Keeping Nurses at Work: A Duration Analysis

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Content

Abstract

A shortage of nurses is currently a problem in several countries, and an important question is therefore how one can increase the supply of nursing labour. In this paper we focus on the issue of nurses leaving the public health sector by utilising a unique data set containing information on both the supply and demand side of the market. To describe the exit rate from the health sector we apply a semi-parametric hazard rate model. In the estimations we correct for unobserved heterogeneity by both a parametric (Gamma) and a non-parametric approach. We find that both wages and working conditions have an impact on nurses' decision to quit. Furthermore, failing to correct for the fact that nurses' income partly consists of compensation for inconvenient working hours results in a considerable downward bias of the wage effect.

Preface

Keeping nurses at work: A duration analysis is a working paper from the Programme for Health Economics in Bergen, HEB. Author Tor Helge Holmås is a research fellow at the Rokkan centre and Department of Economics, University of Bergen. The paper is part of a doctoral project dealing with labour market studies of health care personnel. Tutors are associate professor Jan Erik Askildsen, the Rokkan Centre and Department of Economics, and associate professor Espen Bratberg, Department of Economics.

Programme for Health Economics in Bergen is a co-operation between the University of Bergen and Norwegian School of Economics and Business Administration. The research programme is financed from the Research Council of Norway. The scientific activity is centred at Department of Economics at the University of Bergen. Other participating departments include the Department of Public Health and Primary Health Care at the University of Bergen, and Centre for Research in Economics and Business Administration at the Norwegian School of Economics and Business Administration. The administrative responsibility is located at Stein Rokkan Centre for Social Studies, the Rokkan Centre. The aim of the research programme HEB is to serve as a main research unit for health economics research in Norway.

HEB's research activity is organised within three fields. This paper belongs to the topic 'Incentives and Organisation of the Health Sector', as project *3.1: Labour supply in the health care sector*. For further information about the research activity at HEB, please consult our web site at http://www.rokkansenteret.uib.no/heb.

The article *Keeping nurses at work: A duration analysis* is a longitudinal study of quitting propensities of nurses at 34 Norwegian hospitals. The nurses are tracked for a period of 5 years, from 1993 to 1997. The analysis shows that increased wages significantly reduces the probability that a nurse will leave the hospital sector. The decision to stay or leave is also affected by other job related factors like work load and shift work.

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Introduction

A shortage of nurses is a problem in several countries. In Norway the Directorate of Labour estimated the nursing shortage to comprise around 3300 whole-time posts in 1998. In the UK recent estimates of the national vacancy rate for nurses are close to 15 000 [1], and according to Ahlburg and Mahoney [2], hospitals in the US have problems with high vacancy rates among registered nurses. Nurses are key personnel in the health sector, and in some cases, staff shortages have caused ward closures in Norwegian hospitals. Even though these are extreme examples, sufficient supply of nurses is vital in order to secure a well functioning health service. Clearly, an increase in the labour supply of nurses is a policy relevant question and in this paper we focus on one important side of this issue, namely why nurses leave the health sector.

In order to improve nurse retention, focus has been on working conditions and wages. However, little economic research has been done in analysing how these factors influence nurses' quitting behaviour. Two studies (Ahlburg and Mahoney [2] and Schumacher [3]) focus on how wages affect the retention of nurses. Both studies find that wages have significant, but small, effects. This finding leads Ahlburg and Mahoney [2] to conclude; «Why nurses leave the profession may have more to do with conditions of employment than with wages». Shields and Ward [4] investigate the importance of job satisfaction in determining nurses' intention to quit. As opposed to the two other studies, they have a data set that makes it possible to investigate the effect of wages and a large number of factors influencing nurses' working conditions. They find that poor career advancement opportunities, increased workload, wage and workplace relations are the most important factors in determining quitting intentions. However, a problem with this approach is that the intention to quit could be just another way of expressing dissatisfaction. It is therefore not clear how much is explained by examining this correlation [5].

The aim of the present study is to assess the effect of wages and working conditions on nurses' probability of leaving the public health sector. We utilise a unique data set containing information on both the supply and demand side of the market. Our sample consists of female nurses working in Norwegian hospitals. To characterise the exit rates we use a proportional hazard model with a nonparametric baseline hazard. We correct for unobserved heterogeneity using parametric (gamma) and semi-parametric techniques. In several important ways the study differs from most previous studies on nurses' retention and turnover.

First, we take into account that one of the most important characteristics of the nursing profession is the large amount of shift work. For most individuals, shift work is more stressful than working normal hours [6]. Therefore, shift work may be an important determinant of nurses' retention. Another important reason to correct for shift work is that failing to do so might lead to a downward bias on the wage effect. The problem arises as a result of how the wage variable is normally constructed. Nurses who work shifts will have incomes partly consisting of compensation for inconvenient working hours. If we divide the total income by the number of hours worked, we in effect get an average hourly wage. In this case a high wage might be the result of compensation for work outside normal hours. If shift work were considered a disadvantage, the effect of shift work would increase the exit rate. By including a covariate in our regression that measures the degree of shift work, we remove the effect of shift work from the wage variable, thus preventing an underestimated wage effect.

Second, our study departs from most other studies in this area in that we use data where we have information on hospitals as well as extensive individual information. This makes it possible to include in our analyses several objective measures on nurses' working conditions, together with other more general descriptions of the hospitals.

Third, using administrative data compared to survey data has some obvious advantages. Rather than relying on individual retrospection, the researcher is able to construct case histories based on information collected for bureaucratic reasons. Individuals will less precisely recall some exactly recorded information, such as earnings and hours worked. The presence of measurement error in survey data is confirmed in many studies, e.g. Poterba and Summers [7] and Bollinger [8]. Also, problems resulting from sample dropouts that are often encountered in surveys are to a large extent avoided.

The paper is organised as follows. Section 2 describes the data used in the study and provides summary statistics, while the econometric specification is discussed in section 3. In section 4 the results from the regressions are reported, and we conclude the paper in section 5.

Data

Our data set consists of administrative data from different sources. Information on wages, occupation and working time is taken from the Norwegian Association of Local and Regional Authorities (NALRA) personnel register. This register includes information on all individuals working in the health sector in Norwegian counties and municipalities. Since one of our aims in this paper is to study nursing retention using both individual and firm specific data, we had to exclude from our sample individuals working in the health services in the local councils. The reason is that our data does not provide institutional information about local municipalities. We therefore restrict our analysis to trained nurses working in hospitals.

Except for five specialised private hospitals representing less than 1 percent of the total number of hospital beds [9], hospitals in Norway are primarily in the public sector. Two large hospitals, the National Hospital of Norway (Rikshospitalet) and the National Cancer Hospital (Radiumhospitalet), and a few small and highly specialised hospitals are owned by the national health authorities. The counties own other public hospitals, and this means that most major Norwegian hospitals report information to the NALRA register. However, data from the different hospitals may vary in terms of detail. Most importantly, about 40 percent of the hospitals do not provide information on the degree of shift work among the nurses. As this aspect of the job presumably is an important determinant for whether a nurse leaves the public health sector, we exclude individuals working in these hospitals from our sample. Our sample then consists of nurses working in 34 different hospitals. To assess how representative the sample is, we compare the 34 hospitals in our sample to all the hospitals in the NALRA register (58). Table 1 shows that the means and standard deviations of the variables are quite similar for county and local hospitals. For university hospitals the differences are larger, but the means are not statistically different by a *t* test. This indicates that the 34 hospitals constitute a fairly representative sample.

(Table 1 about here)

After dropping individuals with missing observations, our final sample consists of 5284 nurses registered as working in a hospital on 1 January 1993. The reason why we use a stock sample is mainly due to different reporting practices in the hospitals. Some hospitals report the date the actual job starts, while others report the first date the individual starts working for the county. This makes it difficult to decide the exact start of a spell.

Previous labour market research has shown that males and females behave quite differently in the labour market, and we therefore restrict our analysis to female nurses. In Norway most nurses are eligible to early retirement at the age of 62. Because we did not want to include in the sample persons who leave nursing due to early retirement, women older than 57 are excluded from the analyses. We have data for the years until 1997, inclusive, and can therefore track the individuals for a maximum period of five years.

As our focus is on the transition out of the public health sector, nurses who leave a hospital job for work in the local council health service are treated as censored. Nurses who leave a job in one hospital for a job in a new hospital, are treated in two different ways depending on whether the new hospital is in the NALRA register or not. If a county owns the new hospital and the hospital provides full information to the NALRA register, the new job is treated as a continuation of the former job. If, on the other hand, the new hospital is not in the NALRA register, or the hospital does not provide full information to the register, these observations are treated as censored. In total, the number of censored individuals is 669.

Two types of events are defined as transitions out of the public health sector. Firstly, a nurse is registered as leaving the health sector if the spell ends in a transition out of the labour force, and she stays out of the labour force for at least one year. The reason for using a period of one year is to avoid recording a transition for nurses who are on leave. In the public sector, educational and casual leave is normally given for a maximum period of one year, while the maternity leave is of maximum 52 weeks. Secondly, if the nurse is registered as starting a job outside the public health sector, a transition out of nursing is recorded. In total this gave 854 transitions, which means that 16.2 percent of the nurses left the public health sector during the five year period. The number of transitions and censorings in each time period is reported in Table 1 of the appendix.

The data from the NALRA register does not include information about children and spouse characteristics, or on hospitals or place of residence. We have therefore merged these data with data from Statistics Norway. Table 2 provides definitions and descriptive statistics for the covariates used in the analysis. The covariates are all time dependent but only change value once a year.

(Table 2 about here)

Hourly wages are calculated using basic income and all bonuses. Bonuses include compensation for evening, night and weekend duties and overtime. We have argued that the degree of shift work probably is an important determinant for retention. However, we do not have information on the actual number of hours worked outside normal hours. As an approximation we use the variable «share bonuses». This is the share of total monthly income that a nurse receives as compensation for shift work, and we believe that this variable is a very close substitute for the exact magnitude of individual shift work.

We divide the nurses in the sample into three categories. Nursing specialists are nurses with at least one year of specialist training, in for instance anaesthesia, surgery or intensive care. Leading nurses are nurses who are in charge of a hospital ward or a larger hospital unit. Staff nurses constitute the last category.

Centrality indicates the geographical position of the municipality in relation to larger urban settlement. The classification it is based on travelling time to a centre where a higher order of central functions is found [10]. «Centrality level 1» consists of the least central municipalities, whereas the most central municipalities are found in «Centrality level 4».

Model specification

As in many studies on turnover and retention [11, 12], we apply a hazard rate approach in this paper. To study what affects nurses' propensity to leave the public health sector, we use a semi-parametric estimation procedure. As opposed to a parametric approach, such as a Weibull specification, in this method it is unnecessary to make parametric assumptions concerning the hazard's time dependency. This has the advantage that it prevents inconsistent estimation of the coefficients due to a misspecified baseline hazard, and it also provides a non-parametric estimate of the baseline hazard.

Our sample consists of the stock of nurses employed in a hospital on 1 January 1993. This implies that nurses in our sample are likely to have longer average spell lengths than nurses in the population. The reason is that nurses who have stayed in work for, say, the last ten years before 1993 will be present in our sample, while nurses who have quitted during the same time period will not. Therefore the likelihood function requires conditioning on survival at least until 1 January 1993. However, as shown by Allison [13] and Jenkins [14], this conditioning is easily done in a discrete-time hazard model.

We divide the calendar time into three-month periods. Since we observe our sample until 31 December 1997, this gives twenty periods of observation. Let $t = t$ index the first period (the sampling period). Period $t = 1$ is the period a nurse starts working in a hospital, where $1 \leq t$. Further, we define $d_i = 1$ for nurses who leave the public health sector during our observation period and $d_i = 0$ for those still in the public health sector after twenty periods. For nurses who quit we denote the length of the current spell s_i so $t = t + s_i$ is the calendar time of the spell end. Otherwise s_i denotes the period of censoring.

The discrete-time hazard rate is the probability that a nurse leaves the health sector in period *t*, conditional on survival until this period:

$$h_{it} = \text{prob}(T_i = t \mid T_i \geq t;) \qquad (1)$$

where T_i is a discrete variable representing the time at which the spell ends. The probability of surviving any period after having survived the preceding period is $(1 - h_{it})$. Therefore the total likelihood contribution of a nurse with exit in period s_i is:

$$\text{prob}(T_i = t + s_i) = \prod_{t=1}^{t-1}(1 - h_{it}) h_{i\,t+s_i} \prod_{t=t}^{t-1+s_i}(1 - h_{it}) \qquad (2)$$

To get the likelihood contribution for a nurse who is only observed from period t to period s_i, as is the case in our sample, we have to condition on survival up to period

$t-1$. From the law of a conditional probability, this means dividing (2) by $\prod_{t=1}^{t-1}(1-h_{it})$. Then the conditional probability of observing a nurse with an exit becomes:

$$\text{prob}(T_i = t + s_i \mid T_i > t - 1) = h_{i\,t+s_i} \prod_{t=t}^{t-1+s_i}(1-h_{it}) = \left[h_{i\,t+s_i} / (1-h_{i\,t+s_i})\right] \prod_{t=t}^{t+s_i}(1-h_{it}) \qquad (3)$$

In the same way the conditional probability of observing a nurse with no exit during twenty periods of observation is:

$$\text{prob}(T_i > t + s_i \mid T_i > t - 1) = \prod_{t=t}^{t+s_i}(1-h_{it}) \qquad (4)$$

Because of this «cancelling» of terms, the likelihood contribution depends only on hazard rates and data for the periods actually observed. By defining a variable $y_{it} = 1$ if $t = t + s_i$ and $d_i = 1$, and $y_{it} = 0$ otherwise, the likelihood function becomes:

$$\log L = \sum_{i=1}^{n} \sum_{t=t}^{t+s_i} y_{it} \log\left[h_{it} / (1-h_{it})\right] + \sum_{i=1}^{n} \sum_{t=t}^{t+s_i} \log(1-h_{it}) \qquad (5)$$

To estimate this model we have to choose a specification for the hazard rate. A commonly used specification is the complementary log-log (extreme value). This specification has the advantage that it may be derived from the continuous-time proportional hazards model [14]. Introducing explanatory variables, this model is

$$h_{it} = 1 - \exp\{-\exp[q(t) + ß'\mathbf{X}_{it}]\} \Leftrightarrow \log[-\log(1-h_{it})] = q(t) + b'\mathbf{X}_{it} \qquad (6)$$

where $\mathbf{X}_{it}$ is a vector of possibly time-varying cavariates, b is a coefficient vector and $q(t)$ provides the parameterisation of the baseline hazard. As mentioned earlier, we choose a flexible semi-parametric form for the baseline hazard, where $q(t)$ is represented by dummy variables for each time period of the sample.

One important assumption so far has been that all heterogeneity is due to observed variables. It is well established that failures to control for unobserved heterogeneity could produce a downward bias in the estimate of the baseline hazard, and also bias the parameter estimates for the covariates (Lancaster [15]). To control for unobserved heterogeneity in the model, we assume that an unobserved random variable e_i, which is time constant and independent of the observed covariates, enters the hazard. Eq. (6) then becomes:

$$\log[-\log(1-h_{it})] = q(t) + b'\mathbf{X}_{it} + e_i \tag{7}$$

Estimation of this model (often called frailty or mixture model) requires an explicit assumption about the distribution of this unobserved variable. In most applications a gamma distribution is chosen. This distribution is convenient because the probability density function yields a closed form expression for the likelihood [16].

Heckman and Singer [17] suggest a semi-parametric alternative where the unknown distribution of the unobserved heterogeneity term is approximated by a discrete multinomial distribution. The mass points and corresponding probabilities of this distribution can be jointly estimated with other parameters of the model. Estimating the discrete number of mass points, *J*, is complicated, and we adopt the practical approach to estimate the model for increasing values of *J* until the likelihood fails to increase. To estimate the two heterogeneity models, we used Stata programs written by Jenkins [18] and Rabe-Hesketh [19].

Finally, it should be noted that correcting for unobserved heterogeneity in a stock sample implies that the assumptions regarding the distribution of the error term e_i must be with respect to the sample and not with respect to the population [20, 14].

Results

Before we discuss the effect of covariates on the duration hazard, a look at some nonparametric estimates is also instructive. In the analysis the time scale is divided into three-month intervals. Therefore the first point on the graphs corresponds to the transition probability in January, February and March, the second point to the transition probability in April, May and June, and so forth. In Figure 1 we have plotted the Kaplan-Meier hazard rate. Seemingly there are some seasonal differences in the risk of leaving nursing. A possible explanation for the relative high risk in the period July, August and September could be that nurses quit in connection with their summer holyday.

(Figure 1 about here)

In Figure 2 we have plotted the estimated baseline hazards for the model with no correction for unobserved heterogeneity, and for the model with Gamma correction. Since the baseline hazard for the model with non-parametric correction almost exactly overlapped the graph for the model with Gamma correction, this is not plotted. We notice that the shape of the baseline hazard resembles the Kaplan-Meier estimates but the baseline hazards are much lower than the empirical hazard rate. Looking at the Kaplan-Meier estimates, the overall hazard rate seems to exhibit negative duration dependence. However, it is well known that not correcting for heterogeneity (observed and unobserved) leads to incorrect results in duration analysis due to the fact that the proportion of «stayers» in the risk set increases over time [15]. Even if this problem should be less pronounced when using a stock sample, we see that introducing heterogeneity flattens the baseline hazards.

(Figure 2 about here)

In Table 3 we present results of importance for model selection. The Gamma heterogeneity model can be compared with the model without heterogeneity by testing the significance of the variance parameter in the Gamma distribution, or by a likelihood ratio test. The estimated Gamma variance has a t-ratio of 3.24 and the LR statistic is 15.15. Thus both tests indicate that introducing Gamma heterogeneity into the model improves the model fit significantly. The model with non-parametric heterogeneity is estimated using two mass-points. Introducing a third mass point in the model resulted in only a marginal increase in the likelihood value. We therefore conclude that the unobserved heterogeneity can be best explained by a two-point distribution of the stayer-mover type. The estimated support points were –0.45 and 2.25 with associated probability masses of 0.84 and 0.16, respectively. This model can also be compared to the model without heterogeneity by a LR test. In this case we get a

LR statistic of 16.28, implying that the model with no heterogeneity correction is again rejected. Since the two heterogeneity models are mutually non-nested, we use the Akaike information criterion (AIC) and Bayesian information criterion (BIC) for model selection. As shown in table 3, the Gamma model is the preferred model, and in what follows we discuss these results.

(Table 3 about here)

The effects of covariates on the duration hazard are reported in Table 4. We find that the exit rate from the public health sector decreases in wages. An increase in the wage by 1 NOK decreases the hazard by 3.4 percent for staff nurses. The interactions «Wage*Nursing specialist» and «Wage*Leading nurse» demonstrate that the wage effect is somewhat smaller for these groups. As expected the exit rate increases in the degree of shift work («Share bonuses»). The relatively large positive effect indicates that a specification without this variable will result in a biased estimate of the wage effect. As an informal test we estimated the model with Gamma heterogeneity without «Share bonuses». With this specification a marginal increase in the wage will decrease the hazard for staff nurses by only 1.6 percent, which clearly demonstrates that ignoring shift work has a large unwarranted impact on the wage effect.

(Table 4 about here)

Most previous studies find that tenure and the probability of quitting are inversely related. An explanation for this could be that longer tenured employees have more firm specific human capital invested in the organisation and therefore are more reluctant to leave the organisation than those with less tenure. In this study we do not use a direct measure of tenure, but years of experience. Tenure and experience are in general highly correlated, however, and as expected we find that experience decreases the hazard rate out of nursing. The age effect works in the opposite direction. Nurses have a higher exit rate the older they are. The probability of exit is decreasing with age, however, with a turnaround at an age of 41 years.

Our findings further indicate that the propensity to leave nursing is non-linear in working hours. Nurses in full time positions constitute the reference category, and compared to them nurses in half-time positions or less («Part time 1») have higher exit rates. Nurses in the categories «Part time 2» and «Part time 3» seem to have lower exit rates than those working full time.

Some recent studies have focused on the effect of working conditions on job satisfaction, and also on how job satisfaction determines nurses' exit pattern [4, 21]. These studies typically find that poor working conditions, by affecting job satisfaction, constitute major contributors to turnover among nurses. Since we use register data in this study, we do not have information on self-assessed working conditions or job satisfaction. We believe, however, that hospital specific variables like «Occupancy rate», «Beds per nurse» and «Length of stay» constitute objective measures on the working conditions of the respective hospitals. It is reasonable that high occupancy rates, as well as relatively many hospital beds per nurse, lead to lower job satisfaction due to stress, while the length of stay influences job satisfaction in the opposite direction. Since these variables are constant within hospitals, however, they cannot fully substitute for individual data. Neither do these variables take outpatient activities into account. As expected we find that nurses working at hospitals with high occupancy rates or a relatively large number of hospital beds per nurse are more inclined to leave nursing than other nurses. In hospitals where patients stay for a relatively long period, the exit rates from nursing are lower than elsewhere. Turning to the other hospital related variables, we find that nurses working in a local hospital have a significantly lower exit rate than those working in a university/regional hospital or a county hospital. After controlling for type of hospital, there seems to be a tendency that nurses working in large hospitals (measured as number of beds) leave nursing at a higher rate than nurses working in smaller hospitals.

It is also interesting to notice that introducing interactions on wage have a large impact on the estimated exit rates of different skill categories. In a model without interactions (not reported) we find higher exit rates for nursing specialists and leading nurses. However, after correcting for wages having different effects on different groups of nurses, it turns out to be the case that nursing specialists and leading nurses have considerably lower exit rates.

Turning to the family related variables, we find somewhat unexpectedly that nurses having children younger than 7 years of age do not have a significantly higher hazard rate out of nursing than others. A possible explanation for this could be that the relatively flexible labour market for nurses makes it possible to reduce the labour supply for a period, instead of quitting. Nurses with children older than 7 years seem to have lower exit rates than nurses without older children. These results therefore indicate that having children act as a stabilising influence on nurses' job mobility. The same holds true for marriage. Married nurses seem to have a lower exit rate out of nursing than unmarried nurses. As expected, non-labour income works in the opposite direction. Our results indicate that both capital income and spouse's income increase the exit but the effect of these variables are rather small in magnitude.

For interpretation of the results it should be noted that we only analyse a single spell for each nurse in our sample. Nurses who have left a hospital (due to censoring or exit) might return to the initial state at a later time. However, this problem goes beyond the scope of a single spell model. Therefore, we cannot necessarily interpret the results as the «total risk» of leaving the public health sector within the observation period.

Conclusions

The aim of this study has been to contribute to a better understanding of nurses' decision to leave the public health sector. The public debate has focused on the importance of wages and working conditions as relevant policy tools and we discuss in particular whether these factors can reduce the number of nurses leaving the profession. We focus on nurses working in hospitals and estimate single spell duration models with unobserved heterogeneity to describe the exit process. Our sample comes from a large administrative data set containing detailed information on both individuals and hospitals.

Working conditions are measured by hospital specific variables indicating nurses' workload. Nurses working at hospitals with a high occupancy rate or a relatively large number of hospital beds per nurse have higher exit rates than other nurses. In hospitals where patients stay for a relatively long period, the exit rates are lower than elsewhere.

Previous economic research finds small effects of wages on nursing retention. These results indicate that solving the excess demand by increasing wages might be expensive, if not impossible. In this study, however, we show that previous studies probably underestimate the wage effect because they do not correct for the fact that nurses' income partly consists of compensation for shift work. In our particular data set, failing to correct for shift work led to an underestimated wage effect of more than 50 percent. Thus, wages as well as working conditions seem to be important in keeping nurses in the profession.

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Tables

Table 1. Sample hospitals compared to all hospitals in the NALRA register.

	University/central hospitals		County hospitals		Local hospitals	
	Sample	Population	Sample	Population	Sample	Population
Number of beds	451.1	574.1	138.0	142.9	77.4	77.3
	(236.1)	(158.5)	(81.6)	(110.5)	(35.7)	(30.1)
Beds per nurse	0.88	0.83	0.94	0.90	1.00	1.09
	(0.11)	(0.10)	(0.17)	(0.13)	(0.30)	(0.30)
Number of nurses	541.2	613.4	153.5	152.8	87.4	85.6
	(284.7)	(277.7)	(99.4)	(91.1)	(56.1)	(54.0)
Length of stay	6.44	6.53	6.19	6.29	5.65	5.72
	(0.84)	(0.70)	(0.85)	(0.83)	(0.49)	(0.60)
Occupancy rate	0.89	0.88	0.80	0.79	0.85	0.84
	(0.08)	(0.07)	(0.09)	(0.08)	(0.14)	(0.13)
N	8	18	14	19	12	21

Table 2. Variable definitions and descriptive statistics.

Variable name	Definition	Mean	S.D
Wage	Hourly wage including all bonuses (public holiday bonus, late duty bonus, etc.) in NoK	144.17	23.35
Share bonuses	Share of the wages that are bonuses due to late, night and weekend duties.	11.18	7.34
Position	Respondent working as:		
	Staff nurse	0.54	0.50
	Nursing specialist	0.33	0.47
	Leading nurse	0.13	0.34
Centrality:	Measures a municipality's geographical position related to the nearest centre with central functions		
	Centrality level 1 (least central)	0.12	0.32
	Centrality level 2	0.11	0.31
	Centrality level 3	0.39	0.49
	Centrality level 4	0.38	0.49
Years of experience	Years with income above basic counting unit in pension system (NoK 37033 in 1993)	16.22	6.36
Age	Respondent's age in 1993	36.76	7.93
Age^2	Age squared	1724.1	647.7
Part time / Full time	Respondent working:		
	Part time 1 (0 – 0.5 percent of full time)	0.22	0.41
	Part time 2 (0.51 – 0.75 percent of full time)	0.27	0.44
	Part time 3 (0.76 – 0.99 percent of full time)	0.10	0.29
	Full time	0.41	0.50
Capital income	Capital income respondent and spouse/1000 NoK	16.18	101.69
Spouse income	Spouse's gross income/1000 NoK	193.16	173.49
Children > 7	1 if the respondent has children older than 7, 0 otherwise	0.29	0.45
Children < 7	1 if the respondent has children younger or equal to 7, 0 otherwise	0.41	0.49
Married	1 if the respondent is married or cohabitant with children, and 0 else	0.71	0.45
Hospital type:	Respondent working at a:		
	University/central hospital	0.53	0.50
	County hospital	0.31	0.46
	Local hospital	0.16	0.37
Number of beds	Total number of beds set-up and staffed for use	357.58	281.66
Length of stay	Total inpatient days/number of beds	6.27	0.87
Occupancy rate	Total inpatient days*100/effective beds*365	0.86	0.09
Beds per nurse	Total number of beds last year/total number of nurses last year	0.84	0.15
Sample size			5284

Table 3. Model selection.

		No heterogeneity	Gamma heterogeneity	Non-parametric heterogeneity
Gamma variance			2.88 (3.24)	
Mass point 1	probability			0.84 (5.99)
	value			-0.45 (-2.76)
Mass point 2	probability			0.16
	value			2.25
Information criteria tests:				
AIC[1]		8900.1	8886.4	8889.2
BIC[1]		9330.8	9326.5	9348.0
Log-likelihood		-4404.03	-4396.21	-4395.60

[1] AIC = -2 log(L) + 2K, BIC = -2log(L) + K log (N), where L, K and N are the maximised likelihood, number of parameters and number of observations, respectively.

Table 4. Proportional hazard model with non-parametric baseline hazard. Maximum likelihood estimates.

	No heterogeneity		Gamma heterogeneity		Non-parametric heterogeneity	
Variable	Hazard ratio	95% Conf. interval	Hazard ratio	95% Conf. interval	Hazard ratio	95% Conf. interval
Years of experience	0.9276***	0.9085 – 0.9471	0.9032***	0.8753 – 0.9321	0.9061***	0.8803 – 0.9325
Age	1.2064***	1.0954 – 1.3286	1.2880***	1.1285 – 1.4700	1.2604***	1.1101 – 1.4310
Age^2	0.9977***	0.9965 – 0.9989	0.9970***	0.9954 – 0.9986	0.9972***	0.9957 – 0.9987
Wage	0.9731***	0.9664 – 0.9799	0.9659***	0.9576 – 0.9743	0.9658***	0.9578 – 0.9740
Wage*Nursing specialist	1.0064*	0.9990 – 1.0141	1.0062	0.9973 – 1.0152	1.0069	0.9979 – 1.0159
Wage*Leading nurse	1.0146***	1.0054 – 1.0240	1.0176***	1.0063 – 1.0290	1.0175***	1.0063 – 1.0289
Share bonuses	1.0464***	1.0262 – 1.0670	1.0620***	1.0370 – 1.0877	1.0614***	1.0372 – 1.0861
Part time 1[a]	1.2472**	1.0221 – 1.5220	1.4554***	1.1221 – 1.8877	1.4420***	1.1164 – 1.8626
Part time 2[a]	0.7250***	0.5891 – 0.8924	0.7217***	0.5641 – 0.9234	0.7116***	0.5535 – 0.9148
Part time 3[a]	0.8468	0.6541 – 1.0962	0.8998	0.6637 – 1.2200	0.8791	0.6443 – 1.1996
Capital income	1.0007***	1.0003 – 1.0010	1.0005**	1.0000 – 1.0010	1.0006**	1.0001 – 1.0012
Spouse income	1.0007***	1.0003 – 1.0011	1.0008***	1.0003 – 1.0014	1.0008***	1.0003 – 1.0014
Children > 7	0.6947***	0.5810 – 0.8308	0.6317***	0.4997 – 0.7987	0.6394***	0.5082 – 0.8045
Children < 7	1.1194	0.9278 – 1.3501	1.2236	0.9527 – 1.5716	1.2089	0.9382 – 1.5578
Unmarried	1.1314	0.9516 – 1.3451	1.2604*	0.9912 – 1.6027	1.2298*	0.9777 – 1.5469

Table 4. (Continued)

	No heterogeneity		Gamma heterogeneity		Non-parametric heterogeneity	
Variable	Hazard ratio	95% Conf. interval	Hazard ratio	95% Conf. interval	Hazard ratio	95% Conf. interval
Nursing specialist	0.4959	0.1695 – 1.4505	0.5631	0.1561 – 2.0314	0.5115	0.1411 – 1.8540
Leading nurse[b]	0.1913**	0.0527 – 0.6941	0.1403**	0.0297 – 0.6629	0.1428***	0.0301 – 0.6775
University hospital[c]	1.8692***	1.3396 – 2.6084	2.1959***	1.4127 – 3.4131	2.1085***	1.3388 – 3.2008
County hospital[c]	1.6915***	1.2447 – 2.2989	1.7885***	1.2109 – 2.6416	1.7241***	1.1303 – 2.6298
Occupancy rate	1.0401***	1.0296 – 1.0508	1.0438***	1.0311 – 1.0567	1.0431***	1.0307 – 1.0556
Beds per nurse	1.9679**	1.1613 – 3.3350	2.4792***	1.2453 – 4.9358	2.2846***	1.1810 – 4.4194
Length of stay	0.8144***	0.7099 – 0.9343	0.7953***	0.6709 – 0.9428	0.8050***	0.6808 – 0.9528
Number of beds	0.9083***	0.8595 – 0.9599	0.8674***	0.8046 – 0.9350	0.8662***	0.8049 – 0.9321
Centrality level 1[d]	0.7651	0.5405 – 1.0829	0.6906	0.4438 – 1.0746	0.7398	0.4569 – 1.1980
Centrality level 2[d]	0.6017***	0.4321 – 0.8380	0.5442***	0.3575 – 0.8284	0.5839**	0.3735 – 0.9128
Centrality level 3[d]	1.1480	0.8293 – 1.5892	1.3483	0.8851 – 2.0539	1.4235	0.9190 – 2.2051
Log Likelihood	-4404.03		-4396.21		-4395.60	

Reference categories: [a)] Full time, [b)] Staff nurse, [c)] Local hospital and [d)] Centrality level 4.

Figures

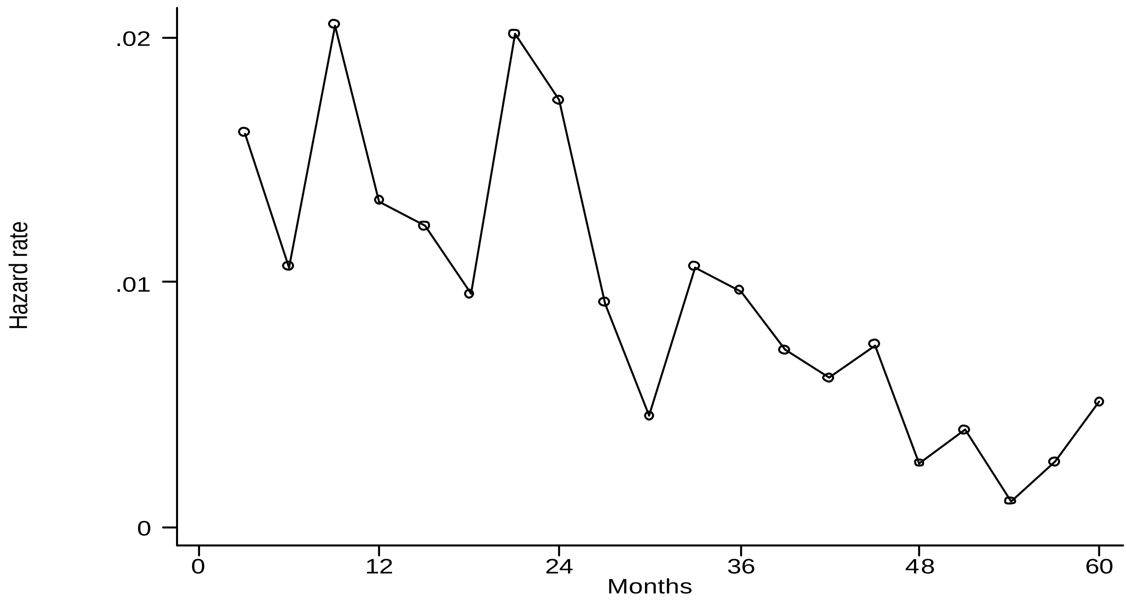

Figure 1. Kaplan-Meier estimates.

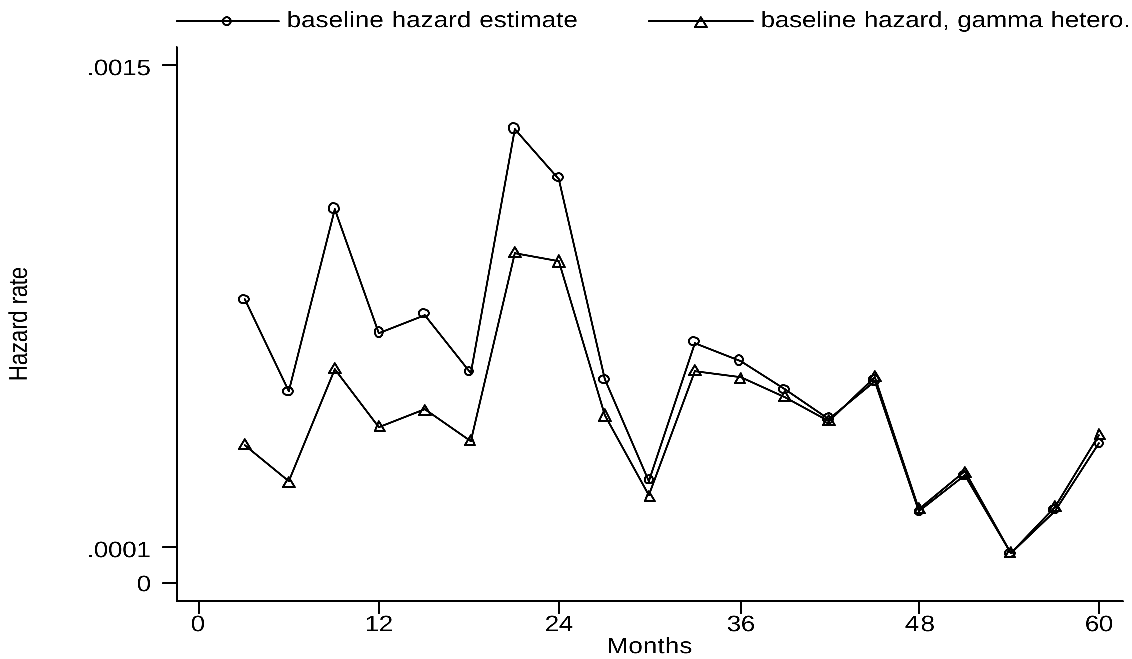

Figure 2. Baseline hazard functions.

Appendix

Table 1. Estimated baseline hazard, individuals at risk, exits and censoring, by period.

Period	At risk	Exits	Censored	Baseline hazard	Z-values
1	5284	84	73	-7.107	-6.601
2	5127	54	30	-7.499	-6.935
3	5043	102	88	-6.828	-6.363
4	4853	64	35	-7.230	-6.719
5	4754	58	38	-7.159	-6.588
6	4658	44	33	-7.404	-6.785
7	4581	91	74	-6.633	-6.148
8	4416	76	32	-6.749	-6.238
9	4309	39	37	-7.440	-6.579
10	4233	19	25	-8.128	-7.080
11	4094	44	51	-7.269	-6.435
12	3999	39	23	-7.349	-6.499
13	3937	29	21	-7.488	-6.461
14	3887	24	21	-7.654	-6.581
15	3842	29	34	-7.445	-6.420
16	3779	10	8	-8.489	-7.123
17	3761	15	11	-8.080	-6.748
18	3735	4	11	-9.394	-7.368
19	3720	10	12	-8.474	-6.972
20	3698	19	12	-7.817	-6.569

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