Sequential Incentive Systems and Sorting; Evidence from a Downsizing Firm

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Abstract:
We investigate sickness absenteeism in two plants of a Dutch manufacturer over the period July 2001 – May 2005. Both plants are comparable in terms of the structure of production and their work force. In March 2004, the manufacturer unexpectedly announced that it would relocate the production from the smaller plant to some plants abroad, so that a substantial fraction of the work force in this plant would become redundant; another part of the work force was allowed to change jobs to the other plant. We investigate empirically the effects of this announcement on absence, using a four dimensional hazard rate model. We find evidence that low-effort workers in the small plant are more likely to report less absent after the announcement.

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1. Introduction

How will work effort develop after a firm announced unexpectedly that many of its workers were to be laid off in the coming period? And to what extent is the selection of workers by the firm related to their past and current work performance? The aim of this study is to address empirically both questions by analysing information of personnel records of a Dutch firm that went through a painful episode of downsizing. We claim that the empirical literature of workplace absenteeism has struggled with issues of causality to measure the effect of downsizing on job performance and employees' sorting. To obtain causal parameter estimates, we exploit a specific empirical design that consists of a diff-in-diff setup as well as that it uses exogenous information of a monthly lottery on absenteeism that was held by the firm.

Let us consider a firm that wants to retain its high-performing workers, for which the firm makes use of information on the workers' job performance.[1] With respect to the source of information, economic theory would predict two different approaches for the effect of downsizing on work effort and employees' sorting. We distinguish a so-called static approach from a dynamic approach, which depend on whether current or past information of work effort is used by the firm. For the static approach, the firm makes use of information of current work effort only that is acquired by the firm during the period of downsizing. It may lead to higher work effort of employees with a poor outside option, because the consequences of dismissal may be more severe for them than for the other workers. On the other hand, the announcement would not lead to a change of performance by employees who have a good outside option in the external labor market. Furthermore, there may a decreased effort by discouraged workers or by workers who have an increased work load during the period of downsizing.[2]

For the alternative, dynamic approach, the firm includes information on work effort before the unexpected announcement. The advantage of this approach is that it was gathered by the firm at a moment at which workers were not aware of any future development of the workforce, so that it does not lead to contaminated information on true work effort. Another advantage is that it may provide additional information about the development of work performance, in particular if the worker has changed

[1] See Gerard Pfann (2006).

[2] In addition, in a medically-oriented literature, it was argued that there may be more absence in a downsizing firm, because job insecurity may lead to stress and bad health of the employee (Østhus and Mastekaasa, 2010).

his productivity over time.[3] The dynamic approach does not necessarily invoke any change of work effort.

Both alternative approaches have been investigated in a broad empirical literature of workplace absenteeism (see for instance Røed and Fevang, 2007; Treble and Barmby, 2011). For a proper inquiry of the causal effects of downsizing on work effort and employees' sorting, we claim there are four strong requirements about the structure of the data of investigation. The first requirement is that there must be information of the date at which the announcement by the firm took place, because workers may perform differently before and after the bad news of downsizing. Second, one needs to have a counterfactual case of a firm that has an identical production structure and that did not reduce its employment. Third, the workers in the downsizing firm must have any prospect of being retained by the firm, so that there may be a difference in the response of workers to the announcement of downsizing. Fourth, there must be exogenous information of past work effort. This requirement is needed because work effort may be strongly intertemporally correlated, so that we cannot distinguish between past and current effort.

In the area of research of workplace absenteeism, none of the empirical studies has satisfied all of the aforementioned data requirements that are needed to measure causal effects. It may explain why previous investigations were inconclusive about the size of the effect of downsizing on workplace absence. With respect to the first and second requirement that we mentioned about the firm: most of the studies are based on large administrative data sets of a set of firms that do not include information of the moment of announcement of downsizing and there is no counterfactual. Some studies have found a small, negative effect of downsizing or dismissal rates on absenteeism (Kauermann and Ortlieb, 2004; Røed and Fevang, 2007; Dionne and Dostie, 2007). Other studies have found no effect or a small positive effect (Westerlund et al., 2004); Østhus and Mastekaasa, 2010). With respect to the second requirement about work effort: some studies have considered flows into absenteeism and presenteeism, but it makes it impossible to distinguish between workers of different quality (Røed and Fevang, 2007). For the third requirement: Henningsen and Hægeland (2008) found that past sickness absence may influence the decision whom to dismiss, however it does not satisfy our requirement of exogeneity of past effort.

[3] See Waldman (1999).

The specific case that we investigate in this paper satisfies all of the four aforementioned data requirements that are needed for the measurement of causal effects of downsizing on work effort and employees' sorting. With respect to the first and second requirement, we consider two plants of a Dutch firm that had an identical production structure over the period July 2001 – May 2005. On 1st March 2004, the firm unexpectedly announced a substantial employment reduction for the workers operating in the smaller plant. The sudden decline in employment in the smallest plant was unexpected to the personnel and it pertained to this plant only. We exploit the fact that both plants had an identical production structure, and that they were located in the same regional labor market. It gives an empirical difference-in-differences design.

The third requirement is about the structure and measurement of the employees' job performance. Work effort may have reduced the probability of dismissal during the process of downsizing, because the employer had to decide whom to dismiss and the workers could respond to this pending decision by changing their effort. Some of the workers moved laterally to the other plant.

The fourth requirement is about exogenous information of past work effort of individual workers, to measure the effect on current work effort and employee sorting. We exploit information of previous monthly lottery draws that were held in the firm in the period before the announcement of downsizing. The lottery was held among eligible workers who had not reported absent in the last three calendar months in the period before the lottery draw and who had not won any of the previous monthly lotteries.[4] The random selection of seven lottery winners was done at the first work day of each month over the period June 2002 – December 2004. Each winner received a gift coupon of 75 Euros, and after each draw the names of the seven winners were announced to the co-workers.[5] At first glance, such an incentive system seems to be weak of nature because of the low expected revenue to the workers. However, we show that we can exploit the randomness of having won any of the past lotteries.

There are two methodological novelties in this paper. The first novelty is that for the empirical framework, workers will be classified toward different states of effort. By changing their effort, the workers can move along the different states. We

[4] Because of the peculiar design this incentive system, the structure of the lottery has been denoted by prof. Tim Barmby as the "Utrecht problem".
[5] Hassink and Koning (2009) demonstrated that the lottery resulted in a change of behavior, even with a small expected revenue. In particular, lottery winners had an increase in absence after winning the lottery.

allow for a difference in response by classifying workers towards different levels of effort. The classification of high-effort and low-effort workers is based on work effort in the previous period. We assume that workers who have not been on sick leave in the past two calendar months (and all work days of the current month so far) have provided the highest effort.[6] Workers have the lowest effort, if they have reported sick during the current or the previous calendar month. Workers may increase (decrease) their effort by having a higher transition rate towards a higher (lower) state of effort.

We specify a four-dimensional proportional hazard model that describes the transitions of leaving one of the three states of effort (for the stayers) as well as the transition of leaving the firm. Workers can move from the state of low effort to the high-effort state, by not reporting absent during the month, whereas they will move from the high-effort to the lowest effort state by reporting absent. The four-dimensional hazard rate model will be used to infer whether there is a change in work effort for different groups of workers. Downsizing leads to an increase of effort if there is either an increase in the hazard for the low-effort states (thus workers who have been absent recently) or a decrease in the hazard of leaving the state of the highest effort.

The two main time-varying explanatory variables are: a) a 0-1 interaction term of being employed in the smaller plant after the announcement, and b) a 0-1 indicator for whether the worker had won one of the previous monthly lotteries. Using information of absenteeism at the daily level, the empirical model is formulated as a mixed proportional hazard model with four possible transitions and multiple mass points (Gaure, Røed and Zhang, 2007).[7] Interestingly, the estimates indicate that the conclusions will change somewhat after adding more mass points to the nowadays commonly used two-mass-point specification.

The estimates indicate that previous lottery winners are less likely to provide more effort after winning the lottery. It seems that winners are more likely to stay

[6] Importantly, this structure corresponds to the design of the lottery that took place in the firm. We formulate a Markov transition matrix in which there are three states of absenteeism besides a state of leaving the firm. A framework in which effort depends on previous absence has been used by the peanuts problem of Treble and Barmby (2011, page 77 - 82).

[7] A review of the empirical studies that applied techniques of discrete time duration models learns us the following about the unit of time. Most of the studies applied daily information: for a UK manufacturing firm (e.g. Barmby, 2002), Dutch primary-school teachers (Lindeboom and Kerkhoffs, 2000), Swedish social security (e.g. Broström, Johanssen, and Palme, 2004), an Italian bank (Ichino and Moretti, 2009), Dutch self-employed (e.g. Spierdijk, Van Lomwel and Peppelman, 2009). Monthly data are applied by the many studies for Norway, using records of social security (e.g. Røed and Fevang, 2007).

with the firm after winning the lottery. We observe that downsizing resulted in higher effort of the low-effort workers. More specifically, after the announcement the low-effort-workers in the small plant have an increased hazard to transit to the higher-effort states. However, whereas there is no change of the hazard rate for the high-effort workers.

The second methodological novelty of this paper is that we consider the causality effect of winning the lottery on the hazards of job effort and leaving the firm. As a placebo test – a block bootstrapping procedure – we simulate so-called pseudo lottery draws of eligible workers, by applying the design of the lottery. We created pseudo datasets of identical structure, with the only difference that we applied pseudo draws for eligible lottery winners.[8] The only variable that changed was the outcome of the time-varying explanatory variable of having won a previous lottery. All of the other explanatory variables have not changed. The placebo estimates indicate that the parameter estimates do not change, except for the effect of having won a previous lottery. In contrast to the baseline estimates, the pseudo estimates that the effect of having won one of the earlier pseudo lotteries has no effect on the work effort after winning the lottery is insignificant. We conclude that our baseline estimates are the result of the true signaling effect of winning the lottery, instead of having the capacity of winning a lottery.

The setup of this paper is as follows. In section 2, a description is given of the economic framework of sequential incentives and sorting. Section 3 outlays the economic states and the transitions across these states. The states will be applied to the case of the firm in section 4. The statistical identification is explained in Section 5. Section 6 the estimates are discussed. In Section 7, placebo estimates of various draws of winners of the eligible workers of the lottery contests are discussed. Section 8 provides the conclusions.

2. Framework

The framework can be formulated as three sequential decisions about effort and stay. The workers decide about their effort in periods 1 and 2, in which they may participate in contests, whereas the firm takes the decision about their stay in period 3. The worker contest of period 1 is a lottery to decrease workplace absenteeism, for

[8] Under the usual restriction of the lottery that winners had not been absent in the past three months and that they had not won one of the previous lotteries.

which a randomly selected small group of workers gets a reward for their presence at the work floor. With respect to the lottery draws in period 1, it is unforeseen that it yields additional information about the quality of the workers that could be used by the firm subsequently.

At the beginning of period 2, the firm announces to dismiss a substantial fraction of its workers in period 3, which induces another worker contest. Some of the workers may respond to the announcement through a higher work performance in period 2, in order to influence the firm's decision, whereas some other workers may become demotivated, so that they decreased their effort. In our stylized framework, the firm takes the actual decision to dismiss workers in period 3, based on information about work performance in periods 1 and 2.

(1a) $e_1 = f(c_e, \Xi_1)$

(1b) $e_2 = g(c_e, \Psi_2, \Xi_1)$

(1c) $s_3 = h(e_2, e_1)$

where *e* refers to the worker's effort and *s* to the decision of the firm to retain the worker. The subscripts refer to the period. Ξ is the strength of the first incentive mechanism at t=1 and Ψ is the strength of the second mechanism at t=2.

With respect to the work effort, there are two partial effects of interest that we will investigate empirically. The worker responds to the lottery incentive system, so that $\partial e_1 / \partial \Xi_1 > 0$. In addition, the worker may respond to the downsizing, $\partial e_2 / \partial \Psi_2$, which may be either positive (for workers with a small c_e) or negative (for workers with a large c_e). Lottery winners may also respond more strongly to the downsizing, so that $\partial e_2 / \partial \Xi_1 > 0$.

For the sorting of employees, the firm responds to the effort in period 2: $\partial s_3 / \partial e_2 > 0$ (static approach)[9] or the effort in period 1: $\partial s_3 / \partial e_1 > 0$ (dynamic approach).

3. The states

We classify effort by formulating a Markov model, which contains three states of work effort that range from high to low effort. The question is whether workers in these states have a change of effort after winning the lottery and after the

[9] It is a static approach because the firm acquire the information after the announcement of downsizing.

announcement of downsizing. The workers may have a transition along the states of effort by (not) reporting absent during the month.

We formulate three states of effort, which is based on their workplace presence in the previous two months and during the current calendar month. Workers in state Z1 have the highest effort. More specifically, in the first state ($Z1$), the worker has not been absent neither during the working days in the present month so far (*m*) nor in the two previous calendar months (*m*-1 and *m*-2). In the second state ($Z2$), the worker was not absent neither in the present month so far nor in the past calendar month (*m*-1). However, the worker was absent in month *m*-2. In the third state ($Z3$), the worker was on sick leave either during the present month or in the past calendar month (*m*-1). We add an absorbing fourth state $Z4$, in which the worker is not employed anymore with the firm.

We formulate a four-dimensional row vector $\mathbf{z}$. At working day *k* of month *m*, the worker will be in one out of four mutually exclusive states[10]

(2a) $$\mathbf{z}_{k,m} = (Z1_{k,m}, Z2_{k,m}, Z3_{k,m}, Z4_{k,m}) =$$
$$= \left((1-\vec{P}_{k,m})(1-S_{m-1})(1-S_{m-2}), (1-\vec{P}_{k,m})(1-S_{m-1})S_{m-2}, \vec{P}_{k,m}S_{m-2}, Q_{k,m} \right)$$

where

(2b) $$Z1_{k,m} + Z2_{k,m} + Z3_{k,m} = 1$$

The indicator variable S_m is one if the worker had been on sick leave on one of the working days of month *m* (and zero otherwise). *Q* is a dummy variable that is one for the workers who quitted the firm.

Crucially in the model is that the worker is moving from state Z1 to state Z3 as soon as he reports absent at a particular working day during the calendar month. Hence, we introduce the indicator $\vec{P}_{k,m}$ is one if the worker has been not been on sick leave on one of the first *k*-th working days of the *m*-th month.

(2c) $$\vec{P}_{k,m} = \prod_{t=1}^{k} (1-S_{t,m})$$

where the indicator variable $S_{t,m}$ is one if the worker is sick if the worker is sick on working day *t* in month *m* (and zero otherwise).

The transitions across the four states between day *t*-1 and day *t* can be described by the Markov transition matrix:[11]

[10] New hires are in state Z3 during their first month of tenure.

$$(3) \qquad (t-1) \quad M = \overset{(t)}{\begin{bmatrix} P_{11} & 0 & P_{13} & P_{14} \\ P_{21} & P_{22} & P_{23} & P_{24} \\ 0 & P_{32} & P_{33} & P_{34} \\ 0 & 0 & 0 & P_{44} \end{bmatrix}}$$

where P_{ij} registers the conditional probability of moving from origin state *i* to destination state *j* from day *t* to day *t*+1.

The empirical analysis is based on the transitions specified by the Markov matrix. It will be used to determine whether the transitions across the states changed after winning the lottery and after the announcement of downsizing in the smaller firm.

/ Figure 1 about here */*

4. Descriptive evidence

Development and structure of employment

The two plants of investigation were acquired by a large Dutch manufacturer in July 2001. A substantial fraction of the work force consists of lower-educated workers who operate in production lines. We start with some statistics on the size of the workforce. On July 1 2001, there were 435 workers in this firm. Over the entire period until 27 May 2005, 226 workers left the firm and 59 were hired. Furthermore, 19 workers moved from the small plant to the large plant, and 4 workers vice versa. For the entire period, we have information of 492 workers. 305 workers were employed with the larger plant and 188 workers (about 40 percent) from the smaller plant. Figure 1 displays the development of the number of workers in both plants over the entire period.

On 1 March 2004, there was an unexpected announcement to the personnel of the smaller plant that the manufacturer intended to relocate its production from this plant to production plants in Italy and Switzerland. Furthermore, the manufacturer

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[11] Another possible specification would be a three-state model, in which there are states of absence, presence, and out of firm. Such a specification has been applied many studies for Norway (e.g. Røed and Fevang, 2007). Barmby (2002) applied a bivariate model of absenteeism and presenteeism. For our purpose this approach is not attractive, because it is hard to distinguish between workers of different quality (work effort). These workers may have a different response to the announcement of downsizing.

considered either to close or to sell the plant. Subsequently, about 30 workers were encouraged to leave the plant, for which they were assisted in finding another job elsewhere. In October 2004, the manufacturer announced that it intended to sell two of the four production lines from this plant to local firms. A third production line would be removed to the other plant nearby, and the fourth production line would be closed. It implied that part of the work force continued to be employed in the plant (although it would be owned by another manufacturer). Another part of the work force switched from job to the other plant. Finally, about 20 workers had to leave the firm.

/ Table 1 about here */*

Given the information about the development in both plants it seems that the large plant can be used as a counterfactual.[12] It is considered by the composition of the work force in both plants at three days. Table 1 gives the averages for the day of acquisition (1 July 2001), the day of announcement (1 March 2004), and the final day of our period of observation (27 May 2005). The entire period of observation comprises 1003 work days. All of the observable characteristics are formulated as 0-1 indicators. Table 1 include indicators for female, non-native parents, age (5 classes), tenure (4 classes), and job level (7 classes).

/ Figure 2 about here */*

/ Table 2 about here */*

States of effort

Figure 2 portrays the development of the monthly rate of absence for both plants. It suggests that although the absence rate is on average lower in the smaller plant, both rates have a similar development until 2004. In 2004 and 2005, the absence rate has increased in smaller plant, while the rate was stable in the larger plant.

Next, we consider daily effort as being in one of the three states Z1-Z3 (see equation (2a)). We consider the composition of the workforce for each of the states. See Table 2.[13] First, we consider differences in work effort, for which our discussion concentrates on any differences between the states Z1 (highest effort) and Z3 (lowest

[12] In addition, both plants operated under similar local labor market conditions.

[13] The information starts on 1 September 2001, the information of July and August 2001 is needed to determine whether the workers are in state Z1- Z3 in the work days of September 2001. As a result, the set of information on which the table is based is reduced to 958 work days and 481 workers. 11 workers left the firm in July and August 2001. The estimates of the empirical analysis in Sections 6 and 7 are based on the same period.

effort). The is a higher fraction of workers of small plant in Z1 than in Z3 (0.416 versus 0.336). In addition, in the state Z1 there are relative fewer workers with non-native parents (0.302 versus 0.381), the workers are relatively of older age (for the oldest category 0.125 versus 0.086), the workers in Z1 are of longer tenure (for the highest tenure 0.583 versus 0.496). Finally, the workers in Z1 are at a relatively higher job level (0.116 versus 0.046). The fourth column of Table 2 gives the composition of the workers on the work day before they left the firm. It indicates that relatively more workers who left the firm are females, older workers, and workers with short tenures.[14]

/ Figure 3 about here */*

The development over time of the presence in the three states Z1-Z3 is displayed by Figure 3. The prevalence in state Z1 is relatively large in the first two months.[15] After excluding both months, state Z1 and Z3 express a seasonal pattern, whereas Z2 turns out to be relatively stable until March 2004. There seems to be a shift to the states of higher effort after the announcement of downsizing.

/ Tables 3A-3C about here */*

Next, we report the average conditional probabilities of the Markov transition matrix (equation (3)), for which we make use of daily information of absence. See Table 3A. For each row, the conditional probabilities add up to one. The averages at the main diagonal are close to one, because they reflect day-to-day changes. Importantly, for the origin state Z2 the average conditional probability to leave is larger to the destination state Z1 than to Z3. It suggests that Z1 and Z2 are more similar in summarizing work effort (indeed, in the second part of the empirical analysis of Section 6 we will group states Z1 and Z2).

Work effort and downsizing

We consider the development in effort for four subgroups: in both plants separately and before and after the announcement of downsizing. Table 3B gives the averages of the conditional probabilities for each of the four groups.

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[14] The lower part of table 2 gives essential information about the structure of the spells for the states Z1-Z3. Almost all workers (476 out of 481 workers) have reached state Z1 on any of the work days over the period of investigation. In addition, the number of repeated spells is large for most of the states, which is very helpful to correct for duration dependency in the statistical duration analysis.

[15] Exclusion of the information of both months does not alter our conclusions.

/ Figure 4 about here */*

Work effort after winning the lottery

Next, we consider the monthly lotteries, for which the design was described in the introduction. In total we have information of all 30 lottery draws over the period June 2002 – December 2004 (in July 2004 there was no draw), so that in total there is information of 209 winners (in September 2002 one anonymous eligible worker in the largest plant declined the lottery prize).

Figure 4 describes the development of four groups of workers over the entire period. The total number of employees in both plants declined gradually, in particular after March 2004. The development of the number of workers in state Z1 is equal to the of the total workforce in particular in the last two years of investigation. The number of workers who are eligible for the lottery is smaller than the number of workers in Z1. In the period in which the lotteries were held, non-lottery winners in Z1 were eligible in the upcoming lottery at the first work day of the next calendar month. From June 2002 onwards, the number of the workers who had won one of the previous lottery increased gradually, because 7 winners were added to the number of lottery winners each month. There was a decrease from January 2005 onwards, because some of the lottery winners left the firm. Finally, the decline of the number of eligible workers for the monthly lottery (non-winner and not having been absent in the past three calendar months) reflects the increase of the number of lottery winners.

We checked whether the composition of the lottery winners changes across the subsequent lottery draws. See Table 4. For a selection of 209 winners, an OLS estimate of a regression of the lottery draw on the workers' background characteristics does not indicate any significant joint effect (*F*-statistic: 0.91).

Do winners have a change of effort? Table 3C gives the conditional probabilities for non winners (information on top of each cell) and lottery winners (information in italics).

Decision to stay of winners

Are winners more likely to stay with the firm after the announcement? We considered the workers on 1 March 2004 for both plants separately, and we investigated whether they were still employed with the firm on the final day of observation 27 May 2005. A simple descriptive OLS regression suggests there is a positive association between winning the lottery and staying with the firm for the winners in the smaller plant whereas this effect is absent for the winning workers of the other plant (see Table 5).

5. Statistical specification

We group the transitions associated with the ten non-zero conditional probabilities of the Markov transition matrix M (equation (3)) into four transitions. Grouping is because of the implication of Table 3A that some of the probabilities are too small to obtain a proper identification of the effects of the explanatory variables on the hazard rate. We introduce the transition variable *s*, which refers to the transitions across the three states of effort (for which s =1,2,3 correspond to the origin states Z1, Z2, Z3, respectively. *s* = 4 refers to the transition of leaving the firm. To be more specific,

$s = 1$: Its hazard is based on the transition from state Z1 to destination state Z3 (corresponding to the conditional probability P_{13} in equation (3)). It means that the highest-effort worker (state Z1) reported absent during the month, so that he returned to state of the lowest effort.

$s = 2$: Its hazard is related to the transition from state Z2 to either state Z1 or state Z3 (P_{21} and P_{23} in equation (3)). A transition to state Z1 means that the worker did not report absent during the month, whereas the transition to Z3 is the result of an absence.

$s = 3$: It refers to the hazard associated with the transition from state Z3 to destination state Z2 (P_{32}). A transition to Z2 means that the low-effort worker in state Z3 did not report absent during the month;

$s = 4$: transition from states Z1, Z2 or Z3 to destination state Z4 (thus the associated conditional probabilities are P_{14}, P_{24}, and P_{34}). It means that the worker is not working in the firm after transition.

We formulate the grouped transitions as a four-dimensional mixed proportional hazard model, for which we assume that the hazard rates are proportional in the effects. It is a discrete model, because state occupation is observed at the daily level, and hence the spell duration is given in number of days. The four hazard rates are specified as

(4) $$\varphi_s(t, d, \mathbf{x}_i, \mathbf{w}_{it}, \mathbf{v}_{si}) = \exp(\boldsymbol{\beta}_\mathbf{s}'\mathbf{x}_i + \boldsymbol{\gamma}_\mathbf{s}'\mathbf{w}_{it} + \boldsymbol{\sigma}_{st} + \boldsymbol{\lambda}_{sd} + \mathbf{v}_{si}) \qquad s=1,\ldots,4$$

for which d is the spell duration, t is calendar time, $\mathbf{x}_i$ is a vector of individual-specific covariates (0-1 indicators for female, non-native parents, and job level (6 indicators)), and $\mathbf{w}_{it}$ is a vector of calendar time-varying covariates (0-1 indicators for plant, classes of age (4 indicators), and tenure (3 indicators)). $\mathbf{v}_{si}$ is vector of unobserved covariates (mass points). $\boldsymbol{\sigma}$ is a vector of calendar-time effects (day of the week (3 indicators), quarter of the year (3 indicators), and year (3 indicators)). $\boldsymbol{\lambda}$ is a vector of baseline effects association with the spell duration (depending on the state, 4 indicators at maximum).

The vector $\mathbf{w}$ includes two important additional time-varying explanatory in the vector. First, $\mathbf{w}$ contains the interaction term *DShock* ($DShock_{it}$ =1 if person *i* is employed with the smaller plant at calendar day *t*, for which the day *t* is from 1 March 2004 onwards).[16] Our purpose is to compare any differences of the effect of *DShock* on the hazard rate across the transitions *s*=1, 2, 3. A positive (negative) parameter estimate on *DShock* implies that the workers in the small plant are providing more (less) effort by being less (more) absent after the announcement of downsizing.

Second, the vector $\mathbf{w}$ includes the time-varying indicator *DWinner* ($DWinner_{it}$ =1 on the calendar days *t* after the *i*-th worker has won the lottery). A negative parameter on *DWinner* indicates that lottery winners are providing lower effort after having won the lottery (s=1,2,3) or wither they will have a prolonged stay with the firm longer (*s*=4).[17] *DWinner* has an interesting feature, because it is based on the randomness of the lottery draw by the firm, conditional on the fact that the worker is eligible for the lottery.

We can disentangle the effect of duration dependence from that of individual heterogeneity, by relying on repeated spells for individuals. Most of the employees have been multiple times in one of the three states of effort (see lower part of Table 2). Furthermore, the specification includes time-varying explanatory variables.

Equation (4) is estimated by means of a non-parametric maximum likelihood estimator. For a detailed description and assessment of the estimation procedure, see Gaure, Røed and Zhang (2007) and for application we refer to, for instance, Nordberg and Røed (2009) and Markussen et al. (2011). The procedure consists of various

[16] Note that for persons who moved from the smaller plant to the larger plant after 1 March 2004, the value of the interaction term changes.
[17] We can even expand the framework by including a interaction term between *DShock* and *Dwinner*.

rounds of estimation. It increases the number of mass points each round, starting with a heterogeneity distribution of one mass point. The estimation procedure first derives the likelihood function conditional on the unobserved individual effects. Next, the unobserved heterogeneity is integrated out of the likelihood function for a discrete joint distribution of mass points. The likelihood function is maximized with respect to the parameters of interest, together with the parameters that characterize the heterogeneity distribution. It is repeated by adding another mass point to the heterogeneity distribution of mass points, and the model is "saturated" for the number of mass points for which the addition of another mass point would not lead to an increase of the likelihood function. We select the preferred model by the lowest Akaike Information Criterion (AIC).

Compared to previous applications of the estimation procedure, our estimates are based on a different format of the data, because the time dimension (cross-sectional dimension) is much larger (smaller) than usual. As a result of using daily data, in our application the maximum duration consists of 958 discrete time units, whereas the number of the individuals (481) is rather limited.

/* Tables 6, 7 about here */

6. Estimates

Table 6 gives the estimates for a system of four hazard rates. The estimates indicates that 6 mass points are required to have the lowest AIC. There is a different number of baseline indicators for each of the hazards.

First, we consider the effect of the announcement of downsizing on effort. It turns out that there is no influence on the hazard of leaving the highest states of effort Z1 and Z2. Both parameter estimates are statistically insignificant. There is however a positive effect of leaving the lowest state of effort Z3 (estimate: 0.260). It indicates that downsizing leads to an increase in effort for the lower part of the effort distribution.

Next, we consider the effect of having won the lottery. After winning the lottery, there is no influence on the hazard of leaving Z1 and Z2, whereas there is an increase in the stay in Z3 (estimate: -0.244). Furthermore, the parameter estimate of winner on leaving the firm is statistically insignificant (estimate: -0.351 (0.261)).

A transition from Z2 can be to either Z1 (no absence during the month) or Z3 (the worker reports absent). To improve the efficiency of the estimates, we considered that it would be better to group Z2 to Z1. The reason is that Kendal's tau between the random coefficients of Z1 and Z2 is positive (value: 0.599), whereas it is negative for all of the other combinations of the four hazards.

Table 7 gives the parameter estimates for the three-hazards system, in which the transitions from Z1 and Z2 are grouped. The estimates confirm the finding the previous result that the announcement results in a higher effort for the low-effort workers (Z3) in the smaller plant (estimate: 0.240 (0.119)). After winning the lottery, the hazard rate of leaving Z3 becomes smaller (-0.306 (0.106)).[18]

/* Table 8 about here */

7. Placebo estimates

Because lottery winners get a relative small financial reward of 75 Euro after winning the lottery – in addition to the non-financial reward of the announcement to the co-workers –, it may be remarkable that the parameter estimates indicated any effect of having won the lottery on the hazards. Are workers really changing their effort because they have won the lottery? Are the lottery winners have a prolonged stay with the firm, because they belong to the upper part of the effort distribution? In this section we scrutinize our claim that the exogeneity of the lottery draw yields a causal effect of *Dwinner* on the hazards of effort and sorting.

First, we focus on the structure of the explanatory variable *Dwinner*. There may two explanations for *Dwinner* switching from a zero to a one at a particular day. First, the better workers are more likely to become eligible for one of the monthly lotteries, so that the *Dwinner* measures the between-worker effect of ability on the hazards. Second, the specific date of winning the lottery can be considered a within-worker effect, because it contains specific information to both the worker and the firm. Hence, what matters is not only whether someone has won one of the lotteries, but also at which specific date the prize was won.

[18] Furthermore, we are extremely cautious there is some very weak indication that for lottery winners there is a decrease in the hazard of leaving the firm, because the parameter estimate of -0.369 (0.237). The placebo estimates of Section 7 seem not to contradict this outcome.

We can test both explanations by using a series of placebo estimates. For each of the estimates we constructed a pseudo dataset which is identical to the one that was for our baseline estimates except for the variable *Dwinner*. We constructed a pseudo variable *Dwinner*, by taking random draws of "pseudo" lottery winners ourselves, under the restriction of the design of the lottery.

More precisely, we took at random 7 pseudo winners for the first lottery of June 2002, for which we applied the formal rule that 4 of them were drawn from the eligible workers employed in the large plant and 3 of the pseudo winners were employed in the small plant. The 7 pseudo winners are not necessarily the workers who actually won the lottery in June 2002. In total there were 30 lottery draws. For the subsequent 29 pseudo draws of the lottery after June 2002, we sequentially replicated the draws. For each draw, we randomly selected 7 eligible workers, under the restriction that the previous pseudo lottery winners (selected in our pseudo lottery of previous rounds) had no access to the lotteries afterwards. In total we ended up with 209 pseudo lottery winners. Some "true" lottery winners may be also part of the group of pseudo lottery winners, albeit that the pseudo winners may have won one of the other monthly lotteries.[19] The procedure that we apply is comparable to a block bootstrapping procedure, because with exception of the variable 'winner of the lottery in month t', no changes in the explanatory variables were made.

For each pseudo dataset we determined the maximum-likelihood estimates of the three hazard rate model, for which the number of mass points of the preferred model may differ across the estimates. We replicated the maximum-likelihood estimates for 100 pseudo datasets. For most of the explanatory variables and hazard rates, the averages of the 100 pseudo estimates are similar to the real estimates of Table 7.

Table 8 contains the average parameter estimates of the pseudo estimates for the variables of interest. The estimates of the effect of the announcement effect on the hazards in the small plant are hardly different. The major difference is the effect of *Dwinner* on the hazards of Z1 and Z2, Z3, and Z4. All of the averages of the parameter estimates move to zero, so that the average parameter estimate is small relative to the average standard error. This is a remarkable outcome, because it

[19] Thus for a true lottery winner who also happens to be also a pseudo lottery winner, the month of winning the true (or actual) lottery does not necessarily correspond to the month of winning the pseudo lottery that we have drawn.

implies that the effect of winning the lottery is because of the true date of winning the lottery.

8. Conclusions

Our conclusions are twofold. First, during the episode of downsizing, the low-effort workers in the small plant provided more effort by having lower absence, whereas the high-effort workers did not change their absence. This is an important outcome, because it shows that composition effect within firms is relevant. It implies that is hard to draw conclusions from analyses on downsizing by using firm-level data.

Second, we find that lottery winners have a lower effort after winning the lottery. In addition, there is very mild evidence, that they will have a prolonged stay after winning the lottery. The placebo estimates indicate that the result is because of the within effect of the date of winning. We cannot find any evidence of a change of effort of lottery winners in the downsizing plant during the process of downsizing.

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Table 1: Composition of workforce in both plants

	1 July 2001		1 March 2004		27 May 2005	
	Small plant	**Large Plant**	**Small plant**	**Large Plant**	**Small plant**	**Large Plant**
Female	0.245	0.217	0.231	0.144	0.162	0.150
Non-native parents	0.362	0.250	0.359	0.316	0.382	0.315
Age:						
< 25 years	0.037	0.040	0.006	0.019	0.000	0.000
25 – 35 years	0.252	0.261	0.231	0.214	0.162	0.200
35 – 45 years	0.399	0.346	0.397	0.400	0.353	0.420
45 – 55 years	0.258	0.254	0.269	0.260	0.279	0.270
> 55 years	0.055	0.099	0.096	0.107	0.206	0.110
Tenure:						
< 2 years	0.135	0.162	0.109	0.093	0.029	0.005
2 – 5 years	0.209	0.140	0.103	0.195	0.074	0.165
5 – 10 years	0.153	0.136	0.244	0.172	0.265	0.240
> 10 years	0.503	0.563	0.545	0.540	0.632	0.590
Job level:						
Level 1,2	0.135	0.067	0.115	0.070	0.132	0.065
Level 3	0.245	0.159	0.250	0.182	0.265	0.166
Level 4	0.190	0.159	0.192	0.210	0.191	0.191
Level 5	0.110	0.133	0.109	0.150	0.029	0.176
Level 6	0.110	0.181	0.122	0.168	0.118	0.166
Level 7 – 10	0.129	0.185	0.128	0.136	0.147	0.146
Level > 10	0.080	0.111	0.083	0.084	0.118	0.090
Number of workers	163	272	156	215	68	200

Table 2: Composition of workforce by state [a)]

	Z1	Z2	Z3	Leaving the firm [b)]
Small plant	0.416	0.342	0.336	0.493
Female	0.189	0.182	0.203	0.299
Non-native parents	0.302	0.371	0.381	0.280
Age:				
< 25 years	0.012	0.013	0.019	0.023
25 – 35 years	0.210	0.250	0.244	0.206
35 – 45 years	0.378	0.414	0.410	0.388
45 – 55 years	0.274	0.235	0.241	0.182
> 55 years	0.125	0.088	0.086	0.201
Tenure:				
< 2 years	0.096	0.133	0.130	0.192
2 – 5 years	0.176	0.188	0.186	0.164
5 – 10 years	0.145	0.190	0.190	0.168
> 10 years	0.583	0.490	0.495	0.477
Job level:				
Level 1,2	0.082	0.098	0.106	0.103
Level 3	0.175	0.247	0.258	0.229
Level 4	0.176	0.207	0.220	0.164
Level 5	0.118	0.155	0.151	0.107
Level 6	0.159	0.140	0.125	0.145
Level 7-10	0.174	0.099	0.093	0.154
Level > 10	0.116	0.054	0.046	0.098
Day of the week:				
Monday	0.199	0.197	0.198	0.234
Tuesday	0.201	0.200	0.200	0.126
Wednesday	0.199	0.201	0.199	0.126
Thursday	0.199	0.200	0.201	0.154
Friday	0.202	0.203	0.203	0.360
# observations	231296	31634	94381	214
# employees who have been in this state	476	394	410	
# employees > 1 spell in this state	405	394	405	
# employees > 4 spells in this state	217	208	228	
Number of spells	1660	1667	1805	
Number of spells not ending in an exit of the worker from the firm	1525	1654	1739	
Average length of spell	139.3	19.0	52.3	
Median length of spell	67	21	39	
Minimum length of spell	1	1	2	
Maximum length of spell	958	23	489	

a) 481 workers; 357311 work days, which equals the sum of lengths of all spells.
b) Characteristics of the worker on the work day before they left the firm.

Table 3A – Estimated probabilities, transition matrix (all workers)

	day				
		Z1	Z2	Z3	Z4
day - 1	Z1	0.9935	0	0.0059	0.0006
	Z2	0.0405	0.9483	0.0108	0.0004
	Z3	0	0.0177	0.9816	0.0007
	Z4	0	0	0	1

Table 3B – Estimated probabilities, transition matrix (Large plant and small plant; before 1 March 2004 and from 1 March 2004 onwards)[a)]

	day				
		Z1	Z2	Z3	Z4
day - 1	Z1	0.9931 0.9930 *0.9947* *0.9927*	0	0.0063 0.0068 *0.0050* *0.0056*	0.0006 0.0003 *0.0003* *0.0017*
	Z2	0.0408 0.0363 *0.0444* *0.0388*	0.9453 0.9516 *0.9496* *0.9511*	0.0138 0.0117 *0.0056* *0.0083*	0.0001 0.0004 *0.0004* *0.0017*
	Z3	0	0.0185 0.0164 *0.0178* *0.0163*	0.9810 0.9828 *0.9819* *0.9811*	0.0005 0.0007 *0.0003* *0.0026*
	Z4	0	0	0	1

a) 1st row: large plant (before 1 March 2004); 2nd row: large plant (1 March 2004 onwards); 3rd row (italics): small plant (before 1 March 2004); 4th row (italics): small plant (1 March 2004 onwards).

Table 3C – Estimated probabilities, transition matrix (non-winners and winners)[a)]

	day				
		Z1	Z2	Z3	Z4
day - 1	Z1	0.9915 *0.9950*	0	0.0075 *0.0048*	0.0010 *0.0003*
	Z2	0.0386 *0.0429*	0.9464 *0.9508*	0.0146 *0.0060*	0.0005 *0.0003*
	Z3	0	0.0164 *0.0197*	0.9827 *0.9799*	0.0008 *0.0005*
	Z4	0	0	0	1

a) 1st row: non-winners; 2nd row: winners (in italics). Employees are a winner if they have won one of the lotteries.

Table 4: Draw of the lottery

	Dependent: draw of lottery [b)]
Female	1.398 (1.421)
Non-native parents	-1.895 (1.278)
Tenure	-0.054 (0.056)
Job level (>= level 6)	-0.574 (1.188)
Indicator large plant	-0.788 (1.033)
Winner	-
Draw of lottery	-
F-test on regression	F(5, 130) = 0.91
(Pseudo) R-squared	0.030

a) On sub-sample of lottery winners (up to February 2004) for both plants. Dependent: draw of the winning lottery. Robust standard errors in parenthesis.

*.** and **: statistically significant at 10. 5 and 1%- level. respectively.

Table 5: LPM. dependent variable: Indicator of stay

	Dependent: Stay = 1	
	Small Plant a)	**Large Plant a)**
Female	-0.108 (0.103)	-0.095 (0.073)
Non-native parents	0.123 (0.097)	0.031 (0.047)
Tenure	0.012 (0.005)***	0.005 (0.003)
Job level (>= level 6)	0.085 (0.093)	0.084 (0.045)*
Indicator large plant	-	-
Winner	0.357 (0.130)**	-0.011 (0.094)
Draw of lottery	-0.023 (0.011)**	-0.002 (0.007)
F-test on regression	Chi2(6) = 15.28**	Chi2(6) = 7.81
(Pseudo) R-squared	0.076	0.068
Number of observations	156	222

a) Workers are employed in plant on March 1st 2004. Dependent variable is indicator which is one for persons who will stay with firm until May 28th 2005. Robust standard errors in parenthesis. Probit; marginal effects at average reported.
*.** and **: statistically significant at 10. 5 and 1%- level. respectively.

Table 6: Estimates – 4 states (equation (4))

	Z1		Z2		Z3		Z4	
	Est. Coeff	**Std Err.**	**Est. Coeff**	**Std Err.**	**Est. Coeff**	**Std Err.**	**Est. Coeff**	**Std Err.**
Small plant	0.088	0.405	0.099	0.108	-0.482	0.129	-0.548	0.275
Female	0.006	0.356	-0.236	0.112	0.044	0.151	0.973	0.241
Non-native parents	0.033	0.327	-0.024	0.106	-0.072	0.136	-0.332	0.278
Age:								
25 – 35 years	0.138	1.556	0.232	0.311	-0.064	0.331	-0.257	0.777
35 – 45 years	0.144	1.541	0.229	0.319	-0.117	0.351	0.141	0.773
45 – 55 years	0.164	1.555	0.192	0.337	-0.236	0.364	-0.360	0.798
> 55 years	0.153	1.576	0.154	0.359	-0.433	0.368	1.131	0.803
Tenure:								
2 – 5 years	0.036	0.569	-0.279	0.136	-0.260	0.145	-0.778	0.309
5 – 10 years	-0.034	0.480	-0.285	0.158	-0.209	0.168	-0.865	0.330
> 10 years	0.028	0.493	-0.283	0.156	-0.403	0.169	-1.405	0.312
Job level:								
Level 3	-0.010	0.454	0.180	0.160	0.285	0.200	-0.237	0.394
Level 4	0.033	0.514	0.271	0.158	-0.133	0.204	-0.463	0.415
Level 5	0.030	0.523	0.235	0.183	0.139	0.228	-0.344	0.454
Level 6	0.114	0.544	0.371	0.167	-0.322	0.215	-0.335	0.457
Level 7 – 10	0.109	0.638	0.510	0.218	-0.788	0.222	-0.253	0.432
Level > 10	0.105	0.904	0.396	0.217	-0.962	0.262	-0.549	0.447
Incentives:								
after winning lottery	0.029	0.367	0.181	0.134	-0.244	0.111	-0.351	0.261
from 1st March 2004, small plant	-0.043	0.543	-0.078	0.183	0.260	0.132	2.257	0.415
Time:								
June 2002 – Dec 2003	0.031	0.467	0.234	0.128	0.070	0.106	-0.036	0.273
2004	-0.017	0.552	0.039	0.152	0.214	0.130	-0.169	0.354
Jan – May 2005	-0.335	0.602	-0.204	0.222	0.290	0.167	0.911	0.492
Day of the week:								
Tuesday	-0.655	0.162	-0.480	0.129	-0.170	0.100	-0.606	0.353
Wednesday	-0.525	0.171	-0.828	0.164	-0.280	0.109	-0.602	0.330
Thursday	-0.137	0.173	-0.493	0.146	-1.124	0.153	-0.407	0.326
Friday	0.832	0.134	0.745	0.110	0.709	0.083	0.439	0.275
Quarter:								
Q2	-0.073	0.332	-0.049	0.133	-0.380	0.104	-0.631	0.310
Q3	-0.098	0.423	0.004	0.149	-0.518	0.113	0.360	0.284
Q4	-0.087	0.395	-0.083	0.134	-0.080	0.096	0.011	0.304
Baseline:								
2 days	-		-		-0.832	0.248	-1.967	1.379
3 – 4 days	-		-5.231	1.485	-0.141	0.150	-1.757	0.846
5 – 9 days	-		-4.277	0.740	-0.112	0.126	-1.788	0.718
10 – 19 days	-0.738	0.112	-3.348	0.305	-0.177	0.113	-0.736	0.330

a) All explanatory variables are 0-1 dummy variables (1 refers to variable name). Reference categories: Age (<25 year), Tenure (< 2 year), job level (< 3), Time (July 2001 - May 2002); Quarter of the year (Q1). Baseline: (20 days and above).

b) 6 support points; 153 parameters; log-likelihood: -23720.2537; 357311 dates; 481 workers.

Table 7: Estimates; 3 states (states Z1 and Z2 combined); (equation (4))

	Z1 and Z2		Z3		Z4	
	Est. Coeff	Std Err.	Est. Coeff	Std Err.	Est. Coeff	Std Err.
Small plant	0.021	0.104	-0.552	0.119	-0.524	0.273
Female	-0.154	0.118	0.018	0.136	0.733	0.213
Non-native parents	-0.054	0.108	0.110	0.132	-0.372	0.229
Age:						
25 – 35 years	0.279	0.261	-0.166	0.287	-0.221	0.900
35 – 45 years	0.248	0.265	-0.148	0.302	0.129	0.898
45 – 55 years	0.209	0.285	-0.280	0.310	-0.243	0.910
> 55 years	0.240	0.310	-0.492	0.330	0.693	0.923
Tenure:						
2 – 5 years	-0.172	0.151	-0.158	0.129	-0.821	0.304
5 – 10 years	-0.154	0.169	0.023	0.157	-0.988	0.305
> 10 years	-0.201	0.159	-0.106	0.161	-1.379	0.312
Job level:						
Level 3	0.024	0.166	0.270	0.213	0.239	0.328
Level 4	0.138	0.171	-0.085	0.217	-0.016	0.354
Level 5	0.110	0.177	-0.055	0.245	0.065	0.377
Level 6	0.239	0.172	-0.431	0.234	0.047	0.356
Level 7 – 10	0.314	0.206	-0.818	0.238	0.153	0.361
Level > 10	0.252	0.236	-1.039	0.281	-0.213	0.374
Incentives:						
after winning lottery	0.151	0.138	-0.306	0.106	-0.369	0.237
from 1st March 2004, small plant	-0.095	0.191	0.240	0.119	2.202	0.386
Time:						
June 2002 – Dec 2003	0.226	0.129	0.035	0.099	0.060	0.360
2004	0.070	0.152	0.176	0.112	-0.065	0.438
Jan – May 2005	-0.165	0.223	0.245	0.142	0.859	0.573
Day of the week:						
Tuesday	-0.460	0.111	-0.168	0.091	-0.608	0.346
Wednesday	-0.850	0.132	-0.260	0.099	-0.605	0.320
Thursday	-0.520	0.120	-1.102	0.147	-0.410	0.318
Friday	0.703	0.081	0.729	0.078	0.438	0.267
Quarter:						
Q2	-0.003	0.127	-0.362	0.089	-0.660	0.313
Q3	-0.014	0.151	-0.498	0.098	0.341	0.277
Q4	-0.101	0.126	-0.060	0.079	-0.026	0.304
Baseline:						
2 days	-		-		-1.984	1.131
3 – 4 days	-		-0.072	0.138	-1.771	0.838
5 – 9 days	-		-0.043	0.113	-1.804	0.698
10 – 19 days	-3.049	0.292	-0.113	0.087	-0.754	0.321

a) All explanatory variables are 0-1 dummy variables (1 is referring to variable name). Reference categories: Age (<25 year), Tenure (< 2 year), job level (< 3), Time (July 2001 - May 2002); Quarter of the year (Q1). Baseline: (20 days and above).
b) 8 support points: 8; 123 parameters; log-likelihood: -19029.5556; 357311 days; 481 workers.

Table 8 - Placebo estimates 100 replications (average of replications in bold)[a)]

	Z1 and Z2		Z3		Z4	
	Est. Coeff	**Std Err.**	**Est. Coeff**	**Std Err.**	**Est. Coeff**	**Std Err.**
Incentives:						
After winning lottery	0.151	0.138	-0.306	0.106	-0.369	0.237
	0.0571	**0.125**	**-0.056** [b)]	**0.093**	**-0.075**	**0.226**
From 1st March 2004, small plant	-0.095	0.191	0.240	0.119	2.202	0.386
	-0.083	**0.190**	**0.236**	**0.121**	**2.220**	**0.286**
Time:						
June 2002 – Dec 2003	0.226	0.129	0.035	0.099	0.060	0.360
	0.248	**0.127**	**0.030**	**0.095**	**-0.064**	**0.281**
2004	0.070	0.152	0.176	0.112	-0.065	0.438
	0.109	**0.146**	**0.132**	**0.111**	**-0.251**	**0.349**
Jan – May 2005	-0.165	0.223	0.245	0.142	0.859	0.573
	-0.109	**0.214**	**0.199**	**0.136**	**0.751**	**0.464**

a) In each row, the upper line gives the estimates of Table 7, whereas the row below (in bold) gives the estimates of the 100 pseudo estimates.
b) For 9 out of 100 samples is the estimated parameter below -0.369.

Figure 1 – Employment in both plants (period: July 2001 – June 2005)

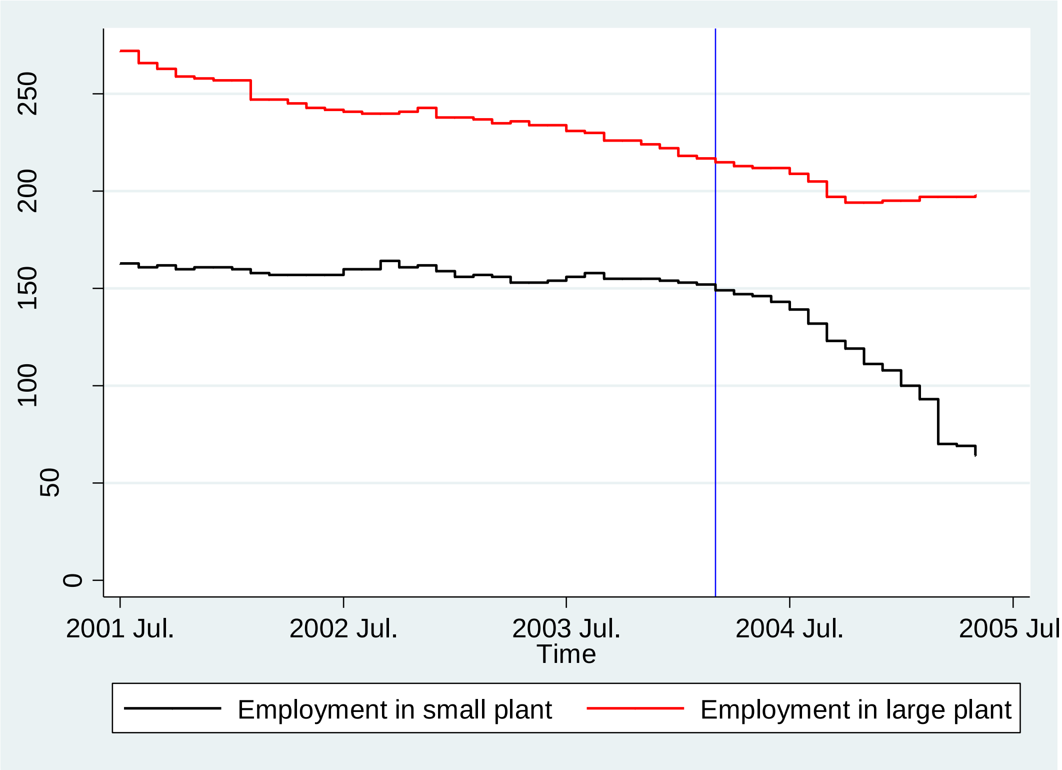

Figure 2 – Rate of sick leave in both plants (period: July 2001 – June 2005)

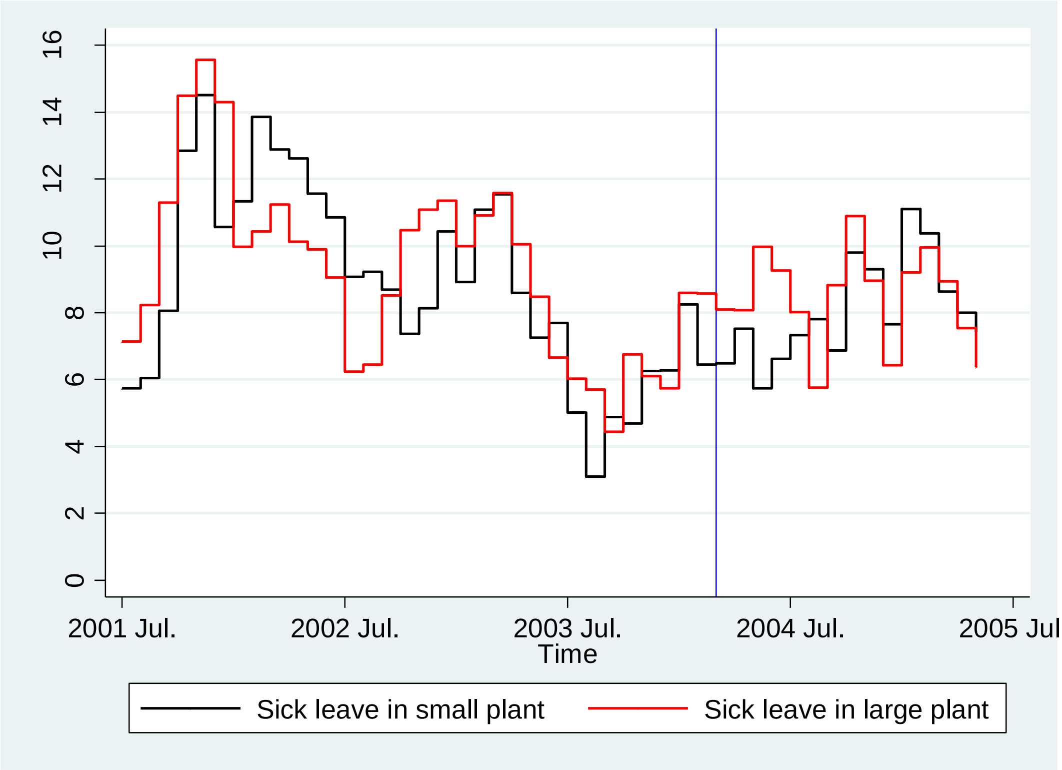

Figure 3 – 3 States (Z1 – Z3) (period: September 2001 – June 2005)

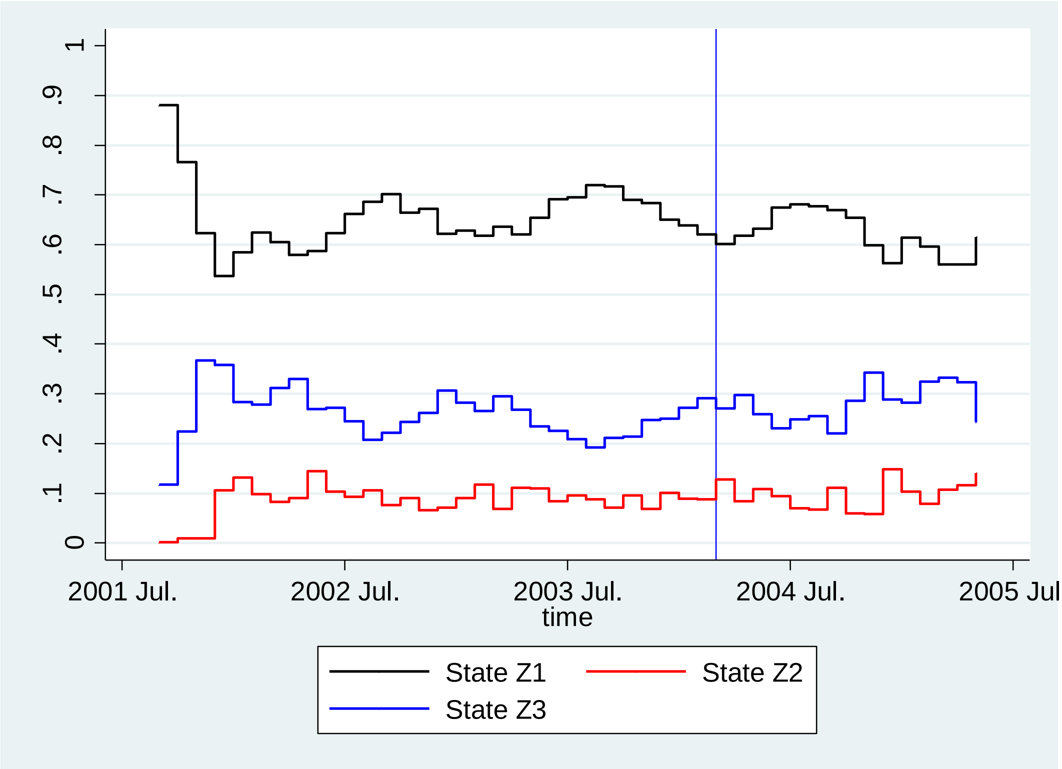

Figure 4 – Development of lottery and eligibility (period: September 2001 – June 2005)