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Random effects Weibull regression model for occupational lifetime

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Abstract

High job turnover rate can cause many problems and each company needs proper strategies to prevent the brain-drain of its manpower. For effective human resource management, predicting the occupational life expectancy or the mean residual life of those who are to leave and join another company is important. In this paper, we propose a random effects Weibull regression model for forecasting the occupational lifetime of the employees who join another company, based on their characteristics. Advantage of using such a random effects model is the ability of accommodating not only the individual characteristics of each employee but also the uncertainty that cannot be explained by individual factors. We apply the proposed model to the occupational lifetime data obtained from the company affiliated to general trading in Korea. From our analyses, we can infer the characteristics of those who have a relatively longer occupational lifetime as follows: the managing director level, relatively old, those who entered the company earlier, high school graduates, those who were involved in technical service, and married female employees. Accordingly, effective human resources management policy is necessary to retain those who are good but want to leave and those who stay but need more improvement for the betterment of the company.

Keywords: Reliability; Occupational lifetime; Turnover rate; Survival analysis; Random effects Weibull model; Mean residual life

1. Introduction

Effective human resource management is a matter of great importance to a company. According to the investigations of the National Statistical Office of Korea, the industry turnover rate is on an increasing trend in Korea since 2000. Moreover, it is reported that the turnover rate is very high after six months of employment and about 60% of university graduates take another job within 2 years of their first employment. According to The Federation of Korean Industries (2003), the turnover rate displays regional disparity and turnover rate of males is higher than that of females. It is also reported that a frequently observed time to departure is

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3–4 years after their employment. As reflected by these statistics, companies suffer from the separation of employees, which cause instability and significant economic loss.

Much of this kind of loss can be avoided by predicting the occupational lifetime based on the employees' characteristics and applying proper precautions according to their characteristics. Note that other methodology such as structural equation model (Currivan, 1999; Kim, 1999), and discriminant analysis (Williams, 1999) have been applied for turnover research. But they have not considered the occupational lifetime.

Most of the existing survival models for occupation dealt with fixed effects regression models where parameters of a life distribution is modeled based on employees' characteristics (McClean, 1991; Oakes, 1983). Moncrief and Lucas (1990) observed through the use of survival analysis that part-time sales people are becoming an important strategic sales tool for many firms and industries. Spiceland et al. (1992) used survival analysis to track the intensity of turnover rate over time among auditors with professional training in accounting. However such a fixed regression effect model cannot explain the situation where individuals with the same characteristics exhibit different occupational life expectancy. Accordingly, in this paper we propose a random effects Weibull model.

Using random effects Weibull model, Chen (2002) analyzed a lifetime of US petroleum refining plants for the 1981–1986 period, when the industry as a whole declined in response to the decontrol of crude oil markets. The purpose was to examine the duration dependence and determinants of post-deregulation plant lifetimes. The Weibull model with correction for unobserved individual heterogeneity provided a better fit to the data than the fixed effects Weibull model. Empirical results showed that plant size, age, regulatory subsidies, technology use, and multiplant coordination are the key determinants of refinery life duration after deregulation. Moreover, Zhang and Meeker (1995) suggested simple closed form expressions for the relationship between the needed number of failures and the precision criteria using a Bayesian design and a Weibull survival function. The advantage of using such a random effects model for life analysis is that one can consider not only the individual characteristics but also uncertainty that cannot be explained by such characteristics.

In this paper, we propose a random effects Weibull regression model where an inverse gamma distribution is used for the random effects of uncertainty. Use of inverse gamma distribution enables to explain the very heterogeneous behavior of the employers with similar characteristics.

Using our proposed model, it is expected that the companies can prevent brain-drain by forecasting the mean residual lifetime of employees. Additionally, it can contribute to the effective management of the human resources of a company in the long run.

The organization of this paper is as follows. In Section 2, we set up the research hypotheses and introduce a random effects Weibull model. In Section 3, we conduct an empirical data analysis. Finally in Section 4, we discuss the results of our study.

2. Random effects Weibull model

Occupation turnover phenomena are mainly caused by (1) employees who are dismissed or retire from the company, (2) employees who quit for their own personal matters such as continuing education or health problems, and (3) employees who quit their current job to join another company. In this study, we only focus on the last category of employees.

We set up the following research hypotheses.

Hypothesis 1. The occupational lifetime of younger employees with higher educational background would be shorter than their counterpart.

Hypothesis 2. Job evaluation results and duties would be influential on the occupational life expectancy.

Hypothesis 3. Turnover rate of males is higher than that of females.

It is based on the findings of The Federation of Korean Industries (2003).

In testing the hypotheses, we assume that occupational lifetime follows a Weibull distribution which flexibly fits various kinds of lifetime data (Elsayed, 1996). Xie and Lai (1995) suggested effective models using Weibull survival functions. Bayus (1998) applied Weibull distribution to describe the product lifetimes of desktop