.4 |
| 1994 | 95.0 | 3.8 | 1.2 |
| 1995 | 94.0 | 5.0 | 1.1 |
| 1996 | 93.8 | 5.1 | 1.2 |
| 1997 | 92.7 | 5.8 | 1.5 |
| 1998 | 91.6 | 7.5 | 0.9 |
| 1999[c] | 89.3 | - | - |
| 2000 | 90.0 | 9.2 | 0.8 |
| 2001 | 89.3 | 9.7 | 1.0 |
| 2002 | 90.4 | 8.4 | 1.2 |
| N = 106146 | 92.6 | 6.3 | 1.1 |

Note: Worker-specific weights are used to obtain representative results for the Netherlands.

[a] No observations for low experience workers, because we focus on prime-age workers (aged between 30 and 50).

[b] No observation for low tenure workers since we restricted the analysis to workers with more than one year of tenure, in order to get rid of temporary contracts.

[c] No detailed separation information for the year 1999 is available.

**Table 2: Parameter estimates wage equation**

| | **OLS** **(1)** | **IV** **(2)** |
|---|---|---|
| Tenure | 0.067 (0.003)** | 0.040 (0.004)** |
| Tenure$^2$ | −0.017 (0.000)** | −0.008 (0.000)** |
| Experience | 0.276 (0.005)** | 0.453 (0.011)** |
| Experience$^2$ | −0.050 (0.000)** | −0.092 (0.000)** |
| Female | −0.078 (0.002)** | −0.075 (0.002)** |
| Part-time | −0.004 (0.002)** | −0.005 (0.002)** |
| *Occupation* | | |
| Technical | 0.012 (0.002)** | 0.011 (0.002)** |
| Administrative | 0.005 (0.002)** | 0.005 (0.002)** |
| Computer | 0.014 (0004)** | 0.014 (0.004)** |
| Commercial | 0.076 (0.003)** | 0.077 (0.003)** |
| Creative | −0.009 (0.004)** | −0.008 (0.004)** |
| Management | 0.092 (0.003)** | 0.091 (0.002)** |
| *Wage contract* | | |
| CAO | −0.080 (0.003)** | −0.079 (0.003)** |
| AVV | −0.075 (0.017)** | −0.079 (0.017)** |
| *Education level* | | |
| Primary | −0.107 (0.003)** | −0.088 (0.004)** |
| Junior general | −0.091 (0.003)** | −0.092 (0.003)** |
| Pre-vocational | −0.072 (0.002)** | −0.074 (0.002)** |
| Senior general | −0.026 (0.002)** | −0.029 (0.002)** |
| Vocational colleges | 0.070 (0.002)** | 0.073 (0.002)** |
| University | 0.156 (0.004)** | 0.164 (0.004)** |
| *Job complexity level* | | |
| f2 | 0.044 (0.004)** | 0.044 (0.004)** |
| f3 | 0.135 (0.004)** | 0.135 (0.004)** |
| f4 | 0.290 (0.005)** | 0.291 (0.005)** |
| f5 | 0.476 (0.005)** | 0.474 (0.005)** |
| f6 | 0.720 (0.006)** | 0.712 (0.006)** |
| Constant | 2.615 (0.007)** | 2.453 (0.012)** |

Note: Dependent variable is log of gross hourly wages, denoted in 1993 Dutch guilders. Estimations are based on 106146 observations. Tenure (*0.1) and experience (*0.1) are instrumented by deviations from means for observations in "jobs" defined by occupation, job complexity level and education. Also, observations with tenure and experience less than or equal to one year are excluded. The reference group is male, occupation service oriented, no collective bargained wage contract, senior vocational education level, job complexity level 1, fulltime. Standard errors in parentheses, a **/* indicates that the coefficient is different from zero at a 5%/10% level of significance.

**Table 3: Wage residual interval and observable characteristics (in % of the workforce)**

| | Wage residual ($\widehat{\varepsilon}^*_{ij}$) | | | | | |
|---|---|---|---|---|---|---|
| | $< -0.3$ | $-0.3$ to $-0.1$ | $-0.1$ to 0 | 0 to 0.1 | 0.1 to 0.3 | $\geq 0.3$ |
| *Gender* | | | | | | |
| Male | 2.6 | 18.0 | 19.1 | 20.8 | 28.1 | 11.4 |
| Female | 3.3 | 17.3 | 20.0 | 22.2 | 28.5 | 8.6 |
| *Education level* | | | | | | |
| Primary | 5.5 | 31.2 | 23.4 | 16.9 | 17.7 | 5.2 |
| Junior general | 3.1 | 19.9 | 19.3 | 20.8 | 26.6 | 10.4 |
| Pre-vocational | 2.3 | 17.8 | 20.6 | 22.1 | 28.9 | 8.3 |
| Senior general | 3.4 | 15.7 | 17.0 | 23.2 | 30.0 | 10.7 |
| Senior vocational | 2.0 | 14.8 | 19.5 | 21.6 | 31.1 | 11.1 |
| Vocational colleges | 2.9 | 17.1 | 18.8 | 21.3 | 27.9 | 11.9 |
| University | 5.2 | 18.4 | 15.3 | 18.2 | 25.0 | 18.0 |
| *Experience (years)* | | | | | | |
| 6-10 | 4.2 | 15.6 | 20.0 | 21.9 | 29.4 | 8.9 |
| 11-15 | 2.2 | 15.3 | 20.2 | 21.9 | 30.4 | 10.0 |
| 16-20 | 2.6 | 18.0 | 19.2 | 22.3 | 28.3 | 9.6 |
| 21-30 | 3.2 | 19.4 | 19.2 | 20.2 | 26.9 | 11.0 |
| 30+ | 2.5 | 15.1 | 19.0 | 21.7 | 29.6 | 12.1 |
| *Tenure (years)* | | | | | | |
| 2-5 | 5.6 | 23.2 | 20.3 | 19.5 | 23.0 | 8.4 |
| 6-10 | 2.4 | 17.4 | 19.6 | 21.9 | 28.7 | 10.1 |
| 11-15 | 1.3 | 14.9 | 19.1 | 21.9 | 30.7 | 12.1 |
| 16-20 | 1.6 | 15.0 | 18.4 | 22.1 | 31.8 | 11.1 |
| 21-30 | 1.3 | 13.8 | 18.4 | 22.1 | 31.2 | 13.2 |
| 30+ | 0.0 | 9.1 | 19.3 | 21.8 | 39.3 | 10.4 |
| *Job complexity* | | | | | | |
| F1 | 2.7 | 32.2 | 26.1 | 18.1 | 17.3 | 3.7 |
| F2 | 4.0 | 25.0 | 23.9 | 20.4 | 21.5 | 5.2 |
| F3 | 2.8 | 17.0 | 19.0 | 21.8 | 30.6 | 8.8 |
| F4 | 2.0 | 15.2 | 18.8 | 22.4 | 30.2 | 11.5 |
| F5 | 2.9 | 17.4 | 19.3 | 20.3 | 27.1 | 13.0 |
| F6 | 5.6 | 20.5 | 15.6 | 18.2 | 24.4 | 15.7 |
| *Wage contract* | | | | | | |
| CAO | 1.8 | 16.1 | 19.3 | 21.9 | 29.9 | 10.9 |
| AVV | 6.1 | 25.7 | 18.8 | 19.1 | 24.0 | 6.3 |
| No collective wage | 8.1 | 25.6 | 19.8 | 17.9 | 19.9 | 8.7 |

Continued on next page

**Table 3 – continued from previous page**

| | Wage residual ($\widehat{\varepsilon}^*_{ij}$) | | | | | |
|---|---|---|---|---|---|---|
| | $< -0.3$ | $-0.3$ to $-0.1$ | $-0.1$ to 0 | 0 to 0.1 | 0.1 to 0.3 | $\geq 0.3$ |
| *Occupation* | | | | | | |
| Technical | 1.7 | 17.8 | 19.6 | 20.9 | 29.3 | 10.6 |
| Administrative | 2.7 | 14.1 | 18.4 | 24.8 | 31.3 | 8.8 |
| Computer | 4.2 | 16.9 | 18.4 | 20.4 | 28.6 | 11.5 |
| Commercial | 6.2 | 25.9 | 17.8 | 17.9 | 22.6 | 9.7 |
| Service | 2.7 | 18.0 | 21.3 | 21.6 | 27.4 | 9.0 |
| Creative | 2.5 | 13.2 | 16.0 | 21.7 | 28.0 | 18.5 |
| Management | 3.8 | 18.3 | 17.9 | 18.8 | 27.1 | 14.2 |
| *Firm size* | | | | | | |
| 1-9 | 12.0 | 24.3 | 29.1 | 16.2 | 15.2 | 3.3 |
| 10-19 | 7.5 | 24.5 | 20.8 | 20.6 | 21.6 | 5.0 |
| 20-49 | 4.9 | 23.0 | 21.2 | 20.9 | 24.0 | 6.0 |
| 50-99 | 3.1 | 21.0 | 21.8 | 22.0 | 24.8 | 7.1 |
| 100-199 | 3.3 | 19.0 | 21.2 | 22.6 | 25.9 | 8.1 |
| 200-499 | 2.0 | 17.2 | 20.3 | 22.3 | 28.4 | 9.8 |
| 500+ | 2.6 | 16.8 | 18.1 | 20.7 | 29.7 | 12.1 |
| *Sector* | | | | | | |
| Agriculture, fishing | 1.3 | 14.4 | 20.1 | 24.2 | 26.0 | 14.0 |
| Industry | 1.5 | 15.5 | 18.2 | 20.3 | 31.6 | 12.8 |
| Construction | 0.8 | 13.8 | 17.8 | 25.2 | 34.3 | 8.1 |
| Trade and catering | 5.4 | 25.1 | 22.1 | 21.3 | 20.3 | 5.8 |
| Transport, storage | 3.5 | 16.0 | 19.0 | 17.8 | 30.8 | 12.9 |
| Financial services | 4.7 | 21.1 | 18.4 | 21.3 | 24.1 | 10.3 |
| Health care | 2.6 | 16.5 | 21.2 | 22.9 | 28.0 | 8.8 |
| *Exit route* | | | | | | |
| Stay | 2.7 | 17.7 | 19.4 | 21.3 | 28.4 | 10.5 |
| Layoff | 5.2 | 18.3 | 19.9 | 20.2 | 26.2 | 10.2 |
| Quit | 4.6 | 20.4 | 16.7 | 25.6 | 23.9 | 8.8 |
| N = 106146 | 2.9 | 17.8 | 19.4 | 21.2 | 28.2 | 10.5 |

Note: Worker-specific weights are used to obtain representative results for the Netherlands.

**Table 4: Parameter estimates separations equation**

| | | Separation (1) | Quit (2) | Layoff (3) |
|---|---|---|---|---|
| **A. Total residual** | | | | |
| *A.1. Linear effects* | | | | |
| $\widehat{\varepsilon}^*_{ij}$ | | −0.187 (0.145) | −0.045 (0.155) | −1.191 (0.265)** |
| *A.2. Asymmetric main effects* | | | | |
| $\widehat{\varepsilon}^*_{ij}$ | given $\widehat{\varepsilon}^*_{ij} > 0$ | 0.448 (0.196)** | 0.602 (0.209)** | −0.621 (0.464) |
| $\lvert\widehat{\varepsilon}^*_{ij}\rvert$ | given $\widehat{\varepsilon}^*_{ij} < 0$ | 1.239 (0.264)** | 1.154 (0.283)** | 1.858 (0.364)** |
| *A.3. Asymmetric linear and quadratic effects* | | | | |
| $\widehat{\varepsilon}^*_{ij}$ | given $\widehat{\varepsilon}^*_{ij} > 0$ | 0.564 (0.293)* | 0.815 (0.324)** | −0.724 (0.694) |
| $\widehat{\varepsilon}^{*2}_{ij}$ | given $\widehat{\varepsilon}^*_{ij} > 0$ | −0.278 (0.497) | −0.462 (0.544) | 0.558 (0.885) |
| $\lvert\widehat{\varepsilon}^*_{ij}\rvert$ | given $\widehat{\varepsilon}^*_{ij} < 0$ | 0.913 (0.432)** | 0.700 (0.489) | 2.856 (1.121)** |
| $\lvert\widehat{\varepsilon}^*_{ij}\rvert^2$ | given $\widehat{\varepsilon}^*_{ij} < 0$ | 0.781 (0.644) | 1.109 (0.817) | −2.278 (2.275) |
| **B. Residual components** | | | | |
| *B.1. Linear effects* | | | | |
| $\widehat{\mu}_{ij}$ | | −0.008 (0.137) | 0.113 (0.146) | −0.884 (0.258)** |
| $\widehat{\gamma}T_{ij}$ | | −0.293 (0.022)** | −0.282 (0.022)** | −0.315 (0.045)** |
| *B.2. Asymmetric main effects* | | | | |
| $\widehat{\mu}_{ij}$ | given $\widehat{\mu}_{ij} > 0$ | 0.449 (0.210)** | 0.586 (0.224)** | −0.504 (0.493) |
| $\lvert\widehat{\mu}_{ij}\rvert$ | given $\widehat{\mu}_{ij} < 0$ | 0.664 (0.257)** | 0.591 (0.279)** | 1.271 (0.372)** |
| $\widehat{\gamma}T_{ij}$ | | −0.288 (0.022)** | −0.276 (0.022)** | −0.312 (0.045)** |
| *B.3. Asymmetric linear and quadratic effects* | | | | |
| $\widehat{\mu}_{ij}$ | given $\widehat{\mu}_{ij} > 0$ | 0.626 (0.311)** | 0.872 (0.343)** | −0.744 (0.731) |
| $\widehat{\mu}^2_{ij}$ | given $\widehat{\mu}_{ij} > 0$ | −0.442 (0.532) | −0.650 (0.592) | 0.674 (0.815) |
| $\lvert\widehat{\mu}_{ij}\rvert$ | given $\widehat{\mu}_{ij} < 0$ | 0.166 (0.421) | −0.025 (0.467) | 1.725 (1.014)* |
| $\lvert\widehat{\mu}_{ij}\rvert^2$ | given $\widehat{\mu}_{ij} < 0$ | 1.198 (0.655)* | 1.521 (0.773)** | −1.238 (1.901) |
| $\widehat{\gamma}T_{ij}$ | | −0.265 (0.081)** | −0.190 (0.088)** | −0.635 (0.195)** |
| $\widehat{\gamma}{T_{ij}}^2$ | | −0.041 (0.013) | −0.016 (0.015) | 0.056 (0.033)* |

Note: Estimations are based on 106146 observations. Table presents results for 18 separate logit estimations. Observations with tenure and experience less than or equal to one year are excluded. Estimates for other explanatory variables (gender, age, age squared, occupation, wage contract, education level, job complexity level, part-time work, cyclical indicators (aggregate, sectoral, firm-specific), firm size and sector) are not presented. Tenure effects ($\tau$) are multiplied with 100. Robust Murphy-Topel (1985) standard errors in parentheses, a **/* indicates that the coefficient is different from zero at a 5%/10% level of significance.

**Table 5: Panel estimates wage growth estimation**

| | **Wage growth (1)** | **Total earnings growth (2)** |
|---|---|---|
| *1. Baseline* | | |
| $\widehat{P_q}$ | 0.181 (0.011)** | 0.182 (0.012)** |
| $\widehat{P_l}$ | −0.207 (0.027)** | −0.229 (0.030)** |
| *2. Include employment change* | | |
| $\widehat{P_q}$ | 0.211 (0.013)** | 0.214 (0.014)** |
| $\widehat{P_l}$ | −0.047 (0.027)* | −0.053 (0.029)* |
| $\Delta E_j$ | 0.045 (0.004)** | 0.049 (0.004)** |
| $\Delta E_s$ | 0.064 (0.017)** | 0.079 (0.019)** |

Dependent variable is wage growth, $w_{it}$ - $w_{i,t-1}$, and total earnings growth, $w_{it}^{tot}$ - $w_{i,t-1}^{tot}$, where $w^{tot}$ includes additional payments. In estimates 2 and 3 selectivity is accounted for using the inverse Mill's ratio based on a probit estimate of the probability to separate (see Table 4).
The dependent variable is regressed on the same individual, job and worker characteristics as the wage estimation in Table 2. The Table presents results for 6 separate least square estimations. Robust Murphy-Topel (1985) standard errors in parentheses, a **/* indicates that the coefficient is different from zero at a 5%/10% level of significance.

**Table 6: Actual and predicted worker-firm separations**

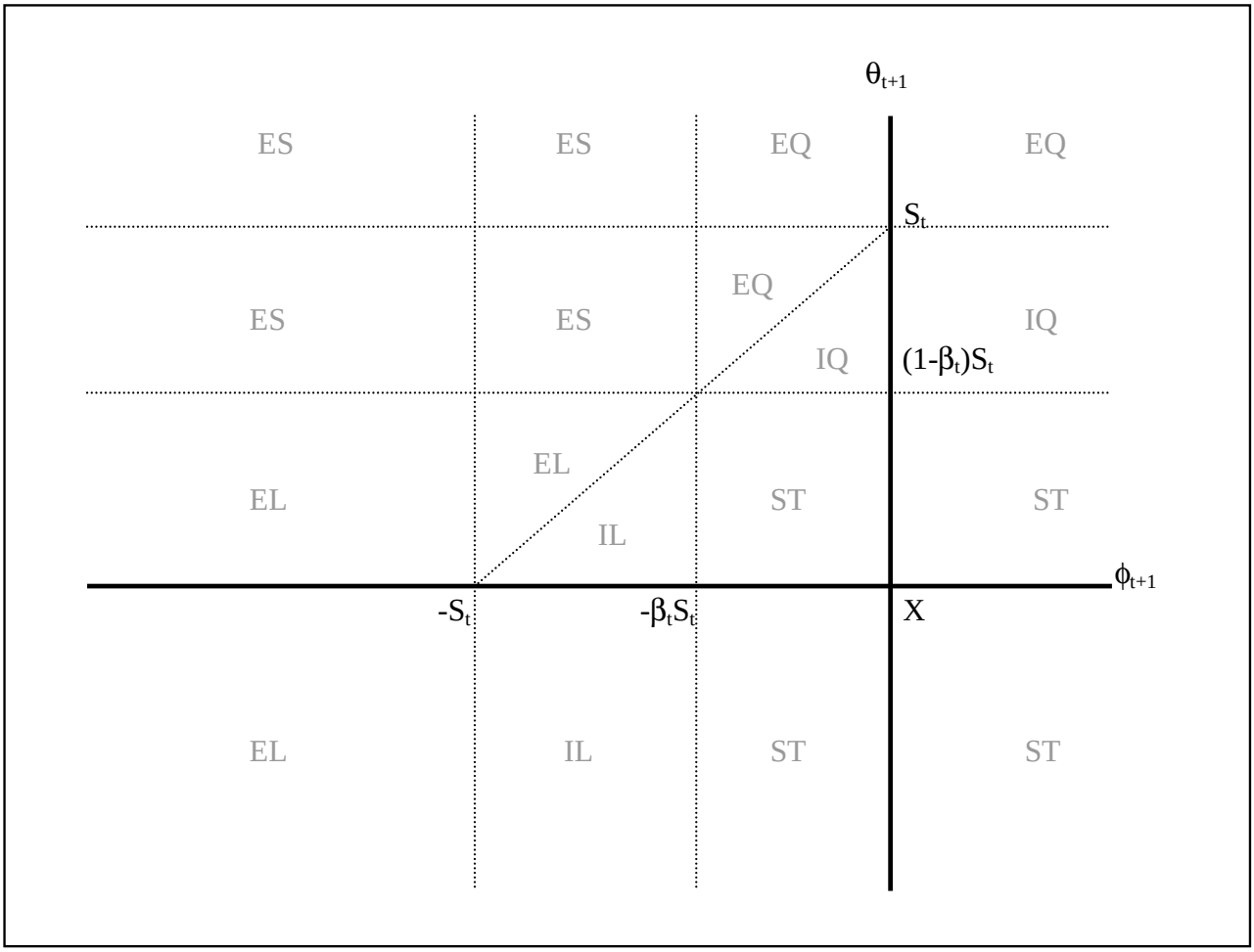
| | **Actual:** | | |
|---|---|---|---|
| % | **Quit** | **Layoff** | **Stay** |
| **Predicted:** | | | |
| **Quit** | 41.5 | 17.9 | 20.0 |
| **Layoff** | 21.5 | 57.8 | 51.7 |
| **Stay** | 37.1 | 24.3 | 28.4 |

**Table 7: Inefficiency in worker-firm separations** (in percentages)

| | **Quit** | **Layoff** |
|---|---|---|
| *A. Baseline model* | | |
| Observed average wage change among remaining workers: $\overline{\Delta w_j}$ | 5.4 | 49.1 |
| *B. Sensitivity analysis* | | |
| Predicted average wage change among all workers: $\widehat{\overline{\Delta w_j}}$ | 1.0 | 48.8 |
| *C. Baseline model for different groups of workers* | | |
| *Gender:* | | |
| Male | 4.8 | 51.7 |
| Female | 6.8 | 42.8 |
| *Tenure:* | | |
| 5 years or less | 6.5 | 45.0 |
| more than 5 years | 4.4 | 51.7 |
| *Education level:* | | |
| Low | 5.8 | 49.3 |
| High | 5.1 | 48.6 |
| *Collective bargaining:* | | |
| Yes | 5.2 | 51.3 |
| No | 5.9 | 39.5 |

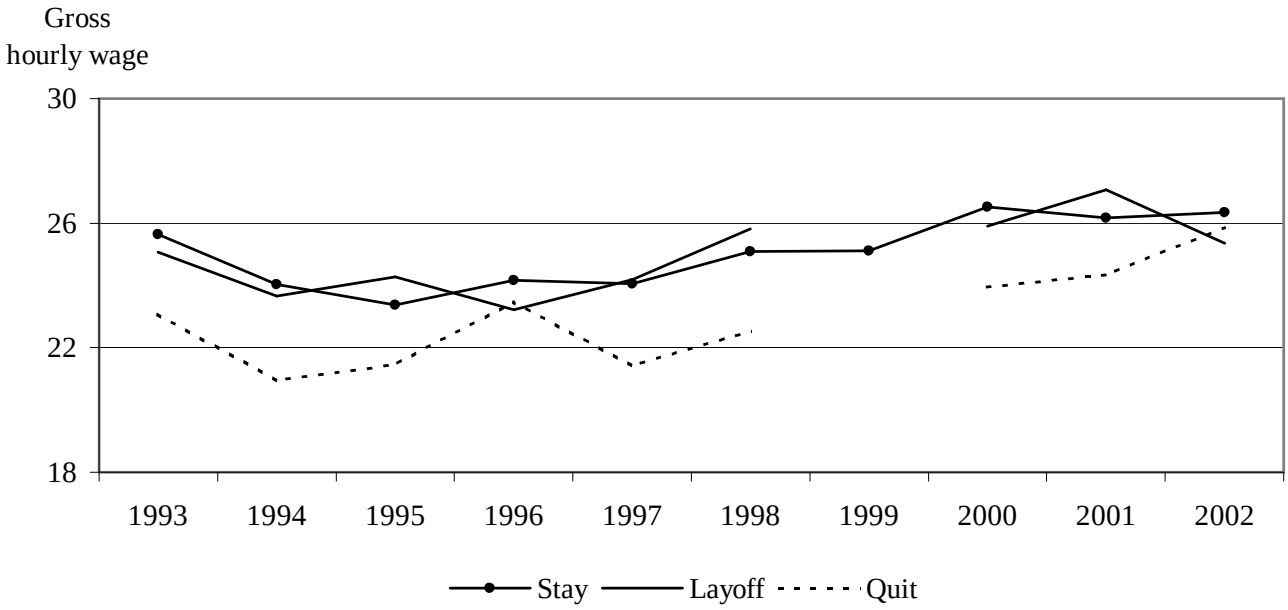
Note: Low educated workers have a senior general degree or lower, while high educated workers have a senior vocational degree or higher.

**Figure 1: Efficient versus inefficient separations**




Note: S = stay, IQ = inefficient quit, EQ = efficient quit, IL = inefficient layoff, EL = efficient layoff, ES = efficient separation.

**Figure 2: Gross hourly wages and separations**




Note: For 1999 specific separation information is missing. Hourly wages are denoted in 1993 Dutch guilders. 1 guilder = 0.454 euro

**Figure 3: Separations per wage residual decile**

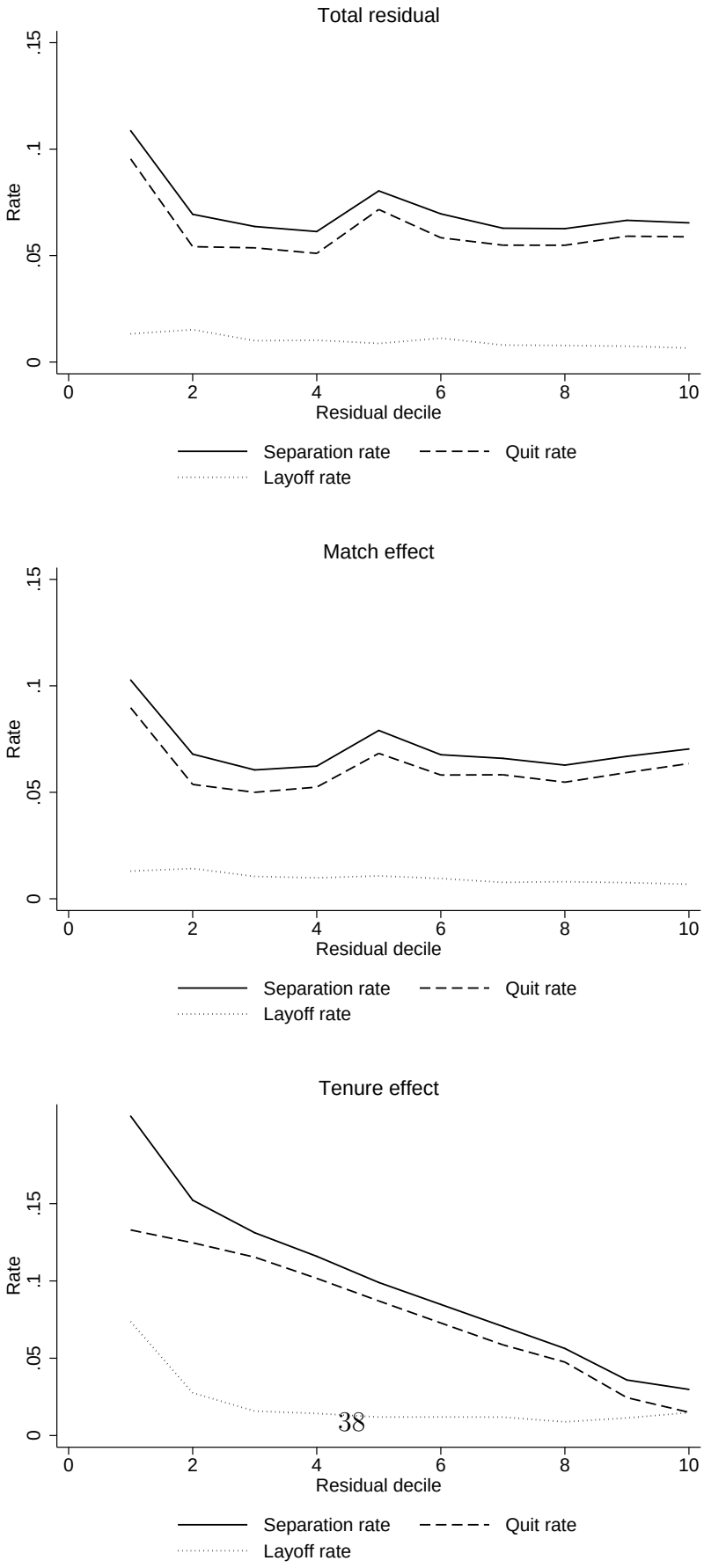
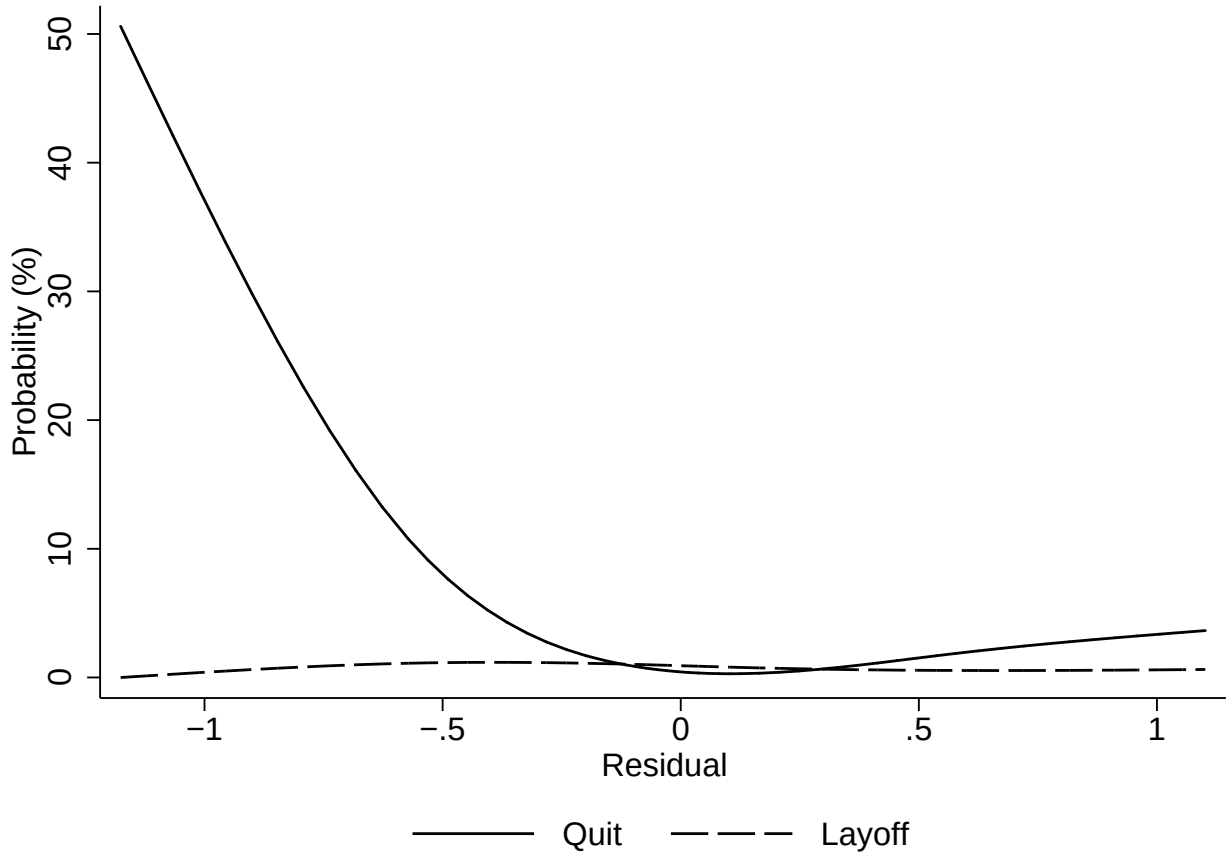


**Figure 4: Quit and layoff probability**




Note: Based on results from spline estimation.