Establishing and Closing Down Plants - Assessing the Effects of Firms' Financial Status[*]

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Abstract

This paper analyzes whether the financial characteristics of firms have an effect on their decisions to open and close down plants. Using a rich firm-level data set the study considers different variables describing firms' indebtedness, solvency, asset structure and profitability. Furthermore, the paper analyzes the possibility of unobserved heterogeneity. The results show that firms' current financial status plays an important role in the plant closure decision, whereas, the decision to establish a new plant is more affected by past financial conditions. In addition, the study finds evidence on the presence of unobserved heterogeneity.

Keywords: Financial status of firms, decision to establish and close down plants, unobserved heterogeneity

JEL Classifications: L1, L6, G3

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1 Introduction

A firm's decision to establish a new plant may be considered as a large investment, whereas, the decision to close down an existing plant may be viewed as an extreme case of disinvestments. Such decisions are often seen as a part of a selection process where firms with productive investment projects expand and firms owning unproductive plants are forced to close down their plants. This process facilitates industrial restructuring and thus enhances aggregate productivity growth. Moreover, job creation and destruction are closely related to the firms' decisions to open and close plants. Consequently, the analysis of factors determining these investment decisions has important implications for employment and industrial policy.

Over the recent decades, there has been an increasing interest in the role of financial constraints in determining firms' investment.[1] The research in this field has typically not distinguished between different types of investment activities. However, firms' decisions to open and close plants are likely to be especially affected by the financial constraints. The aim of this paper is to study whether the financial characteristics of firms affect these decisions.

There are reasons to believe that firms' financial status may influence their decisions to establish and close down plants given the firms' growth opportunities. Myers (1977) suggests that the level of debt has a negative impact on the investment policy of a firm as highly indebted firms may be unable to raise funds to finance large new investment projects or may be even forced to exit the market. It may also be argued that highly leveraged firms are likely to be more vulnerable to competition than their less leveraged "deep pocket" incumbents. Thus, they may be exposed to predation and even forced to exit the market. Financial constraints may also be desirable in the sense that they may reduce the investment on unproductive projects and force inefficient firms to liquidate.[2] According to these theories the study should find a negative effect of firms' indebtedness on plant creation and a positive effect on plant closure.

There are also alternative theories suggesting a negative (positive) relationship between firms' decisions to close plants (firm survival) and the high degree of leverage. Jensen (1989) proposes that highly leveraged firms may be forced to restructure sooner than their competitors and thus their probability to survive may be higher than that of their competitors. The positive relationship between survival and indebtedness may also result from the fact that a highly leveraged firm may have an aggressive investment policy due to limited liability enjoyed by equity as suggested by Brander and Lewis (1986).

[1] See Hubbard (1998) for literature review on investment and financial constraints.
[2] See, e.g. theoretical studies by Jensen (1986) and Harris and Raviv (1990).

Most of the empirical research on financial constraints and investment focuses on publicly quoted firms. However, firms that are not traded at the stock exchange are likely to be financially more constrained, as they may not have access to external financing. In particular, they may have fewer possibilities to issue equity. This study seeks to contribute to the literature by examining all types of firms with three or more employees. Moreover, the study looks at a wide range of financial factors which may be considered to reflect firms' financial status and constraints.

The empirical analysis is based on a rich data set on Finnish manufacturing sector including information on various firm-specific characteristics, as well as, factors reflecting performance and conditions at the industry and aggregate level. In particular, it includes information on firms' financial status as provided by firms' financial statements.

In this study each firm is assumed to decide between establishing and closing plants, or continuing with the previous number of plants in each year of the study period. The fact that all the three choices are available allows us to analyze the probability of these choices using a multiple discrete choice model, namely the multinomial logit model. However, it may be thought that a firm's decisions to establish and close down plants are two separate questions and should be modeled separately. This approach may be justified by the view that firms closing down their plants are not usually planning to establish plants at the same time. In order to check the robustness of the results the econometric analysis is also conducted using binary choice models[3]. The results of these models (not shown here) are similar to those of the multiple choice models analyzed in this study.

Estimation of the multinomial logit model is based on the assumption that probabilities of the alternative choices are independent of each other. This property is called the independence from irrelevant alternatives (IIA). The validity of this assumption is tested using tests introduced by Hausman and McFadden (1984) and Small and Hsiao (1985). In order to relax the IIA assumption and to consider the possibility of unobserved heterogeneity a random effects model is introduced. To my knowledge there are no studies applying random effects multinomial model to analyze the effects of firms' financial characteristics on their decision-making.

The results show that financial status has an important role in determining firms' decisions to open and close plants. The paper finds evidence that a high level of debt increases the probability of a plant closure. Moreover, it is found that a high level of initial debt may become a financial obstacle for a firm intending to establish a new plant. It seems that the closure decision is based on the firm's recent

[3] The binary choice models are analyzed using both logit and probit models. The results are provided upon request.

financial conditions whereas the decision to open a plant is likely to be based on past financial conditions. Firms' profits are found to affect their decision to close down plants. Higher profitability tends to increase the probability to establish a plant and reduce the risk of plant failure. The study finds also evidence of the presence of unobserved heterogeneity. In particular, it is found that there is a strong positive correlation between the random effects for the decision to establish and close down plants.

Before drawing general conclusions from the effects of firms' financial status it is also useful to examine whether there are differences between the manufacturing and services. The results show that financial conditions are also important determinants of firms' decisions in the service sector. In particular, the indebtedness and structure of assets of the firms tends to have a significant impact on both their decision to establish and close down plants whereas the effect of profits is less significant.

The remainder of this paper is organized as follows. Section 2 provides the theoretical background for the study. Section 3 describes data and definitions used in the study. Sections 4 and 5 present the results of the econometric analysis of the factors affecting firms' decisions to establish and close down plants. Finally, conclusions follow in Section 6.

2 Theoretical Underpinnings

Conventional economic thinking is based on the idea that competition and free entry to an industry ensure a selection process where only the most efficient firms survive. Such a framework assumes perfect capital markets where firms' financial structure does not essentially have any real effects. A firm with productive investment projects should always be able to find funding, no matter how its balance sheet looks. This is the central result of the so-called Modigliani-Miller theorem (1958). Consequently, if the financial structure was irrelevant, the study should find that firms' financial characteristics do not affect their decision to establish and close down plants.

Over the recent decades several studies have recognized the need to extend the conventional theories to incorporate capital market imperfections. These theories are often based on informational imperfections in the capital markets which lead to the problems of adverse selection and moral hazard generating frictions in the financial markets. The main result of these theories is that in the presence of capital market imperfections firms may be forced to give up promising investment projects or even to close down plants.

Financial frictions are typically thought to have negative effects on firms' possibilities to establish new plants, invest and survive. Myers (1977) shows that highly indebted firms may not be able to finance large new investments and may be forced to close down profitable plants due to the so-called debt overhang. This implies that the senior debt claims of the firms are "too" high. If firms do not hold assets that can easily be used as collateral for new loans they do not have the possibility to borrow to finance their investment projects.

Alternatively, it may be thought that highly leveraged firms are more vulnerable to competition than their less leveraged "deep pocket" incumbents. Consequently, they may be exposed to predation and forced to exit from the market.[4] Predation may, thus, force indebted firms to lose their market share. Zingales (1998) argues that this effect should be present mainly in less competitive industries since only in the presence of barriers to entry can the predator recover the short-term cost of preying. He finds some evidence that highly leveraged firms are weaker competitors. Kovenock and Phillips (1997) show that indebted firms operating in industries with high concentration, i.e. less competition, are more likely to close down and less likely to invest.

The possibility that financial constraints prevent firms with promising growth opportunities from establishing new plants or force them to abandon productive plants is often thought to be undesirable. However, it may be argued that financial constraints improve general welfare and increase productivity by forcing inefficient firms to liquidate. Financial constraints may prevent overinvestment and help to reduce excess capacity in declining industries.

Jensen (1986 and 1993) argues that debt has beneficial effects on motivating managers and their organizations to be efficient. The central idea of Jensen (1986 and 1993) is that debt reduces the agency costs of free cash flow by reducing cash flow available for spending at the discretion of managers. In addition, increasing debt financing forces firms to raise funds from external capital markets and thus firms are more likely to be monitored by the capital markets. This control function is important in firms where managers have incentives to let the firm grow beyond the optimal size or where managers are reluctant to close down less productive operations.

Harris and Raviv (1990) emphasize the role of debt in forcing inefficient firms to liquidate. They postulate that managers are reluctant to liquidate firms under any circumstances and that they are also unwilling to provide investors with information that might lead to such an outcome. In their model, debt provides investors with information about the firm and its prospects. Investors use this information to decide whether to liquidate the firm or continue current operations. Thus, by providing

[4] See e.g. Bolton and Scharfstein (1990).

information about the firms, debt facilitates monitoring of the management. Following the above theories the hypothesis of this study should be that firms' indebtedness has a negative effect of on plant creation and a positive effect on plant closure.

However, there are also competing hypotheses. The argument that financial frictions cause firms to close unproductive functions may be used to support the view that frictions have a positive effect on the survival of firms. Jensen (1989) suggests that if highly leveraged firms are forced to restructure sooner than their competitors their probability to survive may be higher than that of their competitors. In this case, even the threat of not being able to make debt service payments may serve as a motivating force facilitating the process of restructuring. The positive relationship between survival and indebtedness may also result from the fact that a highly leveraged firm may have aggressive investment policy due to limited liability enjoyed by equity. Brander and Lewis (1986) model the effect of increase in debt in such a framework. In their model, firms' profits are affected by a random shock that increases profits in a good state and reduces profits in the bad state. They argue that due to the limited liability the shareholders of highly leveraged firms (who in this model act also as the managers of firms) have incentive to choose investment strategies that increase their profits in the good state and decrease the profits in the bad state. In other words, they increase the variation in firms' profits which increases their value of option-like claims on the firms' future profits.

Other variables than debt and the magnitude of debt service payments may be used as proxies for financial constraints. The empirical research in this field has used such variables as internal funds and a firm's age to measure financial constraints.[5] Young firms may be particularly likely to face financial obstacles since they have no past track record reducing the uncertainty about their quality. This is closely related to the view stressed by Diamond (1991) that an established reputation helps to raise external funds. Based on this approach the study should find that the age of a firm has a positive effect firms' decisions to open new plants and a negative effect on decision to close down old plants. However, it should be kept in mind that the age of a firm may also capture other characteristics of the firm and thus the analysis of the effects of age is not straightforward.

[5] Many of these studies have found that investment is significantly correlated with internal funds and that the correlation is most important for firms likely to face capital market frictions. However, there are also studies following Kaplan and Zingales (1997) who argue that the sensitivity of investment to cash flow is lowest for the firms a priori classified as "financially constrained" and that investment-cash flow sensitivities are not good measures of financial constraints.

3 Data and Definitions

The main source of data in this study is the Business Register on plants provided by the Statistics Finland. It allows following birth and death of plants and linking them to their owner firms. The Business Register includes all the Finnish firms and their plants which are registered as employers or subject to value added tax. However, there are some problems with longitudinal linkages due to changes in taxation and statistical practices which have affected the reliability of the information concerning the smallest plants in the Business Register. Therefore, the cut-off limit for the size of a plant has been set to three employees. An important additional data source is the Financial Statement Statistics. This database provides information on firms' balance sheets and thus allows for the analysis of the effects of firms' financial status on plant creation and destruction.

The variable controlling the aggregate business fluctuations, i.e. the GDP growth, is obtained from the FinStatistics also provided by the Statistics Finland. The data on aggregate financial conditions is from the International Financial Statistics of the IMF, and the statistics of the Bank of Finland. The industry-level data, except industry R&D expenditure, growth, concentration and entry rate, is obtained by aggregating data from the Longitudinal Database on Plants in Finnish Manufacturing (LDPM) to three-digit industry level. The R&D expenditure of industries is taken from the OECD ANBERD database whereas industry-level growth, concentration and entry rate are obtained by aggregating data in the Business Register. Appendix I provides a detailed description of the explanatory variables used in the study.

In order to analyze the full set of firms' choices the study focuses on firms with at least one existing plant. The data set is originally provided at plant level. This allows following individual plants over time which enables tracking of the "true" births and deaths of plants. However, the analysis of plant-level data does not reveal the firm-level decisions. Thus the data is aggregated to a firm level using identification codes which link plants to their owner firms. The firm-level data set includes information on the number of plants the firm owns and whether it has established a new plant or closed down a plant in a certain year.

Definition 1: Plant is defined as an economic unit that, under single ownership or control, produces similar goods or services, and usually operates at a single location.

Definition 2: Firm refers to an economic activity carried out by one or more persons for profit-making purposes. Firms are either natural persons (self-employed), legal persons (e.g. limited companies, co-operative societies, saving banks, or economic associations), public financial institutions or unincorporated government enterprises.

Definition 3: Plant establishment is determined by the year when the plant first appears in the data set. If a plant is missing for more than two years but reappears later, it is considered as a new birth if the ownership of the plant changes or the number of employees changes more than 50 % during the period when it is missing from the data set.

Definition 4: Plant closure is defined according to the year when the plant last time appears in the data set. If a plant is missing for more than two years but reappears later, it is considered as being closed if the ownership of the plant changes or the number of employees changes more than 50 % during the period when it is missing from the data set.

The period of interest covers the years 1995-2002. This is the period during which the Financial Statement Statistics have a wide coverage of 95 to 99 percent of all the firms in the Business Register. By definition exit cannot be determined for the last year of the study period since it is not possible to distinguish between continuing and exiting plants, as there is no information about which plants survive in the following years. Thus, all the observations for the year 2002 are excluded from the analysis. Identifying exit for the years 2000 and 2001 may overestimate the number of exits in these years, because plants that seem to have exited may reappear in 2003 or 2004 and these plants would then be considered as continuers. Hence, the study focuses on the period of 1995-1999. However, the results of the econometric analysis do not change if the years 2000 and 2001 are included in the data set.

Although the study period begins in 1995, the Business register includes data on years preceding 1995. This allows checking that a plant is a "true" entry in the sense that it has not existed before 1995. Due to some missing values in lagged financial variables, the number of firms included in the analysis varies between different model specifications. The basic regression without lagged financial variables includes 10 258 firms.

4 Evidence on the Effects of Firms' Financial Status in Manufacturing

4.1 Analysis with Standard Multinomial Logit Model

When a firm decides simultaneously whether to open or close down plants, the probability of these decisions may be analyzed using probability models with multiple discrete choices. Due to its computational feasibility the multinomial logit model is one of the most frequently used nominal regression models.[6] There are three possible choices in the model: the firm may establish a new plant, close down an old plant, or operate as before.[7] These alternative choices are nominal, i.e., they cannot be ordered. Let Y_i be the dependent variable, i.e. the firm's decision, with J=3 nominal alternative choices. The multinomial logit model specifies the probability of jth choice as follows:[8]

$$\text{Prob}(Y_i = j) = \frac{\exp(\mathbf{x}_i \boldsymbol{\beta}_j)}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_i \boldsymbol{\beta}_j)} \qquad (1)$$

where the left hand side represents the probability of observing choice j given $\mathbf{x}_i$. $\mathbf{x}_i$ refers to the vector of the firm-, industry- and macro-level explanatory variables. The vector $\boldsymbol{\beta}_j$ includes the intercept and coefficients for the effect of $\mathbf{x}_i$ on choice j. There are no alternative-specific covariates in the model and $\boldsymbol{\beta}_j$ differs for each choice. The multinomial logit model is described further in Appendix II.

In order to identify factors affecting the decisions of firms, different aggregate-level and industry-level variables, as well as, firm-specific characteristics are examined. The precise definitions of the potential explanatory variables are presented in Appendix I, Table A1.

The non-linearity of the multinomial model makes the interpretation of the effects of the explanatory variables somewhat more complicated compared to linear regression models. For example, marginal effects are not simply equal to the estimated coefficients, but depend also on the values of explanatory variables. A frequently used method is to analyze the effects of marginal or discrete changes when the explanatory variables are set to their mean. An alternative approach to interpret the results of multinomial logit model is to examine the effects of changes in terms of the odds ratios. This implies analyzing the effect of a change in one of the explanatory variables on the odds of outcome j versus outcome k, holding other variables constant. This interpretation does not depend on the level at which

[6] While probit versions of this model are possible, the issues of computation and identification have limited their use. See Greene (2003) pp-714-715, and Wooldridge (2002) pp. 500-504.

[7] In practice, firms could also both open and close plants at the same time. However, these are special cases and represent less than 0.2 per cent of the observations in the data set of the study and thus less attention has been paid to these cases.

[8] See e.g. Greene (2003) pp. 720-722, Long (1997) pp.151-156, and Skrondal and Rabe-Hesketh (2004) pp. 28-29 and 36-38.

the level of explanatory variables implying that the effect of a change in a given variable is on the odds ratio is constant regardless of the value of the explanatory variables. Nevertheless, it is important to keep in mind that although the changes in explanatory variables have constant effects on the odds, their effects on the probability of an outcome are not constant.

Table 1 presents the estimation results of different specifications using the multinomial logit model. In addition to the coefficients the results are reported as relative risk ratios (RRR). These ratios may be interpreted such that they represent the changes in the odds of choice *j* relative to choice *k* associated with changes explanatory variables. In this study the focus is on the effect of one standard error change in an explanatory variable on the odds different choices. For comparison, the results are also presented as marginal effects. (See Appendix I, Table A4). These results support the findings of this sub-section.

In all the specifications the null hypothesis that all parameters are equal to zero is rejected using overall chi-square test. Since some omitted firm characteristics may cause observations within firms to be correlated over time, the usual standard errors may be incorrect. Thus, they are replaced in all the estimations by robust standard errors with additional correction for the effects of clustered data. [9]

The aggregate business cycle is captured by real GDP growth and the aggregate financial conditions are controlled using interest rates and the ratio of credit to private sector and GDP. However, these variables may be correlated with each other and the GDP growth, and thus, introduce multicollinearity to the estimated model. The possible effects of multicollinearity were studied by examining model specifications with different combinations of macro-level variables and using year dummies. However, the results (not shown here) concerning industry- and firm-level factors did not change between the different specifications.[10]

The industry-level explanatory variables are measured at the three-digit industry level except for the R&D intensity which is measured at two-digit level. An industry's level of hourly wages has a positive effect on firms' decision to establish plants implying that firms operating in the industries characterized by high salaries are more likely to establish new plants. This result may be interpreted such that high wages in a certain industry are signals of an overall positive development in the industry. On the other hand, high capital intensity of an industry is likely to discourage the creation of plants. This may be explained by arguing that capital intensity reflects the sunk costs related to opening a new plant in the industry and thus high capital intensity implies higher costs.

[9] Clustered error terms are introduced by using the cluster option in the STATA program. See Long and Freese (2003) for more details.
[10] The results of these estimations are provided upon request.

An industry's investment rate and the level of hourly wages have a negative and significant effect on destruction of plants. One explanation for this result is that a high level of investment and wages indicates a commitment to some labor and capital related sunk costs and a stronger commitment, in turn, reduces the likelihood of plant closure. On the other hand, the industry-level capital intensity seems to increase the probability of plant destruction.

The growth opportunities of firms operating in a certain industry are measured by the growth rate of the net sales of the industry. The results show that growth opportunities are one of the main determinants of the firms' decision to close down plats. The coefficient of industries' net sales growth is negative and statistically significant in most estimations concerning plant destruction. The industry growth seems to have a positive effect on plant creation, but the effect is not statistically significant in most of the estimations.

Competition in different industries may directly affect firms' decisions to open and close plants, but it may also have indirect effects on firms with different financial characteristics as proposed by the so-called long purse theories in Section 2. The degree of competition may be measured by using several indicators. This study focuses on two types of measures. First, an index called Herfindahl Index[11] is used to measure concentration in an industry. The higher is the index value the more concentrated is the industry suggesting a correspondingly lower level of competition. Second, the study uses past entry rate as an indicator of competition in an industry. High entry rates are often though to reflect harder competition. This view is based on the argument that entry enhances the selection process and forces exit through displacement.

The Herfindahl Index does not seem to have a statistically significant effect on firms' decisions to open new plants or to close down old plants in any of the specifications except in the first specification concerning plant opening. The effect of the lagged entry rate seems to be statistically significant for the decision to open a plant in some specifications. The high level of entry in the previous period tends to reduce the probability to establish new plants in the current period. This finding may be interpreted such that the new entrants increase competition and thus force the incumbents to carefully consider whether it is profitable to open new plants.

The firm-specific non-financial variables included in the basic analysis are the age, size and ownership structure of a firm, and the number of plants owned by the firm. These factors are significant for both the creation and destruction of plants, except for foreign ownership structure which is not significant

[11] The Herfindahl Index is obtained by squaring the market-share of plants and then summing those squares.

in the case of the plant establishment decision. It seems that the more plants the firm owns the higher is the probability that the firm establishes or closes its plants. For a standard deviation change in the number of plants the odds of a firm choosing to establish a plant are more than 1.80 times greater than choosing not to establish nor to close plants. The effect on plant closure seems to be even greater: An increase in the number of plants increases the odds of closing down a plant by a factor larger than two. The positive relationship between plant closure and the number of plants may be interpreted such that it is easier for firms with several plants to close unprofitable branches relative to the owners of independent plants who may be willing to accept lower rates of return without closing their plants.

Foreign ownership structure is measured as the share of a firm's equity owned by non-Finnish agents. It seems that foreign ownership increases the likelihood of the decision to close down plants. As in the case of multi-plant firms this may be explained by the argument that it may be easier for foreign owners of a multinational firm to close down business in Finland compared to Finnish owners running business in more regional scale.

The firm size, measured by the number of employees, tends to have a positive effect on the creation of plants and negative effect on the destruction of plants. This implies that smaller firms are less likely to establish new plants but are more likely to close down plants. For a one standard deviation change in the log of the number of employees in a firm the odds of increase around 70 % depending on the specification. Respectively, the odds of closing down a plant decrease by 34-54 %.

The age of a firm has a negative influence on both the creation and destruction of plants implying that the older the firm is the less likely it is to establish a new plant but it is also less likely to close down its plants. Columns (4) and (5) in Table 1 present additional results on the analysis of firm age. These specifications are similar to Specifications (1) and (2) except that in addition to firm age they include the square of this variable. The results of this specification show that there exists a U-shape relationship between firm age and decisions to open and close down plants. This implies that when firms get relatively old the negative relationship becomes positive, that is for very old firms the probability of opening and closing plants increases with age. However, if the effects of age are examined without the linear term, the coefficient of the square term is insignificant.

Instead of examining the firm age, Specifications (6) and (7) focus on a variable measuring the duration from the year the firm last established a plant. This variable reflects the effects of the firm's past establishment decision. If the firm has been a single-plant firm during the whole period, this time equals the age of the firm. Thus, in order to avoid the possibility of multicollinearity between the age and the duration from the establishment of a last plant these measures are not included in the same model specification. It seems that the longer time from the decision to establish a new plant the less likely it becomes to establish a plant and to close down plants. When the square of this measure is included in the estimation the relationship takes the form of a U-shape. This may be thought to support the view that large investment episodes, such as plant establishment, occur in spikes and periods of zero investment are frequent. For example, Nilsen and Schiantarelli (2003) examine the probability of a large investment conditional on the duration from the last high investment episode and find that the relationship between the probability of large investment episode and the length of the duration from the last episode has a U-shape.[12]

The study includes the following firm-level financial variables: profits, the ratio of fixed assets and total assets, debt-to-asset ratio, and interest coverage. The results show clearly that the degree of firms' indebtedness is an important financial factor determining plant closure. A low degree of debt tends to reduce likelihood of plant destruction. The odds of the choice of a firm to close an old plant increase by 11 % when the debt-to-asset ratio increases one standard deviation. This finding gives support to the theories suggesting that highly indebted firms may be forced to liquidate their investment projects.

The interest coverage (the ratio of cash flow and interest expenses)[13] may be thought to reflect the short-term financial constraints of firms. Furthermore, it may be considered as an alternative measure of firms' debt burden. Low values of this variable restrict firms' financial status and indicate a relatively high debt burden. According to the results, a high ratio of a firm's cash flow and interest expenses tends to decrease the risk of closure. The analysis of odd ratios shows that for a standard deviation increase in the interest coverage the relative probability of closing down a plant is reduced by 30 %. This is consistent with the finding that indebted firms are more likely to close down plants.

According to the estimation results the structure of firms' assets has also a statistically significant effect on the decision to close down plants. The higher the fixed to total asset ratio the less likely the firms' are to close their plants. This result is plausible if a high value of the ratio is considered to reflect a more committed firm entity. Furthermore, firms' profits tend to reduce the likelihood of a plant failure. The odds of a plant closure decrease by a factor of 0.96 when firms' profits increase by one standard deviation.

Firms' current financial status does not seem to affect the creation of new plants to the same extent as the destruction of plants. However, it may well be that these decisions are based on past financial considerations because firms start planning the establishment of a plant some years before the actual

[12] See also Licandro, Maroto and Puch (2003).
[13] Following Zingales (1998) the coverage is determined as log(1+coverage) and if a firm's cash flow, earnings before interest and taxes, is negative or zero the interest coverage is set to equal zero.

establishment. Therefore, it is important to consider financial variables describing firms' past financial status.

Column 2 in Table 1 shows the results of a model specification including firm-specific financial variables with two years lag. The findings concerning the plant closure are similar to those focusing on current financial status. However, the decision to establish a plant seems now to be affected by the past interest coverage implying that firms with relatively high debt burdens are less likely to open new plants.

The effects of leverage on the establishment decision are even more pronounced when the focus is on firms' initial debt to assets ratio. (See Column 3 in Table 1.) If the initial level of leverage is analyzed instead of debt ratio from the past two years, the degree of indebtedness turns out to be statistically highly significant for both the decision to open and close down plants. The odds of choosing to open a plant are decreased by 17 % when the initial debt of a firm is increased by one standard deviation. Respectively, the odds of choosing to close a plant 17 %. Conequently, it can be argued that high degree of initial leverage may represent a financial obstacle for establishing a new plant. This finding is consistent with the theoretical models by Myers (1997) and Jensen (1986). They both suggest that the firm's level of debt has a negative effect on investment, although the mechanism through which leverage affects investment is different in the two models.

The result with the initial debt should, however, be analyzed carefully since the number of observations reduced considerably compared to the other specifications. The decrease in the number of observations is due to the lack of information about the initial debt for some firms. In particular, this concerns older firms since the Financial Statement Statistics database does not cover data from years before 1988. In addition, the coverage of the database is limited in the period 1988-1993 and thus firms established during this period may lack information about their initial financial status.

It is worth emphasizing that the estimation of the multinomial logit model is based on an assumption that the probabilities of the alternative choices are independent of each other. This property is called the independence from irrelevant alternatives (IIA). The independence assumption follows from the initial assumption that the disturbances are independent and homoscedastic. This assumption implies that adding or deleting alternative outcomes does not affect the odds among the remaining outcomes.

The following sub-section discusses the possibility to relax this assumption by introducing an alternative-specific random effects model. However, the validity of the assumption may also be tested. The study provides the results of two tests to assess the validity of the IIA assumption: the tests proposed by Hausman and McFadden (1984) and Small and Hsiao (1985). The details about these tests and their results are presented in Appendix III. It seems that the Hausman-McFadden test does not reject the null hypothesis that the IIA holds for the two alternatives to establish and close down plants. However, the results of the Small-Hsiao test are less clear.

Long and Freese (2003) point out that the results of the Hausman and Small-Hsiao tests may vary considerably and thus provide little guidance to violations of the IIA assumption. Furthermore, there is no evidence of the small sample properties of these tests. A general advice concerning the use of multinomial logit model given by Long and Freese (2003 p. 210) is that the model should be specified such that it involves distinct outcomes that are not substitutes for one another. In the case of this study the alternative decision are hardly substitutes for each other.

4.2 Analysis with Random Effects Multinomial Logit Model

Sub-section 4.1 discussed shortly the assumption of the independence from irrelevant alternatives (IIA). This sub-section introduces a method to relax the IIA assumption and to analyze unobserved heterogeneity. This methodology is then applied to study firms' decision to establish and close plants in a panel data setting.

The critical implication of the independence from irrelevant alternatives assumption is that unobserved factors are assumed to be uncorrelated over alternatives and to have the same variance for all alternatives. Although the independence assumption is relatively restrictive, it provides a convenient way to model and estimate the choice probability[14]. However, it may be inappropriate in some situations where unobserved factors related to one alternative may be similar to those related to other alternatives.[15]

The limitations of the independence assumption may be more pronounced when the multinomial logit is applied to a sequence of choices over time. The IIA assumption implies that each choice is independent of the others. However, it is plausible that unobserved factors affecting the choice of an agent in one period would persist, at least to some extent, and induce dependence between the choices of the agent over time. This question is of particular interest of this study since the analysis is based on panel data where observations for the same firm may be influenced by the same firm-specific unobserved heterogeneity. In this case, firms are thought as clusters and the dependence between choice decisions by the same firms is called within-cluster correlation.

[14] See Train (2003) pp.22-23.
[15] Train (2003) gives an example of a person's choice between alternative means of travel: if a person dislikes traveling by bus due to the presence of other passengers, he or she may dislike traveling by train for the same reasons. If this is the case, then the unobserved factors affecting the choice between bus and train are correlated rather than independent.

In practice, observed covariates cannot explain all the variability in firms' decisions. The remaining unobserved heterogeneity may be modeled by introducing firm-level random effects in the model. As unobserved heterogeneity is often thought to induce dependence between choices, this allows us also to relax the IIA assumption.

Following Skrondal and Rabe-Hesketh (2004) the study captures unobserved heterogeneity by accommodating random effects at the firm level. [16] In particular, a correlated alternative-specific random intercept model with dependence within firms is introduced. The difference between the standard and random-effects multinomial logit models is that in the latter the choice probability is conditional on random effects in addition to the exogenous variables. The conditional probability can be expressed in the following form which resembles Equation (1):

$$\text{Prob}(Y_{kt} = j \mid \gamma_{kj}) = \frac{\exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})} \qquad (2)$$

where $\mathbf{x}_{kt}\boldsymbol{\beta}_j$ is a deterministic fixed part representing observed heterogeneity between firms, k, and the choice situations, t, of each firm. The vector $\mathbf{x}_{kt}$ varies over choice situations and firms but not over alternatives. The corresponding fixed coefficient vector is $\boldsymbol{\beta}_j$. γ_{kj} represents the alternative-specific random intercepts inducing unobserved heterogeneity that is dependent across alternatives, j, and firms, k and is assumed to be normally distributed.

The random intercept multinomial logit model is estimated using the program Gllamm written in Stata by (Rabe-Hesketh, Pickles and Skrondal, 2001). This program implements maximum likelihood estimation and empirical Bayes prediction for different types of generalized linear and latent and mixed models. Numerical integration is used to integrate over the distributions of the random effects. Finally, the marginal log-likelihood is maximized by Newton-Raphson method using numerical first and second derivatives. Appendix IV provides a detailed description of the random intercept multinomial logit model used in the study.

Table 2 shows the results of the alternative-specific random intercept model. The estimated model is two-level model with observations (choice situations) clustered within firms. Two specifications of the model are analyzed. The results of the standard logit model are presented in the first two columns in order to facilitate the comparison between the results. The group of firms that decide not to establish nor close down plants is assumed to be the comparison category in the both specifications.

[16] The study does not consider correlated alternative-specific random intercept models at the level of each choice situation of a firm since these models would be extremely fragile in terms of identification as pointed out by Skrondal and Rabe-Hesketh (2004).

Controlling for the unobserved heterogeneity does not considerably change the previous findings about the effects of the covariates on firms' decisions. On the contrary, the magnitude of many coefficients is greater in the model specifications with random effects than in those without random effects.[17] Moreover, the fit of the model is improved which indicates that there is unobserved heterogeneity at the firm level inducing longitudinal dependence within firms.

The results for the random part of the model are shown in the bottom of the two panels in Table 2. The variance of the random effect for the decision to open a new plant, representing residual variation, is relatively large reflecting, on the one hand, the presence of firms with strong residual (unexplained) tendency to establish plants, and on the other hand, the presence of firms with strong residual tendency not to establish nor close plants. This may be interpreted such that there are large unexplained differences between the two types of firms. There is a positive correlation between the random effects for the decision to establish and close down plants suggesting that those firms that decide to open a plant rather than operate as before, after conditioning on the covariates, are also likely to close down plants. This resembles the industry-level finding that entry and exit rates are positively correlated, i.e. industries with high levels of entry have also often high levels of exit.

5 Sectoral Differences in the Effects of Firms' Financial Status

After studying the effects of firms' financial characteristics on their decisions to open and close down plants in the manufacturing sector, it is interesting to examine whether these characteristics have similar effects in the service sector. There are clear structural differences between these two main sectors of the economy. For example, there are clearly more plants in the services and the average plant size in the service sector is considerably smaller than that in the manufacturing sector. Furthermore, there are some differences in the financial structure between firms operating in the service and manufacturing sectors. On average the share of fixed asset is larger in the manufacturing firms whereas firms' average profits are somewhat higher in the services than in manufacturing sector. Consequently, it may be that firms' decisions are determined by different factors in the services and than in the manufacturing sector. See Appendix I for summary statistics of the explanatory variables for both the service and manufacturing sectors.

The purpose of this section is to examine the relevance of the differences between the explanatory variables in the service and manufacturing sectors. The effects of different explanatory variables are examined in the framework of the standard multinomial logit model. Table 3 presents the results of

[17] This is true, particularly, for the analysis of a firm decision to close down a plant.

this analysis. All the specifications include year dummy variables and a constant. In order to compare the results between the two sectors, the estimation results are also provided for the manufacturing sector. Unfortunately, there is less industry-specific information on the services and for the reasons of comparability the models focusing on both manufacturing and services include less industry-specific explanatory variables than the models focusing only on the manufacturing sector.

The comparison of Table 3 shows that the effects of the explanatory variables are similar in the both sectors. The evidence on the impact of firms' financial characteristics in the services seems to be consistent with that in the manufacturing sector. The results support the finding that the establishing decision is likely to be determined by firms' past financial characteristics. In particular, the initial debt of a firm has a statistically significant effect on the decision to open a plant.

However, there are some differences in the results between the two sectors. Profits seem to be less important determinants of a plant closure in services than in the manufacturing. In addition, the structure of firms' assets has a significant effect on the establishment decision in the services whereas in the manufacturing sector the fixed to total assets ratio is not significant. The larger share of the fixed assets the less likely a firm operating in the service sector is to open a new plant. This result is plausible if a high value of the ratio is considered to restrict a firm's liquidity.[18]

According to the results, industry concentration increases the probability of closing down a plant in the service sector whereas in the manufacturing sector concentration does not seem to play a significant role in determining the closure decision. This somewhat counter-intuitive result[19] may be partly explained by arguing that if highly concentrated industries consist of few large firms and a group of small firms, the dominating large firms may take predatory action against any of the smaller firms attempting to increase its market share. This may force the challenger to withdraw or even to close down.

The entry rate is found to have a positive and statistically significant effect on a firm's probability to close down plants in the services whereas in manufacturing sector this effect seems to be statistically insignificant. The finding that higher entry rates increase the probability of a closure decision is consistent with the view that entry enhances competition and the selection process in industries forcing firms to close their unproductive plants.

[18] See Fotopoulos and Louri (2000).
[19] Usually, one would expect that there is less competition in the highly concentrated industries and thus less pressure to close down plants.

6 Conclusions

This paper analyzes the determinants of firms' decisions to establish and close plants. The focus is on the question whether firms' financial characteristics affect these decisions. Furthermore, the paper examines the role of unobserved heterogeneity. The manufacturing sector is the primary focus of the study, but in order to provide general conclusions from effects of firms' financial status the study considers also the service sector.

In addition to other firm-specific variables, the financial status of a firm is found to play an important role in its decisions to open and close plants. The paper finds evidence that a high level of debt increases the probability of a plant closure. Moreover, it is found that a high level of initial debt may form a financial obstacle for a firm intending to establish a new plant. These findings support the theories suggesting a positive link between indebtedness and plant closure and a negative link between indebtedness and plant creation. However, the paper does not identify the underlining channel through which debt burden may affect these decisions. These linkages may be the result of the so-called debt-overhang as proposed by Myers (1977) or the vulnerability of highly indebted firms to competition, but they may as well capture the fact that debt may be used to reduce investment on unproductive plants and to force firms to liquidate inefficient plants as proposed by Jensen (1986) and Harris and Raviv (1990).

Overall, it seems that the closure decision is based on the firm's current financial conditions whereas the decision to open a plant is likely to be based on past financial conditions. Firms' profits are found to affect their decision to close down plants. The evidence shows that higher profitability tends to reduce the risk of plant failure. The results show that firms' interest coverage has a negative (positive) effect on the probability to close plants (to establish plants). In other words, the higher the better the firms' ability to meet their interest payments on the outstanding debt the less likely the firms are to close down their plants and the more likely they are to establish new plants.

The findings concerning the service sector confirm the previous results from the manufacturing sector, i.e. financial conditions are important determinants of firms' decisions also in the service sector. In particular, the indebtedness and structure of assets of the firms tends to have a significant impact on both their decision to establish and close down plants whereas the effect of profits is less significant.

Finally, the paper recognizes the need to analyze unobserved heterogeneity and finds evidence of the presence of unobserved factors affecting firms' decisions. In particular, it is found that there is a strong positive correlation between the random effects for the decision to establish and close down plants.

This implies that there are some unobserved firm characteristics which are typical to firms establishing as well as firms closing plants.

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TABLE 1 Basic Analysis of firms' decision to establish and close down plants in Finnish manufacturing

	Panel A Results for firms' decision to establish new plants													
Model	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Variable	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR
GDP growth	1.68	1.02	5.12	1.16	17.39**	1.21	1.84	1.02	5.24	1.06	3.90	1.04	5.29	1.06
Interest rate	-0.13	0.87	0.07	1.05	-0.03	0.98	-0.16*	0.84	0.06	1.04	0.02	1.01	0.02	1.02
Lending to GDP	3.35	1.14	2.88	1.10	7.69**	1.27	3.29	1.14	2.88	1.20	2.14	1.07	2.71	1.09
Investment rate	-1.27	0.97	0.86	1.02	1.96	1.05	-1.35	0.97	0.72	1.02	0.85	1.02	0.88	1.02
Wages	0.06	1.12	0.07*	1.16	0.08*	1.17	0.05	1.11	0.07*	1.15	0.07	1.14	0.07*	1.14
Capital intensity	-0.01**	0.83	-0.01***	0.77	-0.01***	0.75	-0.01***	0.83	-0.01***	0.78	-0.01***	0.78	-0.01***	0.78
Export intensity	0.32	1.07	0.42	1.10	0.25	1.06	0.33	1.07	0.42	1.10	0.44	1.10	0.44	1.10
Price cost margin	-0.05	0.95	-0.04	0.95	-0.06	0.91	-0.04	1.06	-0.04	0.95	-0.04	0.95	-0.04	0.94
Industry growth	0.36**	1.10	0.27	1.06	0.24	1.06	0.35**	1.10	0.27	1.06	0.28	1.07	0.29	1.07
Industry R&D intensity	-1.47	0.99	-2.47	0.99	18.00	1.08	-1.54	0.99	-2.23	0.99	-2.06	0.99	-1.99	0.99
Industry concentration	-1.50*	0.89	-1.28	0.91	-1.17	0.91	-1.46	0.89	-1.31	0.91	-1.34	0.90	-1.36	0.90
Entry rate$_{t-1}$	-0.36	0.98	-2.80*	0.88	-2.51	0.89	-0.40	0.98	-2.72*	0.89	-2.87*	0.88	-2.88*	0.88
Number of plants	0.38***	1.84	0.35***	1.88	0.26***	2.02	0.38***	1.82	0.34***	1.85	0.31***	1.76	0.30***	1.73
Firm age	-0.01**	0.86	-0.01*	0.91	-0.00	0.94	-0.03***	0.65	-0.01	0.84				
Firm age^2							0.00***	1.37	0.00	1.10				
Duration from last plant opening											-0.06***	0.83	-0.16	0.62
Duration from last plant opening ^2													0.01	1.35
Firm size	0.44***	1.72	0.42***	1.70	0.24***	1.45	0.44**	1.72	0.42***	1.70	0.42***	1.70	0.42***	1.71
Foreign ownership	0.00	1.02	-0.00	0.95	-0.00	0.92	0.00	1.01	-0.00	0.95	-0.00	0.94	-0.00	0.94
Profit	-0.06	0.98					-0.05	0.98						
Fixed to total assets	-0.43	0.91					-0.39	0.92						
Debt to assets	0.74	1.09					0.70	1.09						
Coverage	0.02	1.03					0.02	1.03						
Profit$_{t-2}$			-0.05	0.98	0.13	1.05			-0.05	0.98	-0.04	0.98	-0.04	0.98
Fixed to total assets $_{t-2}$			-0.26	0.95	0.12	1.02			-0.24	0.95	-0.20	0.96	-0.20	0.96
Debt to assets $_{t-2}$			0.05	1.01					0.06	1.01	0.01	1.00	-0.01	1.00
Coverage $_{t-2}$			0.09*	1.14	0.04	1.06			0.09*	1.14	0.08*	1.13	0.08*	1.13
Initial debt					-2.11**	0.83								
Constant	-8.49***		-9.17***		-9.80***		-8.14***		-9.07***		-8.02***		-8.16***	

Variable	Panel B Results for firms' decision to close down plants													
	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR	Coef.	RRR
GDP growth	0.77	1.01	-8.46**	0.91	1.61	1.02	1.04	1.01	-6.86*	0.93	-10.03***	0.89	-6.89*	0.93
Interest rate	0.00	1.00	0.22***	1.15	0.16*	1.12	-0.02	0.97	0.12	1.08	0.19***	1.12	0.21***	1.14
Lending to GDP	-3.89***	0.86	-5.96***	0.83	-2.73	0.92	-3.88***	0.86	-5.55***	0.84	-6.82***	0.80	-5.48***	0.83
Investment rate	-6.08***	0.88	-5.93***	0.88	-5.41**	0.88	-6.19***	0.88	-6.08***	0.88	-6.32***	0.88	-6.30***	0.88
Wages	-0.04**	0.93	-0.05***	0.90	-0.04	0.92	-0.04**	0.93	-0.05***	0.90	-0.05***	0.90	-0.05***	0.90
Capital intensity	0.00***	1.14	0.00***	1.18	0.00***	1.19	0.00***	1.13	0.00***	1.17	0.00***	1.17	0.00***	1.18
Export intensity	-0.12	0.97	-0.02	1.00	-0.31	0.94	-0.11	0.98	0.01	1.00	-0.02	1.00	-0.01	1.00
Price cost margin	0.00	1.00	-0.02	0.98	-0.02	0.98	0.00	1.00	-0.02	0.98	-0.02	0.98	-0.02	0.98
Industry growth	-0.17	0.96	-0.39**	0.94	-0.54**	0.88	-0.17	0.96	-0.40***	0.91	-0.41***	0.91	-0.40**	0.91
Industry R&D intensity	2.69	1.01	-4.12	0.98	0.17	1.00	1.94	1.01	-4.69	0.98	-4.81	0.98	-4.09	0.98
Industry concentration	0.42	1.03	0.18	1.10	0.27	1.02	0.46	1.04	0.27	1.10	0.16	1.01	0.14	1.01
Entry rate$_{t-1}$	0.63	1.03	0.34	1.02	0.45	1.12	0.56	1.03	0.30	1.01	0.14	1.01	0.08	1.00
Number of plants	0.50***	2.21	0.44***	2.19	0.30***	2.27	0.49***	2.20	0.43***	2.16	0.40***	2.05	0.39***	2.01
Firm age	-0.01**	0.92	-0.01*	0.93	-0.00	0.98	-0.03***	0.65	-0.04***	0.62				
Firm age^2							0.00***	1.48	0.00***	1.57				
Duration from last plant opening											-0.08***	0.80	-0.32***	0.38
Duration from last plant opening ^2													0.02***	2.18
Firm size	-0.63***	0.46	-0.49***	0.54	-0.27***	0.66	-0.62***	0.46	-0.50***	0.53	-0.48***	0.54	-0.49***	0.54
Foreign ownership	0.01***	1.12	0.01***	1.09	0.00	1.09	0.01***	1.12	0.01***	1.09	0.00**	1.06	0.00**	1.09
Profit	-0.17**	0.93					-0.16**	0.93						
Fixed to total assets	-0.33***	0.93					-0.29***	0.94						
Debt to assets	0.91***	1.11.					0.92***	1.11						
Coverage	-0.24***	0.70					-0.23***	0.71						
Profit$_{t-2}$			-0.11***	0.96	0.08	1.03			-0.10***	0.96	-0.10***	0.96	-0.11***	0.96
Fixed to total assets $_{t-2}$			-0.19	0.96	-0.17	0.96			-0.13	0.97	-0.12	0.97	-0.12	0.97
Debt to assets $_{t-2}$			0.82**	1.09					0.78**	1.09	0.77**	1.09	0.78**	1.09
Coverage $_{t-2}$			-0.09***	0.87	-0.09**	0.86			-0.10***	0.87	-0.10***	0.86	-0.10***	0.86
Initial debt					1.84***	1.17								
Constant	1.10		1.36		-1.39		1.38*		1.80*		2.58***		2.33**	
No. of obs.	35812		24829		9789		35812		24829		24829		24829	
Pseudo Log-likelihood	-9853		-6276		-3325		-9831		-6256		-6246		-6233	

Notes: The comparison group is the outcome not to establish nor close down plants. *, **, and *** indicate significance at 10, 5, and 1 per cent level, respectively.

TABLE 2 Analysis of the random effects model

	Panel A			
	Standard multinomial model		Random effects multinomial model	
Variable	Decision to open a plant	Decision to close a plant	Decision to open a plant	Decision to close a plant
Fixed Part				
GDP growth	2.626	-8.326**	0.401	-13.604***
Interest rate	0.073	0.223**	0.100	0.240***
Lending to GDP	1.327	-5.825***	-0.636	-8.595***
Investment rate	0.156	-5.916***	-0.083	-6.579***
Wages	0.059	-0.049***	0.042	-0.053**
Capital intensity	-0.007**	0.005***	-0.007**	0.006***
Export intensity	0.264	0.008	0.456	0.065
Price cost margin	-0.029	-0.020	-0.035	-0.026
Industry growth	0.218	-0.391**	0.160	-0.384**
Industry R&D intensity	-8.361	-2.006	-1.762	-2.248
Number of plants	0.354***	0.434***	0.487***	0.516***
Firm age	-0.007*	-0.006*	-0.009*	-0.006**
Firm size	0.399***	-0.476***	0.374***	-0.576***
$Profit_{t-2}$	-0.041	-0.111***	-0.029	-0.131**
Fixed to total assets $_{t-2}$	-0.213	-0.194	0.038	-0.211
Debt to assets $_{t-2}$	0.004	0.799**	0.356	0.872**
Coverage $_{t-2}$	0.087*	-0.093***	0.086	-0.097***
Constant	-8.168***	1.254	-8.591***	2.649**
Random Part				
Variance			3.226***	1.386***
Covariance			1.749***	
Correlation			0.827	
Log-Likelihood	-6284		-6210	
No. of firms	7892		7892	

	Panel B			
	Standard multinomial model		Random effects multinomial model	
Variable	Decision to open a plant	Decision to close a plant	Decision to open a plant	Decision to close a plant
Fixed Part				
GDP growth	15.208**	1.973	14.430*	-0.627
Interest rate	-0.035	0.161*	-0.029	0.169*
Lending to GDP	6.288*	-2.493	5.0380	-4.140*
Investment rate	1.216	-5.361**	0.891	-5.854**
Wages	0.062	-0.040	0.060	-0.037
Capital intensity	-0.006**	0.004***	-0.006***	0.005***
Export intensity	0.092	-0.281	0.266	-0.259
Price cost margin	-0.051	-0.018	-0.056	-0.030
Industry growth	0.198	-0.552**	0.157**	-0.544**
Industry R&D intensity	12.018	1.849	12.230	1.536
Number of plants	0.259***	0.296***	0.331***	0.355***
Firm age	-0.004	-0.002	-0.003	-0.002
Firm size	0.220***	-0.258***	0.185***	-0.317***
$Profit_{t-2}$	0.172	0.073	0.248	0.085
Fixed to total assets $_{t-2}$	0.164	-0.179	0.300	-0.177
Coverage $_{t-2}$	0.037	-0.093**	0.024	-0.093**
Initial debt	-2.154**	1.853***	-1.826**	2.154***
Constant	-8.884***	-1.548	-9.077***	-1.101
Random Part				
Variance			1.865***	1.340***
Covariance			1.438***	
Correlation			0.913	
Log-Likelihood	-3329		-3292	
No. of firms	3531		3531	

Notes: The comparison group is the outcome not to establish nor close down plants. *, **, and *** indicate significance at 10, 5, and 1 per cent level, respectively.

TABLE 3 Analysis of differences between Services and Manufacturing

	Panel A Results for firms' decision to establish new plants					
	Manufacturing			Services		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Industry growth	0.357*	0.360**	0.359*	-0.144	0.086	0.160
Industry concentration	-0.538	-0.063	-0.551	2.378***	0.929	1.500
Entry rate$_{t-1}$	-1.604	-1.508	-1.573	1.055***	-1.607	-0.877
Number of plants	0.344***	0.254***	0.336***	0.383****	0.187***	0.274***
Firm Age	-0.006	-0.003	-0.010	-0.012****	-0.007*	-0.024**
Firm age ^2			0.000 (0.000)			0.000 (0.000)
Firm size	0.401***	0.230***	0.406***	0.660***	0.540***	0.660***
Foreign ownership	-0.002	-0.003	-0.002	0.001	0.001	0.001
Profit$_{t-2}$	-0.062	0.131	-0.059	0.006*	0.003	0.006*
Fixed to total assets $_{t-2}$	-0.739*	-0.296	-0.718*	-0.807***	-0.805***	-0.806***
Debt to assets $_{t-2}$	0.321		0.334	0.548		0.559
Coverage $_{t-2}$	0.107**	0.055	0.107**	0.022	-0.009	0.023
Initial debt		-1.999**			-2.361***	
	Panel B Results for firms' decision to close down plants					
	Manufacturing			Services		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Industry growth	-0.431***	-0.593**	-0.437***	-0.144	-0.164	-0.143
Industry concentration	0.215	0.362	0.299	2.378***	3.225***	2.372***
Entry rate$_{t-1}$	-0.207	-0.143	-0.304	1.055***	1.233**	1.045**
Number of plants	0.435***	0.298***	0.428***	0.383****	0.262***	0.380***
Firm Age	-0.006**	-0.003	-0.038***	-0.012****	0.001	-0.033***
Firm Age ^2			0.000***			0.000***
Firm size	-0.483***	-0.258***	-0.485***	-0.779***	-0.541***	-0.786***
Foreign ownership	0.005**	0.002	0.005**	0.003***	0.002	0.003***
Profit$_{t-2}$	-0.106***	0.079	-0.097***	-0.004	0.017	-0.004
Fixed to total assets $_{t-2}$	-0.115	-0.011	-0.072	-0.326***	-0.214**	-0.311***
Debt to assets $_{t-2}$	0.820**		0.787**	0.408**		0.391**
Coverage $_{t-2}$	-0.101***	-0.100**	-0.103***	-0.102***	-0.102***	-0.102***
Initial debt		1.777***			0.495*	
No. of obs.	24917	9832	24917	52717	20955	52717
Pseudo Log-likelihood	-6339	-3373	-6319	-15956	-8214	-15937

Notes: The comparison group is the outcome not to establish nor close down plants. *, **, and *** indicate significance at 10, 5, and 1 per cent level, respectively.

Appendix I: Details on the Explanatory Variables

TABLE A1 Explanatory variables

Variable	*Description*
Real GDP growth	Relative change in the real gross domestic product
Credit to private sector	Credit to private sector relative to GDP
M2	M2 relative to GDP
Interest rates	Twelve-month money market rate (Helibor before 1999 and Euribor from 1999 onwards)
Industry investment rate	Industry average investment rate (gross investment/gross output)
Industry capital intensity	Industry average capital intensity (capital-labor ratio)
Industry wages	Industry average hourly wages (Wages/hours worked)
Industry export intensity	Industry average export intensity (exports/gross output)
Industry price-cost margin	Industry average price-cost margin ((Value added-wages-materials)/value added)
Industry R&D intensity	Industry average R&D intensity (R&D expenditure/number of employees)
Industry growth of sales	Relative change in the industry net sales
Industry concentration	Herfindahl Index for net sales
Firm interest coverage	Firm's operating profit/interest expenses[20]
Firm fixed assets to total assets	Firm's fixed assets/total assets
Firm profit	Firm's net profit/total assets
Firm debt	Firm's debt to asset ratio
Firm initial debt	Firm's debt to asset ratio in the year when the firm enters the industry
Firm R&D intensity	Firm's R&D expenditure/number of employees
Firm size	Log of the number of employees in a firm
Firm age	Firm's age expressed in years
Firm ownership structure	Share of a firm's equity held by non-Finnish residents
Number of plants in a firm	Number of plants owned by a firm
Time since last plant opening	Time since a firm last time established a plant

[20] Interest coverage is defined as log(1+coverage).

Table A2 Summary statistics in manufacturing

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP growth	35950	0.044	0.011	0.034	0.063
Interest rate	35950	4.172	1.084	3.182	6.330
Lending to GDP	35950	0.563	0.040	0.521	0.624
Investment rate	35869	0.037	0.021	0.000	0.286
Wages	35869	14.542	1.977	8.870	21.981
Capital intensity	35820	45.634	32.433	0.000	276.326
Export intensity	35867	0.363	0.213	0.004	1.196
Price cost margin	35867	-0.816	1.197	-27.694	7.989
Industry growth 3	35950	0.106	0.260	-0.923	4.493
Industry R&D intensity	35945	0.002	0.004	0.000	0.038
Industry concentration	35950	0.055	0.077	0.006	1.000
Entry rate$_{t-1}$	35950	0.091	0.050	0.000	1.000
Number of plants	35950	1.272	1.604	1.000	97.000
Firm Age	35950	14.045	15.018	0.000	97.000
Firm size	35947	2.592	1.229	0.693	9.694
Foreign ownership	35950	3.032	16.523	0.000	100.000
Profit	35950	0.065	0.430	-36.334	14.204
Profit$_{t-2}$	24052	0.058	0.406	-36.334	5.080
Fixed to total assets	35950	0.424	0.223	0.000	1.000
Fixed to total assets $_{t-2}$	24052	0.433	0.217	0.000	1.000
Debt to assets	35950	0.407	0.118	0.000	0.972
Debt to assets $_{t-2}$t	24052	0.422	0.103	0.000	0.909
Coverage	35950	2.128	1.500	0.000	13.102
Coverage $_{t-2}$	23697	1.832	1.325	0.000	13.102
Initial debt	16794	0.425	0.092	0.000	0.950

Table A3 Summary statistics in services

Variable	Obs	Mean	Std. Dev.	Min	Max
Industry growth	113504	0.123	3.456	-1.000	822.376
Industry concentration	113924	0.013	0.039	0.000	1.000
Entry rate$_{t-1}$	113924	0.141	0.056	0.000	0.992
Number of plants	113924	1.288	2.402	1.000	372.000
Firm Age	113924	12.308	12.117	0.000	97.000
Firm size	113469	2.079	0.883	0.000	10.112
Foreign ownership	113924	2.734	15.958	0.000	100.000
Profit	113924	0.078	3.134	-726.000	277.000
Profit$_{t-2}$	49528	0.074	2.891	-505.644	97.947
Fixed to total assets	113924	0.377	0.263	0.000	1.000
Fixed to total assets $_{t-2}$	49528	0.384	0.260	0.000	1.000
Debt to assets	113924	0.415	0.125	0.000	0.998
Debt to assets $_{t-2}$t	49528	0.422	0.112	0.000	0.984
Coverage	113924	2.287	1.624	0.000	14.712
Coverage $_{t-2}$	48391	2.108	1.488	0.000	14.353
Initial debt	53612	0.431	0.103	0.000	0.987

TABLE A4 Basic Analysis of firms' decision to establish and close down plants in Finnish manufacturing, marginal effects

	Panel A Results for firms' decision to establish new plants						
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable	Marginal effects	Marginal effects	Marginal effects	Marginal effects	Marginal effects	Marginal effects	Marginal effects
GDP growth	0.012	0.041	0.362**	0.013	0.042	0.032	0.042
Interest rate	-0.001	0.000	-0.001	-0.001*	0.000	0.000	0.000
Lending to GDP	0.257	0.024	0.164**	0.025	0.024	0.018	0.022
Investment rate	-0.007	0.009	0.048	-0.007	0.008	0.008	0.009
Wages	0.000	0.001*	0.002*	0.000	0.001*	0.001	0.001*
Capital intensity	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
Export intensity	0.002	0.003	0.006	0.002	0.003	0.003	0.003
Price cost margin	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000	-0.0000
Industry growth	0.003**	0.002	0.006	0.003**	0.002	0.002	0.002
Industry R&D intensity	-0.012	-0.017	0.377	-0.012	-0.015	-0.014	-0.013.
Industry concentration	-1.011*	-0.010	-0.025	-0.011	-0.010	-0.010	-0.010
Entry $rate_{t-1}$	-0.003	-0.021*	-0.053	-0.003	-0.021*	-0.021*	-0.021*
Number of plants	0.003***	0.002***	0.005***	0.003***	0.019***	0.002***	0.002***
Firm age	-0.000**	-0.000*	-0.000	-0.000***	-0.000		
Firm age^2				0.000***	0.000		
Duration from last plant opening						-0.000***	-0.001
Duration from last plant opening ^2							0.000
Firm size	0.003***	0.003***	0.005***	0.003**	0.003***	0.003***	0.003***
Foreign ownership	0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000
Profit	-0.000			-0.000			
Fixed to total assets	-0.003			-0.003			
Debt to assets	0.005			0.005			
Coverage	0.000			0.000			
$Profit_{t-2}$		-0.000	0.003		-0.000	-0.000	-0.003
Fixed to total assets $_{t-2}$		-0.002	0.003		-0.002	-0.001	-0.001
Debt to assets $_{t-2}$		0.000			0.000	-0.000	-0.000
Coverage $_{t-2}$		0.001*	0.001		0.001*	0.001*	0.001*
Initial debt			-0.047**				

	Panel B Results for firms' decision to close down plants						
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Marginal effects	Marginal effects	Marginal effects	Marginal effects	Marginal effects	Marginal effects	Marginal effects
GDP growth	0.037	-0.381**	0.067	0.050	-0.305*	-0.441***	-0.301*
Interest rate	0.000	0.010***	0.009*	-0.001	0.005	0.008***	0.009***
Lending to GDP	-0.192***	-0.268***	-0.160	-0.190***	-0.246***	-0.300***	-0.239***
Investment rate	-0.298***	-0.266***	-0.301**	-0.301***	-0.269***	-0.277***	-0.274***
Wages	-0.002**	-0.002***	-0.002	-0.002**	-0.002***	-0.002***	-0.002***
Capital intensity	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Export intensity	-0.006	-0.001	-0.017	-0.006	0.000	-0.001	-0.000
Price cost margin	0.000	-0.001	-0.000	0.000	-0.001	-0.001	-0.001
Industry growth	-0.008	-0.018**	-0.030**	-0.008	-0.018***	-0.018***	-0.018**
Industry R&D intensity	0.133	-0.184	-0.013	0.095	-0.207	-0.210	-0.177
Industry concentration	0.021	0.009	0.016	0.023	0.012	0.008	0.007
Entry rate$_{t-1}$	0.031	0.016	0.028	0.027	0.014	0.007	0.005
Number of plants	0.024***	0.019***	0.016***	0.024***	0.019***	0.017***	0.017***
Firm age	-0.000**	-0.000*	-0.000	-0.001***	-0.002***		
Firm age^2				0.000***	0.000***		
Duration from last plant opening						-0.003***	-0.014***
Duration from last plant opening ^2							0.001***
Firm size	-0.031***	-0.022***	-0.015***	-0.031***	-0.022***	-0.021***	-0.022***
Foreign ownership	0.000***	0.000***	0.000	0.000***	0.000***	0.000**	0.000**
Profit	-0.009**			-0.008**			
Fixed to total assets	-0.016***			-0.014***			
Debt to assets	0.045***			0.044***			
Coverage	-0.012***			-0.011***			
Profit$_{t-2}$		-0.005***	0.004		-0.005***	-0.004***	-0.005***
Fixed to total assets$_{t-2}$		-0.008	-0.010		-0.006	-0.005	-0.005
Debt to assets$_{t-2}$		0.037**			0.035**	0.034**	0.034**
Coverage$_{t-2}$		-0.004***	-0.005**		-0.004***	-0.004***	-0.004***
Initial debt			0.104***				

Notes: The comparison group is the outcome not to establish nor close down plants. *, **, and *** indicate significance at 10, 5, and 1 per cent level, respectively.

Appendix II: Standard Multinomial Logit Model

In the setting of standard multinomial logit models the probability of *j*th alternative may be specified as follows:[21]

$$\text{Prob}(Y_i = j) = \frac{\exp(\mathbf{x}_i \boldsymbol{\beta}_j)}{\sum_{j=1}^{3} \exp(\mathbf{x}_i \boldsymbol{\beta}_j)} \tag{A.1}$$

where Y_i is the dependent variable, i.e. the firm's decision, with J=3 nominal alternative choices. The left hand side represents the probability of observing choice *j* given $\mathbf{x}_i$. $\mathbf{x}_i$ refers to the vector of the firm-, industry- and macro-level explanatory variables. The vector $\boldsymbol{\beta}_j$ includes the intercept and coefficients for the effect of x_i on choice *j*. There are no alternative-specific covariates in the model and $\boldsymbol{\beta}_j$ differs for each choice.

Unfortunately, multinomial logit model formulated above is not identified. The indeterminacy results from the fact that more than one set of parameters produces the same probabilities of the observed choices. This can be proved by multiplying Equation (A.1) by $\exp(\mathbf{x}_i \boldsymbol{\tau}) / \exp(\mathbf{x}_i \boldsymbol{\tau})$:

$$\text{Prob}(Y_i = j) = \frac{\exp(\mathbf{x}_i \boldsymbol{\beta}_j)}{\sum_{j=1}^{3} \exp(\mathbf{x}_i \boldsymbol{\beta}_j)} \times \frac{\exp(\mathbf{x}_i \boldsymbol{\tau})}{\exp(\mathbf{x}_i \boldsymbol{\tau})} = \frac{\exp(\mathbf{x}_i (\boldsymbol{\beta}_j + \boldsymbol{\tau}))}{\sum_{j=1}^{3} \exp(\mathbf{x}_i (\boldsymbol{\beta}_j + \boldsymbol{\tau}))}$$

The value of the probability does not change as this just multiplication by one, whereas, the initial parameters, $\boldsymbol{\beta}_j$, are replaced by $\boldsymbol{\beta}_j + \boldsymbol{\tau}$. Consequently, there is an infinite number of different parameter sets that result in the same predictions. A frequently used method to identify the model is to set one of the $\boldsymbol{\beta}$'s equal to zero. The choice of $\boldsymbol{\beta}_j$ is arbitrary. In the following, it is assumed that $\boldsymbol{\beta}_1 = 0$. Adding this constraint results in reformulated multinomial logit model[22]

$$\text{Prob}(Y_i = j \mid \mathbf{x}_i) = \frac{\exp(\mathbf{x}_i \boldsymbol{\beta}_j)}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_i \boldsymbol{\beta}_j)} \tag{A.2}$$

[21] See e.g. Greene (2003) pp. 720-722, Long (1997) pp.151-156, and Skrondal and Rabe-Hesketh (2004) pp. 28-29 and 36-38.
[22] See Long (1997) pp. 153-154.

Multinomial discrete choice models can be motivated by a random utility model. These models are based on utility maximization and derived by introducing utilities U_{ij} for each agent *i* and choice *j*. It is assumed that the alternative with greatest utility is chosen. Thus, the probability that the choice *j* is made is the following:

$$\text{Prob}(U_{ij} > U_{ik}) \qquad \text{for all other } k \neq i$$

The utility of choice *j* is modeled as

$$U_{ij} = \mathbf{x}_i \boldsymbol{\beta}_j + \varepsilon_{ij} \tag{A.3}$$

where $\mathbf{x}_i \boldsymbol{\beta}_j$ is called a linear predictor and ε_{ij} is a random term. In his influential paper McFadden (1973) has shown that if and only if the ε's are independent and identically distributed with a type I extreme-value distribution for all *i*:[23]

$$f(\varepsilon_{ij}) = \exp(-\varepsilon_{ij} - \exp(-\varepsilon_{ij}))$$

then the random utility model leads the above-discussed multinomial logit model (See Equation (A.2)). Equation (A.2) is the basis for the maximum-likelihood method used to estimate $\boldsymbol{\beta}$'s. The probability of a firm *i* choosing the alternative that it was actually observed to choose can be expressed as

$$\prod_{j=1}^{3} \left[\frac{\exp(\mathbf{x}_i \boldsymbol{\beta}_j)}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_i \boldsymbol{\beta}_j)} \right]^{y_{ij}} \tag{A.4}$$

where y_{ij}=1 if the firm *i* chose *j* and zero otherwise. Note that since y_{ij}=0 for all the nonchosen alternatives, this term is simply the probability of the chosen alternative. Assuming that the observations are independent the likelihood for *N* observations may be written as

$$\prod_{i=1}^{N} \prod_{j=1}^{3} \left[\frac{\exp(\mathbf{x}_i \boldsymbol{\beta}_j)}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_i \boldsymbol{\beta}_j)} \right]^{y_{ij}} \tag{A.5}$$

[23] This is also called Gumbel distribution and it looks like normal distribution that is skewed to the right with a thinner tail on the left and thicker tail on the right. It has mode 0, mean 0.58, and standard deviation 1.28.

Taking logs results in the following log-likelihood function

$$\sum_{i=1}^{N}\sum_{j=1}^{3} y_{ij} \ln\left[\frac{\exp(\mathbf{x}_i\boldsymbol{\beta}_j)}{1+\sum_{j=2}^{3}\exp(\mathbf{x}_i\boldsymbol{\beta}_j)}\right] \tag{A.6}$$

Appendix III: Assessing the Independence of Irrelevant Alternatives (IIA) Assumption

As discussed in Section 4 the standard multinomial model is based on the assumption of independence of irrelevant alternative (IIA). This is a relatively strong assumption and thus it is important to assess the validity of the assumption. Hausman and McFadden (1984) proposed a test (hereafter Hausman test) based on the idea that if a subset of the choice set is truly irrelevant, excluding it from the model will not alter parameter estimates systematically. Omitting these choices may be inefficient but will not lead to inconsistency. The Hausman test is conducted in three steps: First, the full model is estimated including all the alternative choices. Second, a restricted model is estimated by excluding one or more choices. Third, the following test statistic is used

$$H = (\hat{\beta}_s - \hat{\beta}_f)'[\hat{V}_s - \hat{V}_f]^{-1}(\hat{\beta}_s - \hat{\beta}_f) \tag{A.7}$$

where $\hat{\beta}_s$ and $\hat{\beta}_f$ indicate the estimates based on the restricted subset and full set of choices, respectively. $\hat{V}_s$ and $\hat{\mathrm{V}}_f$ are the respective estimates of the asymptotic covariance matrices. The statistic has a limiting chi-squared distribution with degrees of freedom equal to the number of rows in if IIA holds.[24] Significant values of *H* indicate that the IIA assumption is violated.

Table A5 presents the results of the Hausman test using Specification (2) in Table 1. Two tests are performed. They correspond to excluding one of the two nonbase categories, i.e. decisions to establish and close down plants. Neither of the tests seems to reject the null hypothesis that IIA holds. The test statistics are even negative. Hausman and McFadden suggest that a negative result is evidence that IIA is not violated. The results of the other specifications are similar to those of this specification.

[24] See Greene (2003) p. 724 and Long and Freese (2003) pp. 207-210.

Table A5 Hausman test of the IIA assumption

Ho: Odds (outcome-j vs outcome-k) are independent of other alternatives				
Omitted	Chi2	df	P>chi2	evidence
Decision to open a plant	-7.855	20	1	For Ho
Decision to close a plant	-28.487	18	1	For Ho

Small and Hsiao (1985) proposed an alternative test to examine the validity of the IIA assumption. In this test the data set is divided randomly into two subsets of about equal size. The unrestricted model is estimated for both subsets where $\hat{\beta}_u^{S_1}$ refers to estimates of the unrestricted model on the first subset, and $\hat{\beta}_u^{S_2}$ is its counterpart for the second subset. A weighted average of the coefficients is computed as follows:

$$\hat{\beta}_u^{S_1S_2} = \left(1/\sqrt{2}\right)\hat{\beta}_u^{S_1} + \left[1-\left(1/\sqrt{2}\right)\right]\hat{\beta}_u^{S_2}$$

After this, a restricted sample is created using the second sub-sample by eliminating all outcomes with a chosen value of the dependent variable. The model is the estimated using the restricted sample with $\hat{\beta}_r^{S_2}$ referring to the estimated coefficients and $L(\hat{\beta}_r^{S_2})$ indicating the likelihood. Finally, the following test statistic is used which is asymptotically distributed with degrees of freedom equal to the number of independent variables plus one.

$$SH = -2\left\{L(\hat{\beta}_u^{S_1S_2}) - L(\hat{\beta}_r^{S_2})\right\} \quad \text{(A.8)}$$

Table A6 displays the results concerning Small-Hsiao test of the IIA assumption using Specification (2). Test results support the null hypothesis in the case where the alternative to open a plant is omitted, but when the alternative to close down a plant is omitted the test results suggest that the null hypothesis is violated. The test results are similar for other model specifications except for the specification including initial debt as an explanatory variable. In this case, both tests support the null hypothesis.

Long and Freese (2003) point out that the results of the Hausman and Small-Hsiao tests may vary considerably and thus provide little guidance to violations of the IIA assumption. A general advice concerning the use of multinomial logit model given by Long and Freese (2003 p. 210) is that the model should be specified such that it involves distinct outcomes that are not substitutes for one another. McFadden (1973) suggests that multinomial logit models should only be used in cases where the outcome categories "can plausibly be distinct and weighed independently in the eyes of the decision maker". Furthermore, Amemiya (1981) argues that multinomial logit models work well when the alternatives are not similar or substitutes for one another.

Table A6 Small-Hsiao test of the IIA assumption

Ho: Odds (outcome-j vs outcome-k) are independent of other alternatives						
Omitted	lnL(full)	LnL(omit)	Chi2	df	P>chi2	evidence
Decision to open a plant	-2521.628	-2508.015	27.227	21	0.163	for Ho
Decision to close a plant	-743.613	-718.51	50.205	21	0	against

Appendix IV: Correlated Alternative-Specific Random Intercept Model

The difference between the standard and random-effects multinomial logit models is that in the latter the choice probability is conditional on random effects in addition to the exogenous variables. The conditional probability can be expressed as follows:

$$\text{Prob}(Y_{kt} = j \mid \gamma_{kj}) = \frac{\exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})} \quad \text{(A.9)}$$

where $\mathbf{x}_{kt}\boldsymbol{\beta}_j$ is a deterministic fixed part representing observed heterogeneity between the choice situation of each firm, *t*, and firms, *k*. The vector $\mathbf{x}_{kt}$ varies over observations and/or firms but not over alternatives, *j*. The corresponding fixed coefficient vector is $\boldsymbol{\beta}_j$. γ_{kj} represents the alternative-specific random intercepts inducing unobserved heterogeneity that is dependent across alternatives, *j*, and firms, *k*. ε_{ikj} is the alternative specific error term representing unobserved heterogeneity that is independent across alternatives, observations, and firms. As in the standard multinomial model all effects for the choice *j*=1 are set to 0. Thus, there are two random effects for choice equals 2 and 3. The random effects are assumed to follow normal distribution and to be independent of the alternative-specific error term.

The longitudinal nature of the data used in the study allows for the analysis of sequence of choice situations faced by firms each year. The conditional probability that a firm makes a certain sequence of choices may be computed by multiplying the probabilities of each choice in the sequence of choice situations:

$$\prod_{t=1}^{T}\prod_{j=1}^{3}\left[\frac{\exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})}\right]^{y_{ktj}} \quad \text{(A.10)}$$

where y_{ktj}=1 if Y_{kt}=j and zero otherwise. T indicates the total number of choice situations faced by the firm.

The unconditional probability is derived by integrating the standard multinomial logit probabilities. In order to obtain the likelihood contribution, it is necessary to integrate out random term γ_{kj} with the corresponding normal density.

$$\int \prod_{t=1}^{T} \prod_{j=1}^{3} \left[\frac{\exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})} \right]^{y_{ktj}} \phi(\gamma_{kj}) d\gamma_{kj} \tag{A.11}$$

For the parameter estimation, the marginal log-likelihood from the K firms may be written as

$$\ln L = \sum_{k=1}^{K} \int \prod_{t=1}^{T} \prod_{j=1}^{3} \left[\frac{\exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})}{1 + \sum_{j=2}^{3} \exp(\mathbf{x}_{kt}\boldsymbol{\beta}_j + \gamma_{kj})} \right]^{y_{ktj}} \phi(\gamma_{kj}) d\gamma_{kj} \tag{A.12}$$

Unfortunately, this integral does not have a simple closed form solution. Thus, the integral has to be approximated by numerical integration. Since these distributions are assumed to be normal, adaptive Gauss-Hermite quadrature may be used to approximate the integral of the marginal log-likelihood function. The approximation is based on summation on a specific number of quadrature points for each dimension of integration. The solution goes over the Q^r quadrature points, with summation replacing the integration over the random effect distribution. The conditional probabilities are obtained by substituting the random-effect vector by the current r-dimensional vector of quadrature points B. Finally, the marginal log-likelihood is maximized by Newton-Raphson method using numerical first and second derivatives.