

# How Business Opportunities Constrain Young Technology-Based Firms from Growing into Medium-Sized Firms

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**ABSTRACT.** This paper analyses how the novelty of business opportunities at start-up constrains young technology-based firms from attaining substantial growth and becoming medium-sized. Data from 262 young Swedish technology-based firms are used to estimate a logit regression model relating different types of opportunities to the probability of becoming medium-sized. The results show that firms which seek to exploit opportunities based on new market knowledge are less likely to attain substantial growth than firms that seek to exploit opportunities based on existing market knowledge. The former class of firms can nevertheless increase the probability of such growth by actively seeking external financing.

## Introduction

Many studies have examined barriers to growth in young and small firms and, generally, found growth constraints to be of three types: lack of management competence or motivation, lack of resources, and lack of business opportunities (e.g. Barber et al., 1989).

The purpose of this paper is to analyse how the novelty of business opportunities at start-up constrains young technology-based firms from attaining substantial growth. Through deductive analysis of the effects of differences in novelty of business opportunities on the build-up of management competence and on the need for external financing, two sets of hypotheses are proposed. These hypotheses are empirically tested by using a logit regression model.

Young technology-based firms (YTBFs) are recently established firms where the novelty of start-up opportunities is likely to affect whether they attain substantial growth or not. YTBFs are likely to be involved in activities of very diverse novelty. They take part in the creation and diffusion of new technology, the creation and early development of new markets and industries as well as the renewal of old ones (Rickne, 2000). The degree of novelty of the business opportunity at start-up is likely to affect the obstacles that the founders face when pursuing its profitable exploitation, and hence, to affect their chances of survival and substantial growth.

Young technology-based firms are also likely to be sensitive to start-up conditions regarding the scope of the business opportunities that their founders seek to exploit. This scope is highly constrained by the founders' technical expertise. Due to these constraints, founders are unlikely to make fundamental changes in the scope of the opportunities that they seek, even if conditions turn out to be unfavourable (Oakey and Cooper, 1991).

The paper is structured as follows. First, the constraining influences of differences in the novelty of opportunities at start-up will be derived, resulting in two sets of hypotheses. Second, the sample used for estimating the logit regression model is described, as are the variables used in the model. Third, the results are presented, in terms of both the estimation of the model and analysis of complementary descriptive data. Finally, the results are discussed and further research is outlined.

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## Frame of reference and the development of hypotheses

This section is organized into two parts. First, the nature of business opportunities in young technology-based firms (YTBFs) and how their novelty can differ will be discussed. Second, it will be analysed, using Penrose's (1959) theory of growth and results from recent research, how these differences in novelty influence the likelihood of being constrained from attaining substantial growth.

### *Business opportunities in young technology-based firms*

At start-up the focus of activity in technology-based firms is on the exploitation of a business opportunity that is based upon the technical expertise of the founders (Oakey and Cooper, 1991). This activity can lead to innovation, which in small firms usually is in the form of an introduction of a new product or service (Kirchhoff, 1994).

A business opportunity consists of productive possibilities that the firms' founders can identify, take advantage of, and are willing to act upon (Penrose, 1959). A business opportunity is believed to be profitable, but its future profitability is impossible to determine beforehand (Shackle, 1955, p. 81). This uncertainty is exaggerated in technology-based firms because of the uncertainty inherent in any technological development that may be needed before entering the market with a new product or service (Garnsey, 1995).

The novelty of the business opportunity, and the subsequent innovation, may differ greatly among firms. Some firms may introduce products and services that are new to the world, while others may introduce refinements of existing ones, or similar products at a lower price.

The novelty of the business opportunity is closely related to the novelty of the founders' knowledge base. As the opportunities that founders can identify are based on their prior knowledge (Penrose, 1959; Shane, 2000), novel business opportunities cannot be identified without novel knowledge. Similarly, it is difficult to identify opportunities for refinement without knowledge of what is to be refined.

Two dimensions of the founders' knowledge

base are important determinants of the novelty of the opportunities they seek to exploit: technical knowledge and market knowledge (Abell, 1980; Autio and Lumme, 1998).

The technical knowledge that the opportunity is based on can be well known and common to a large population of experts, e.g. a particular field of engineering. It can also be less well known, at least to the population of experts that are serving particular markets. This may be due to novelty of the knowledge as such, or due to geographical or industrial differences in diffusion. When technical knowledge is less well known, universities may have an important role for both producing and diffusing new technical knowledge (Gibbons et al., 1994).

In the same way, the market knowledge that the opportunity is based on can be more or less well known. The founders, and others, are less likely to have knowledge of markets and industries that are emerging. On the other hand, previous working experience from within existing firms is an important source of knowledge of existing markets and industries (Cooper, 1986).

Based on the above two dimensions of knowledge, one can analytically discern four types of opportunities in young technology-based firms, each representing a different degree and type of novelty (Figure 1).

First, opportunities can be based on existing technical knowledge and existing market knowledge (ET-EM). This type of opportunity is likely to lead to incremental innovations, if any innovations at all. Second, opportunities can be based on new technical knowledge but existing market knowledge (NT-EM). This type of opportunity leverages new technology to existing markets,

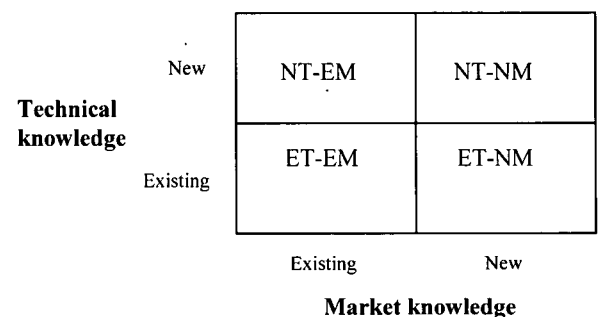


Figure 1. Types of business opportunity in young technology-based firms.

possibly adding new features and improving the performance of previous products. Third, opportunities can be based on existing technical knowledge but new market knowledge (ET-NM). This type of opportunity uses existing technical knowledge to address a new set of customer requirements. It may be related to the emergence of new industries or changes in existing ones. Fourth, opportunities can be based on new technical knowledge and new market knowledge (NT-NM). This type of opportunity addresses a new set of customer requirements by using new technical knowledge, and may lead to radical innovation if successful.

So far, four different types of opportunities have been identified. The novelty of these types ranges from low, when opportunities are only based on existing knowledge, to high, when opportunities are only based on new knowledge. The next step is to investigate how these different types of opportunities at start-up may constrain young technology-based firms from attaining substantial growth. A useful point of departure is Penrose's (1959) theory of the growth of the firm. Her objective was to analyse the limits to growth by creating a theory of the process of firm growth.

#### *Business opportunities and substantial growth*

Firm growth is a process of development leading to an increase in size (Penrose, 1959, p. 1). The pattern of development, as well as the growth rate, can vary greatly across time periods for individual firms and across firm size, age and industry affiliation (Delmar et al., 2002; Audretsch, 1995).

Many studies of growth in young and small firms seek to explain differences in growth rates (Delmar, 1997). Instead, this study aims at explaining what constrains new firms from attaining substantial growth. To attain substantial growth is to make the transition from being a small founder-managed firm focused on innovation into being a professionally managed firm where internal pressures are exerted for further growth (Hofer and Charan, 1984; Garnsey, 1998).

Growth in any single time period, according to Penrose (1959), is made possible by opportunities identified by the firms' entrepreneurs. In order to accomplish growth, the firms' managers need to be willing to act upon these opportunities, to

plan for their exploitation, and to obtain the necessary resources to carry out the plans. After a period of expansion, increased resources and knowledge will provide incentives, as well as opportunities, for further expansion. The development of knowledge is cumulative and new opportunities for growth are therefore likely to be related to previous opportunities.

Based on assumptions about the general availability of resources and of profitable opportunities, Penrose (1959, pp. 43–49) argued that the limit to how fast a firm can grow in any time period is set by the capacity of the firm's managerial resources. She argued that new management capacity could only be developed within the firm by using current managerial resources. Only by being a member of the management team could new managers learn what is needed for creating and executing expansion plans for a particular firm. Hence, the capacity of the current management team will constrain both the degree of expansion possible during the current period and the increase in new management capacity during the next period.

The capacity of management in each firm is dependent on the amount of managerial resources and the knowledge that these human resources possess. This collection of knowledge is the foundation for identifying business opportunities and pursuing them in a profitable manner leading to growth (Penrose, 1959; Shane, 2000).

At start-up, managerial resources tend to be scarce and limited to the founding team. The management capacity in the new firm is therefore built upon the knowledge of the founders – the same knowledge that is the foundation of the opportunity they have selected to exploit. As the novelty of that knowledge is likely to affect the difficulty of finding a way to pursue the opportunity in a profitable manner, the type of opportunity is likely to affect the time it takes to build up the management capacity that is needed for growth. The more time it takes to build up the management capacity, the more growth-constrained the firm becomes, and the less likely to attain substantial growth.

Various researchers have observed how different "lead times" may affect the growth of YTBFs. Oakey and Cooper (1991) observe that firms in different high-tech industries, such as biotechnology and software, differ greatly in how

long it takes them to get a new product to the market, and these differences affect the firms' ability to attain fast growth. Roberts (1991) also observes that success in MIT spin-offs is related to the amount of technology transfer from earlier employers. He argues that the technology is more mature and will take less time to develop into products when the technology transfer is high.

Other researchers have used business similarity of parent organization (previous employer) as a measure of lead times. Feeser and Willard (1990) found that new technology-based firms which obtained high growth were similar to their parents in both the technology utilized and the markets served. Chandler (1996) also found that task environment similarity (same customers, industry, competitors, and technology) between the parent organization and the new venture positively moderated the relationship between pre-ownership experience and sales growth.

Research on small and young technology-based firms tends to emphasize the uncertainty related to development of new technical knowledge (e.g. Garnsey, 1995; Oakey and Cooper, 1991; Roberts, 1991). But this uncertainty is likely to be further exaggerated by uncertainty related to the development of new markets and industries. In Klepper and Graddy's (1990) study, the average time from the creation of a new industry to its stability was 29 years. It takes time to spread knowledge about a new set of customer requirements and to gain legitimacy for their relevance (Aldrich and Fiol, 1994). Additionally, firms may be dependent on the development of complementary technologies and institutions, which takes time and involves a number of external actors of different types (Nelson, 1994; Rickne, 2000; Lindmark, 2002).

There is some evidence that 'lead times' are longer when opportunities are based on new market knowledge, as compared to opportunities based on new technical knowledge. Eisenhardt and Shoonhoven (1990) found that semiconductor firms were less likely to grow in emerging markets as compared to existing markets, but found no relationship between growth and the newness of technology. Autio and Lumme (1998) also found in their sample of Finnish new technology-based firms that firms entering new markets with existing technology had obtained significantly less sales growth than firms entering existing markets

with new technology. Autio and Lumme's results are not very definite as they found no significant differences in employment growth between these two types of firms, and did not control for other variables that may affect growth, such as age.

The above reasoning leads to the conclusion that young technology-based firms seeking opportunities based only on existing knowledge are less likely to be growth-constrained than firms seeking opportunities based on new knowledge. Additionally, firms seeking to exploit opportunities based on new market knowledge and existing technical knowledge are more likely to be growth-constrained than firms seeking to exploit opportunities based on new technical knowledge and existing market knowledge. Finally, firms seeking to exploit opportunities based on both new market knowledge and new technical knowledge are the most likely to be growth-constrained. These conclusions lead to the first set of hypotheses:

*Hypothesis 1:* The novelty of business opportunities at start-up will affect the likelihood that an YTBf will attain substantial growth.

*Hypothesis 1a:* YTBfs seeking to exploit opportunities based on new knowledge are less likely to attain substantial growth than YTBfs seeking to exploit opportunities based on existing knowledge.

*Hypothesis 1b:* YTBfs seeking to exploit opportunities based on new market knowledge and existing technical knowledge are less likely to attain substantial growth than YTBfs seeking to exploit opportunities based on new technical knowledge and existing market knowledge.

*Hypothesis 1c:* YTBfs seeking to exploit opportunities based on new market knowledge and new technical knowledge are less likely to attain substantial growth than other YTBfs.

The time it takes to pursue an opportunity in a profitable manner is highly related to the amount and the quality of available resources. The longer time it takes before firms become profitable, the more firms have to rely on external sources of resources, especially financial resources. Hence, firms seeking to exploit opportunities that have

long "lead times" may also face financial limitations that may further constrain them from attaining substantial growth. The degree of these limitations is determined by the difficulty in obtaining external financing and how sensitive firms are to such difficulties. For example, firms that need to finance extensive technological development before generating any revenues are more growth constrained by difficulties in getting access to financing than are firms that are able to quickly generate revenues.

In young technology-based firms, differences in opportunities are likely to influence both the difficulty in obtaining external financing, and how growth constraining this difficulty is for the firm. Previous research has found that YTBFs are especially prone to financial constraints (Garnsey, 1995; Murray and Lott, 1995; Lockett et al., 2002) and that the degree of those constraints is related to their technical sophistication (Westhead and Storey, 1997). The main argument is that the constraints experienced by YTBFs are due to the lack of willingness, competence, or both, of existing financial markets to provide financial capital to firms facing technological uncertainty. This results in a failure of borrowers and lenders to reach an agreement on the price and conditions for financial support.

If the knowledge on which firms base their opportunity is widely known, it may be easier to get access to financial resources on favourable terms. Financiers may be more confident in estimating risks when opportunities are based on existing knowledge, and founders may be more proficient in convincing the financier about the viability of the opportunity. The opposite is true for opportunities based on new knowledge, especially new market knowledge. When markets are emerging, or do not even exist, it is likely to be more difficult to convince financiers about the viability of an opportunity, as compared to opportunities where the size of the potential market might be known.

The type of opportunity is unlikely to be the only factor explaining the difficulties facing the young technology-based firms when trying to access external sources of financing. There may be individual differences in the ability and willingness to seek external financing (Penrose, 1959), and environments differ in their capacity of

providing financial support (Aldrich, 1979). For whatever reasons firms have difficulties in accessing external financing, the type of opportunity is likely to influence how growth constraining these difficulties are. Firms that seek to exploit opportunities based on new knowledge are likely to be more dependent on external financing than firms seeking to exploit opportunities based on existing knowledge. It is likely to take more time for them to generate own revenues and to obtain the management competence needed to attain substantial growth. As above, one can expect firms that seek to exploit opportunities based on new market knowledge to be more dependent on external financing than firms depending on new technical knowledge.

Thus, it can be argued that firms seeking opportunities based only on existing knowledge are less likely to be growth-constrained due to difficulties in getting access to external financing than firms seeking opportunities based on new knowledge. Additionally, firms seeking to exploit opportunities based on new market knowledge and existing technical knowledge are more likely to be growth-constrained due to such difficulties than firms seeking to exploit opportunities based on new technical knowledge and existing market knowledge. Finally, firms seeking to exploit opportunities based on both new market knowledge and new technical knowledge are the most likely to be growth-constrained due to such difficulties. These conclusions lead to the second set of hypotheses:

*Hypothesis 2:* The novelty of business opportunities at start-up will moderate how difficulties in getting access to external financing influence the likelihood that a YTBF will attain substantial growth.

*Hypothesis 2a:* Difficulties in getting access to external financing are more likely to constrain YTBFs seeking to exploit opportunities based on new knowledge from attaining substantial growth than YTBFs seeking to exploit opportunities based on existing knowledge.

*Hypothesis 2b:* Difficulties in getting access to external financing are more likely to constrain YTBFs seeking to exploit opportuni-

ties based on new market knowledge and existing technical knowledge than YTBFs seeking to exploit opportunities based on new technical knowledge and existing market knowledge.

*Hypothesis 2c:* Difficulties in getting access to financing are more likely to constrain YTBFs seeking to exploit opportunities based on both new market knowledge and new technical knowledge from attaining substantial growth than other YTBFs.

Figure 2 summarizes the proposed relationships between differences in the type of opportunity, difficulty in getting access to external financing, and the probability of attaining substantial growth.

The type of opportunity is hypothesized to influence the probability that firms attain substantial growth in two ways. First, differences in the type of opportunity is hypothesized to influence this probability directly due to differences in the time it takes to build up sufficient management capacity to exploit the opportunity in a profitable manner (H1). Second, the type of opportunity is hypothesized to influence the probability of attaining substantial growth indirectly through its moderating influence on the effects of difficulties in getting access to external financing (H2).

It was also argued that the type of opportunities would influence the difficulty in getting access to financing. Hence, it could be expected that differences in the type of opportunities could also influence the probability that firms attain sub-

stantial growth through influences on these difficulties. To reduce the complexity of the logit regression model this relationship was not included in the model. Instead, complementary data on external financing of the firms in sample is analysed to investigate the assumptions made about differences in the need for external financing and difficulties in obtaining such financing.

In the next section the methods and sample used to test the two sets of hypotheses are described.

## Method and sample

To test the hypotheses, a logit regression model is estimated for a sample of YTBFs<sup>1</sup> in Sweden. In this section the identification of the sample is described, as are the variables and measures included in the model.

### Sample

Based on information from the Swedish Bureau of Statistics (SCB) all firms fulfilling the following criteria were included in a population of Swedish YTBFs:

- The firms should be founded between 1975 and 1993.
- In 1993 the firms should have at least three employees, of whom at least one should have a university degree in engineering, natural science or medicine.
- The firms should not have been established as

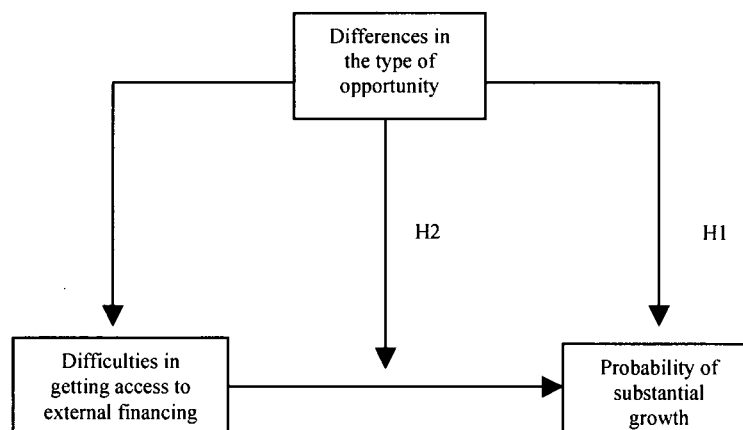


Figure 2. Summary of the proposed relationships between differences in the type of opportunities, difficulties in getting access to external financing, and the probability of attaining substantial growth.

a foreign direct investment or as a diversification from a larger firm.<sup>2</sup>

- The firms should belong to industries, both manufacturing and industry-related services, that can be termed knowledge-intensive.<sup>3</sup>

In 1998 a postal questionnaire was sent to all surviving firms (1,190) belonging to the population. After a single reminder, 400 firms had responded to the survey, of which 344 had answered the questionnaire. Additionally 20 firms answered it after a telephone reminder. These answers were used to test response bias. Since no significant difference was found between respondents and non-respondents regarding age and size distribution, the 20 firms were added to the sample. Thus, the total sample of firms having answered the postal questionnaire consists of 364 firms.

Of these 364 firms, only 262 provided complete answers that could be used for model estimation, while 102 answers had missing values for at least one of the variables used in the model. Since the size and age distribution of the 102 firms having missing values did not differ significantly from the distribution of the total sample of 364, it was considered unlikely that removing the answers with the missing values from the sample would bias the results. Hence, the final sample of YTBFs used for model estimation consists of 262 firms, or 22% of the identified population. Of these, 36 were medium-sized or larger.<sup>4</sup>

#### *Variables and measures*

**Substantial growth.** The hypotheses proposed in the previous section are concerned with how differences in the types of business opportunities at start-up may constrain young technology-based firms from obtaining substantial growth. To attain substantial growth is to make the transition from being a small founder-managed firm focused on innovation into being a professionally managed firm where internal pressures are exerted for further growth (Hofer and Charan, 1984; Garnsey, 1998).

This transition is related to changes in organizational structure, which are related to the number of employees. The number of employees is therefore an appropriate measure for estimating when

firms have attained substantial growth. While it is impossible to determine the exact point of transition that fits all firms, the EU definition of medium-sized firms (50–249 employees) was used in this study. Firms that had become medium-sized or larger were therefore considered to have attained substantial growth.

The dependent variable of substantial growth in the model is therefore a categorical variable having the value of 1 for those firms having 50 employees or more, and 0 for those having less than 50 employees.

#### *Difficulties in getting access to external financing.*

In the postal questionnaire, the respondents were asked to report the difficulty they had experienced in obtaining external financing, both at start-up and later. Difficulty was reported on a scale from 1 to 5, ranging from very easy to very difficult, for different financial sources. The different sources included self-financing, business angels, venture capital, various sorts of loans, government support, and "other" sources of financing.

The variable used in the model was constructed by calculating a single average from all the reported external sources, both at start-up and later. For those firms which reported that they were wholly self-financed, which can be considered as the lowest degree of difficulty in getting access to external financing, the variable was set to zero.

**Opportunities.** Two measures were used to quantify the newness of market and technical knowledge.

First, if the new firm had any business relations at start-up with former employers, the business opportunity was considered to be based on existing market knowledge. If there were no business relations at start-up, or if the founders did not have any previous employment, the business opportunity was considered to be based on new market knowledge. Founders coming directly from the university belong to the latter category.

This measure of market knowledge captures well whether opportunities are based on knowledge of existing markets and industries. The measure may nevertheless overestimate the newness of market knowledge in some of the cases where founders had no business relationships with

previous employers, or had no previous employer. It is therefore possible that the results are biased towards less difference between new and existing knowledge.

Second, if the respondent reported that universities or research institutes had been important at start-up, the business opportunity was considered to be based on new technical knowledge. If the respondent did not report this, the business opportunity was considered to be based on existing technical knowledge.

The measure of technical knowledge captures well those cases where the technical knowledge is new due to strong links to science. The measure may nevertheless underestimate the newness of technical knowledge in some of the cases where there is no relationship with universities or research institutes at start-up. Firms, especially large firms, may develop new technology that can be used by independent spin-offs without any links with universities or research institutes at start-up. It is therefore possible that the results are biased towards less difference between new and existing knowledge.

Based on the above two measures of market knowledge and technical knowledge at start-up, the four categories of opportunities were created:

- 1) ET-EM: Existing technical knowledge and existing market knowledge
- 2) NT-EM: New technical knowledge and existing market knowledge
- 3) ET-NM: Existing technical knowledge and new market knowledge
- 4) NT-NM: New technical knowledge and new market knowledge

*Control variables.* Three variables were included in the model as control variables: growth intentions, age and industry.

The lack of growth intentions has been found to constrain the growth of many small firms (Davidsson, 1989), including technology-based firms (Oakey, 1994). Growth intentions were measured as self-reported intentions about future growth. The growth intentions were reported on a scale of 1–4, ranging from reducing the number of employees to greatly increasing the number of employees.

As the process of growth takes time, older firms

should be more likely to have obtained substantial growth, all other things equal. Age in years is therefore included as a control variable.

Previous research has shown that growth rates of new firms vary between industries. In his study of manufacturing industries, Audretsch (1995) found relationships between growth rates of firms on one hand, and industry innovation rate, industry growth rate, and minimum efficient scale in an industry, on the other. Differences in innovation rates were not controlled for here, as the whole sample in this study belongs to industries with relatively high rates of innovation. A control variable measuring differences in industry growth in Sweden at the two-digit level was constructed and tested, but was found to have no effect, either on the coefficients in the model or on the model fit. It was therefore not included in the final model. A variable that classifies firms as belonging to either manufacturing industries or industry-related services was used to control for differences in minimum efficient scale between these two types of activities. This variable has the value of one for service firms, and the value of zero for manufacturing firms.

*Descriptive statistics and correlation.* The descriptive statistics and correlations for the non-categorical independent variables are presented in Table I. There is little correlation between the variables, reducing the risk of disturbing effects due to multi-collinearity.

In Table II the descriptive statistics and frequencies for the independent variables in the logit model are displayed for YTBFs that have attained substantial growth (growth firms) and YTBFs that have not (constrained firms).

#### *Analysis and model estimation*

The four categories of opportunities were included in the model by using three dummy variables. The interaction effects between types of opportunities and difficulty in getting access to external financing (the opportunity and difficulty variables) were modelled by adding three variables, each a multiplication of the difficulty variable and the corresponding opportunity variable. In effect, a logit model including the difficulty variable and the control variables was simultaneously estimated

TABLE I  
The descriptive statistics and correlations for the non-categorical independent variables

| Variable                                        | Descriptive statistics |      | Correlations |       |      |
|-------------------------------------------------|------------------------|------|--------------|-------|------|
|                                                 | Mean                   | S.D. | 1.           | 2.    | 3.   |
| 1. Difficulties in accessing external financing | 2.24                   | 1.44 | 1.00         |       |      |
| 2. Growth intentions                            | 3.12                   | 0.71 | 0.10         | 1.00  |      |
| 3. Age                                          | 11.66                  | 4.85 | -0.07        | -0.12 | 1.00 |

TABLE II  
Descriptive statistics (means and SDs) and frequencies of the variables in the logit model for YTBFs that have attained substantial growth (growth firms) and those YTBFs that have not attained substantial growth (constrained firms)

| Variables                                | Constrained firms<br>N = 224 | Growth firms<br>N = 36 |
|------------------------------------------|------------------------------|------------------------|
| Difficulties in accessing ext. financing | 2.2 (1.4)                    | 2.4 (1.5)              |
| Growth intentions                        | 3.1 (0.70)                   | 3.5 (0.69)             |
| Age                                      | 11.3 (4.0)                   | 13.3 (8.0)             |
| Industry                                 |                              |                        |
| Manufacturing                            | 25%                          | 42%                    |
| Service                                  | 75%                          | 58%                    |
| Opportunities                            |                              |                        |
| ET-EM                                    | 50%                          | 50%                    |
| NT-EM                                    | 17%                          | 21%                    |
| ET-NM                                    | 15%                          | 18%                    |
| NT-NM                                    | 18%                          | 11%                    |

ET = Existing Technical Knowledge, EM = Existing Market Knowledge, NT = New Technical Knowledge, NM = New Market Knowledge.

for the four different types of opportunities, allowing for differences between groups in both the coefficient of difficulty variable and the constant term. In that way it could be tested whether the relationship between difficulties in accessing external financing and attaining substantial growth is different depending on the type of opportunity, and whether there is a direct relationship between the type of opportunity and attaining substantial growth.

A logit regression model with eleven parameters was estimated by using the STATA software package. First, a baseline model, including only the control variables, was estimated for comparison with the full model. Second, three configurations of the full model were estimated, each including different sets of opportunity variables. The presentation of three different configurations makes the comparison between the relative effects of different opportunities easier. Each configura-

tion represents the same model, but the opportunity that is the point of reference when interpreting the coefficients is different in each configuration.

In addition to estimating the model, complementary data on external financing in the selected sample were analysed. The purpose of this additional analysis was to increase the robustness of the conclusions of the study. Investigating the assumptions made about external financing when deriving the hypotheses provides a better understanding of the results from the model.

A limitation of the study that is important to keep in mind when interpreting the results is the survivor bias inherent in the data. Because the data only include survivors, they can only answer questions about the characteristics of the surviving firms, not questions related to the characteristics of all firms belonging to the original population. Hence, we can only make inferences from our data about what constrains the surviving firms from

attaining substantial growth, not what constrains firms in general from doing so.

### Empirical results

The empirical results will be presented in two parts. The first part will present the estimated model. The second part will present complementary data on differences in external financing for young technology-based firms seeking different types of opportunities.

#### *Estimation of logit regression model*

The estimated logit regression model is presented in Table III, including both the baseline model and the three configurations of the full model (Models A, B, and C).

The baseline model including age, industry affiliation (manufacturing or service) and growth

intentions is highly significant, and age and growth intentions have significant influence on the probability of becoming medium-sized. This is consistent with previous research which predicts that younger firms, and firms with lower growth orientation, are less likely to have become medium-sized than older firms and firms with higher growth orientation.

The addition of the investigated variables doubles the explanatory power of the model, supporting the idea that the investigated variables have a significant influence on the likelihood of becoming medium-sized. In the full model the industry control variable is significant, indicating that service firms are less likely than manufacturing firms to grow into medium-sized firms. This is consistent with previous research which predicts that the minimum efficient scale is higher in manufacturing industries than in service industries.

TABLE III

The estimated logit regression model. The baseline model is a model including only the control variables. Models A, B, and C are the same full model with different dummy variables left out of the model to facilitate comparisons between different types of opportunities

| Variables                               | Baseline model | Model A  | Model B  | Model C  |
|-----------------------------------------|----------------|----------|----------|----------|
| Intercept                               | -6.52***       | -6.36*** | -6.36*** | -6.36*** |
| Age (A)                                 | 0.103**        | 0.104*** | 0.104*** | 0.104*** |
| Industry (I)                            | -0.703         | -1.04**  | -1.04**  | -1.04**  |
| Growth intentions (GI)                  | 1.20***        | 1.43***  | 1.43***  | 1.43***  |
| Difficulty in access to financing (DAF) |                | -0.330   | -0.163   | 1.08*    |
| ET-EM (O1)                              |                | -        | -0.0491  | 3.90*    |
| NT-EM (O2)                              |                | 0.0491   | -        | 3.95*    |
| ET-NM (O3)                              |                | -3.90**  | -3.95*   | -        |
| NT-NM (O4)                              |                | -7.19**  | -7.24*   | -3.29    |
| O1*DAF                                  |                | -        | -0.167   | -1.42*   |
| O2*DAF                                  |                | 0.167    | -        | -1.25*   |
| O3*DAF                                  |                | 1.42**   | 1.24*    | -        |
| O4*DAF                                  |                | 2.07**   | 1.90*    | 0.655    |
| Log likelihood                          | -95.3          | -85.7    | -85.7    | -85.7    |
| Model $\chi^2$                          | 26.3***        | 45.50*** | 45.50*** | 45.50*** |
| Pseudo $R^2$                            | 0.121          | 0.210    | 0.210    | 0.210    |

$N = 262$ , \* =  $p < 0.05$ , \*\* =  $p < 0.01$ , \*\*\* =  $p < 0.001$ .

$H_1$  (using Model A):  $O2 = O3 = O4 = 0$ ,  $p < 0.05$ .

$H_2$  (using Model A):  $O2*FC = O3*FC = O4*FC = 0$ ,  $p < 0.05$ .

O1: Opportunities based on existing technical knowledge and existing market knowledge (ET-EM).

O2: Opportunities based on new technical knowledge and existing market knowledge (NT-EM).

O3: Opportunities based on existing technical knowledge and new market knowledge (ET-NM).

O4: Opportunities based on new technical knowledge and new market knowledge (NT-NM).

### **Hypothesis 1: Direct influence of different types of opportunities**

Using post-estimation statistical tests, it was found that the coefficients of the dummy variables representing the different types of opportunities (O2-O4 in Model A) were, as a group, significantly different from zero ( $p < 0.05$ ). This supports Hypothesis 1, which stated that differences in the type of opportunities at start-up influence the probability of attaining substantial growth.

According to Hypothesis 1a, firms seeking to exploit opportunities based on existing technical knowledge and existing market knowledge (O1) should be less constrained than firms seeking other types of opportunities (O2-O4). This is supported for O3 and O4, i.e. opportunities that are based on new market knowledge, but not for O2, which is based on new technical knowledge and existing market knowledge.

According to Hypothesis 1b, firms seeking to exploit opportunities based on new technical knowledge and existing market knowledge (O2) should be more likely to attain substantial growth than firms seeking to exploit opportunities based on existing technical knowledge and new market knowledge (O3). The model supports this hypothesis.

According to Hypothesis 1c, firms seeking to exploit opportunities based on new technical knowledge and new market knowledge (O4) should be less likely to attain substantial growth than firms seeking other opportunities (O1-O3). This is only partially supported by the model. Firms seeking to exploit O4 were found to be significantly less likely to become medium-sized than firms seeking to exploit existing knowledge (O1) or new technical knowledge and existing market knowledge (O2) as predicted, but were not found to be significantly less likely to become medium-sized than firms seeking to exploit opportunities based on existing technical knowledge and new market knowledge (O3).

### **Hypothesis 2: Indirect influence of different types of opportunities**

Using post-estimation statistical tests, it was found that the coefficients of the variables representing the interaction between types of opportunities and

difficulty in accessing external financing (O2\*DAF, O3\*DAF, and O4\*DAF in Model A) were, as a group, significantly different from zero ( $p < 0.05$ ). This supports Hypothesis 2, which stated that differences in the type of opportunities at start-up moderate how the difficulty in getting access to external financing influences the probability of attaining substantial growth.

According to Hypothesis 2a, firms having difficulties in getting access to external finance should be more likely to attain substantial growth if they seek to exploit opportunities based on existing knowledge (O1) compared to other types of opportunities (O2-O4). This hypothesis is not supported. There is no difference found between firms seeking to exploit O1 and firms seeking to exploit opportunities based on new technical knowledge and existing market knowledge (O2). For both types of opportunities, the degree of difficulties in getting access to external financing has no significant effects on the probability of becoming medium-sized, even if it has a negative sign (see the coefficients for DAF in models A and B). There is a significant difference between firms seeking to exploit O1 and firms seeking to exploit opportunities based on existing technical knowledge and new market knowledge (O3) as well as firms seeking to exploit opportunities based on new technical knowledge and new market knowledge (O4). But instead of the expected negative relationship between difficulties of getting access to external financing and the probability of becoming medium-sized, the relationship is significantly positive for both O3 and O4. Hence, for firms seeking to exploit O3 and O4, those firms that report less difficulty in getting access to external financing are more likely to stay small.

Because of the positive relationship between the difficulty of getting access to external financing and the probability of attaining substantial growth for firms seeking to exploit O3 and O4, Hypothesis 2b and Hypothesis 2c are not supported. While firms seeking to exploit O3 differ significantly from firms seeking to exploit O2, the relationship between financial constraints and growth is positive instead of negative. As for Hypothesis 1, there is no significant difference between O3 and O4.

### External financing

Investigating differences in external financing across different types of opportunities may help to understand the reasons for the lack of support for Hypotheses 2a–2c. In this section complementary data are provided on the sources of financing obtained by the firms in sample (Table IV), the importance of each source (Table V), and the difficulties in accessing them (Table VI).

Table IV shows that the average number of sources of external financing increases with increased novelty of the opportunity, with the exception of opportunities based on new technical knowledge and existing market knowledge. These results are in line with the argument made earlier that firms seeking to exploit opportunities based on new knowledge are more dependent on external financing than firms seeking to exploit opportunities based on existing knowledge. This is especially true for firms seeking opportunities based on new market knowledge.

Table IV also shows that the degree of bank financing is similar for all types of opportunities, where around 60% of the firms have obtained bank financing. The degree of prepayment or loans from customers is also similar across different types of opportunities, even for the firms that seek to exploit new market knowledge.

Financing from private persons is three times as common in firms seeking to exploit opportuni-

ties based on both new technical knowledge and new market knowledge as for firms that seek to exploit opportunities based on existing knowledge. Financing by private persons includes investment by business angels.

Table IV also shows the importance of the "other" types of financing, especially for firms seeking to exploit opportunities based on both new technical knowledge and new market knowledge. Almost half of the firms have obtained financing from other sources than those that are considered traditional sources of venture financing. Table V also shows that this source of financing is of high importance for these firms.

Table V shows the relative importance of government support and venture capital for firms seeking to exploit opportunities based on new knowledge. Interestingly, government support seems to be especially important for firms seeking to exploit opportunities based on new technology, while venture capital firms are especially important for firms seeking to exploit new market knowledge.

Table V shows that the importance of external financing is higher for firms that seek opportunities based on new knowledge than for firms that seek opportunities based on existing knowledge. The importance of external financing is also highest for firms that seek to exploit opportunities based on both new technical knowledge and new market knowledge.

Table V also shows the relative importance of

TABLE IV  
Sources of external financing in young technology-based firms seeking different types of opportunities

| External sources of financing       | Opportunities           |                        |                        |                        |
|-------------------------------------|-------------------------|------------------------|------------------------|------------------------|
|                                     | ET-EM<br><i>N</i> = 130 | NT-EM<br><i>N</i> = 47 | ET-NM<br><i>N</i> = 40 | NT-NM<br><i>N</i> = 45 |
| Private persons                     | 6%                      | 11%                    | 8%                     | 20%                    |
| Prepayments or loans from customers | 22%                     | 13%                    | 18%                    | 24%                    |
| Government grants or loans          | 27%                     | 34%                    | 28%                    | 42%                    |
| Bank loans                          | 62%                     | 57%                    | 60%                    | 67%                    |
| Venture capital                     | 18%                     | 23%                    | 33%                    | 44%                    |
| Other                               | 32%                     | 26%                    | 33%                    | 47%                    |
| Average number of sources per firm  | 1.66                    | 1.64                   | 1.78                   | 2.44                   |

ET-EM: Opportunities based on existing technical knowledge and existing market knowledge.

NT-EM: Opportunities based on new technical knowledge and existing market knowledge.

ET-NM: Opportunities based on existing technical knowledge and new market knowledge.

NT-NM: Opportunities based on new technical knowledge and new market knowledge.

TABLE V

Importance of different external sources of financing for young technology-based firms seeking different types of opportunities (average and standard deviation)

| External sources of financing       | Opportunities    |                 |                 |                 |
|-------------------------------------|------------------|-----------------|-----------------|-----------------|
|                                     | ET-EM<br>N = 130 | NT-EM<br>N = 47 | ET-NM<br>N = 40 | NT-NM<br>N = 45 |
| Private persons                     | 3.00 (0.93)      | 2.60 (1.82)     | 2.83 (1.89)     | 3.67 (1.41)     |
| Prepayments or loans from customers | 3.73 (1.16)      | 3.44 (1.19)     | 4.19 (0.90)     | 3.95 (1.42)     |
| Government grants or loans          | 2.78 (1.56)      | 2.97 (1.19)     | 2.45 (1.06)     | 3.60 (1.45)     |
| Bank loans                          | 3.63 (1.19)      | 4.02 (1.01)     | 4.03 (1.14)     | 3.76 (1.20)     |
| Venture capital                     | 4.02 (1.12)      | 3.03 (1.57)     | 4.09 (1.26)     | 4.22 (1.15)     |
| Other                               | 3.68 (1.22)      | 3.60 (1.32)     | 3.68 (1.19)     | 4.19 (1.10)     |
| Total                               | 3.63 (1.14)      | 3.80 (1.03)     | 3.74 (1.05)     | 3.99 (1.08)     |

ET-EM: Opportunities based on existing technical knowledge and existing market knowledge.

NT-EM: Opportunities based on new technical knowledge and existing market knowledge.

ET-NM: Opportunities based on existing technical knowledge and new market knowledge.

NT-NM: Opportunities based on new technical knowledge and new market knowledge.

Importance is measured on a scale 1 to 5, where 1 is very little importance and 5 is very high importance.

TABLE VI

Difficulties in getting access to external sources of financing for young technology-based firms seeking different types of opportunities (average and standard deviation)

| External sources of financing       | Opportunities    |                 |                 |                 |
|-------------------------------------|------------------|-----------------|-----------------|-----------------|
|                                     | ET-EM<br>N = 130 | NT-EM<br>N = 47 | ET-NM<br>N = 40 | NT-NM<br>N = 45 |
| Private persons                     | 3.06 (0.42)      | 4.33 (0.62)     | 3.00 (2.00)     | 2.91 (1.26)     |
| Prepayments or loans from customers | 2.29 (1.08)      | 2.69 (0.91)     | 3.14 (1.57)     | 2.88 (1.20)     |
| Government grants or loans          | 2.85 (1.46)      | 3.62 (1.05)     | 3.05 (1.11)     | 3.30 (1.23)     |
| Bank loans                          | 2.43 (1.27)      | 2.85 (1.26)     | 2.63 (1.07)     | 2.68 (1.22)     |
| Venture capital                     | 3.26 (1.20)      | 4.03 (1.03)     | 3.40 (1.23)     | 3.13 (0.95)     |
| Other                               | 2.12 (1.58)      | 2.42 (0.96)     | 3.00 (1.41)     | 2.63 (1.41)     |
| Total                               | 2.47 (1.17)      | 3.18 (1.12)     | 2.87 (0.98)     | 2.74 (1.04)     |

ET-EM: Opportunities based on existing technical knowledge and existing market knowledge.

NT-EM: Opportunities based on new technical knowledge and existing market knowledge.

ET-NM: Opportunities based on existing technical knowledge and new market knowledge.

NT-NM: Opportunities based on new technical knowledge and new market knowledge.

Difficulty is measured on a scale 1–5, where 1 is very easy and 5 is very difficult.

loans and prepayments of customers for firms that seek to exploit opportunities based on new market knowledge. This finding indicates not only that the customers provide financial assistance, but that contacts with potential customers are important in order to learn about customer needs and requirements.

Table VI provides data about the difficulties in getting access to different sources of external financing. It shows that firms which seek to

exploit opportunities based on new knowledge report more difficulties in getting access to external sources of financing than firms seeking to exploit opportunities based on existing knowledge. Interestingly, the firms that seek to exploit opportunities based on both new technical knowledge and new market knowledge report the least difficulty among firms that seek to exploit opportunities based on new knowledge.

Table VI also shows that firms seeking to

exploit opportunities based on new technical knowledge and existing market knowledge report the highest difficulty in getting access to external financing. This finding is interesting because it contradicts the relative difference between new market knowledge and new technical knowledge found in the regression model. It is also interesting to note that these firms have great difficulties in obtaining financing from venture capital investors, private investors and government, while at the same time financing from venture capital investors and private investors is of relatively low importance for those who get it. It is difficult to interpret this finding, but it might indicate the lack of commitment of these investors to this particular class of firms.

The results of the analysis of complementary data on the degree, importance and difficulty of external financing in young technology-based firms seem to support the results from previous research about the role of external financing for different types of opportunities. Firms that seek to exploit opportunities based on new knowledge need more external financing than firms that seek to exploit opportunities based on existing knowledge, and also experience more difficulty in getting access to external sources of financing. The high number of different sources that these firms are able to access indicated that the difficulty in accessing financing might be more due to greater needs than to the impossibility of accessing a particular source of financing. For example, banks do not seem to be sensitive to different types of opportunities. This might though not be true for firms that seek to exploit opportunities based on new technical knowledge and existing market knowledge. These firms seem to have difficulties getting access to, and taking advantage of, certain sources of financing, most notably private investors and venture capitalists.

It is nevertheless interesting to note the importance of venture capital financing, government support, support from customers, and other unspecified sources of financing. These types of financing seem to have a special role for particular types of opportunities, especially for opportunities based on new knowledge. This role could be related to complementary resources that these actors provide, which could be important for attaining substantial growth.

## Discussion and conclusions

The aim of this paper was to investigate how business opportunities at start-up constrain young technology-based firms from attaining substantial growth. The results of the empirical analysis support the basic hypothesis of the paper that the type of business opportunities at start-up significantly influences the probability of attaining substantial growth, both directly and by moderating the effects of difficulties in getting access to external financing. The support for the hypothesis about the specific direction of this influence was more mixed.

The results confirmed that firms seeking to exploit opportunities based on existing knowledge are least likely to stay small. The results also confirmed that firms seeking to exploit opportunities based on new market knowledge are less likely to attain substantial growth than firms seeking to exploit opportunities based on new technical knowledge.

The results did not confirm that firms seeking opportunities based on new technical knowledge, irrespective of the newness of market knowledge, were less likely to attain substantial growth than firms seeking to exploit opportunities based on existing technical knowledge. This finding is unexpected because previous studies of young technology-based firms (e.g. Oakey and Cooper, 1991; Roberts, 1991) have emphasized the importance of low technological uncertainty for success and growth.

A possible explanation of this discrepancy is that studies emphasizing the importance of low technological uncertainty were only studying firms that were operating in new markets as well. Then the uncertainty about the user problem is a part of the technological uncertainty.

Another possible explanation has to do with measurement problems. The measure used in this study might underestimate the difference between new and existing knowledge. This study is nevertheless not the only study to report a weak, or no, relationship between newness of technology and growth. Eisenhardt and Schoonhoven (1990) found no relationship between innovativeness of firms' technology and growth, and Autio and Lumme (1998) found no difference in growth between market innovators and paradigm innova-

tors. Hence, it seems reasonable to argue that the difference between existing and new market knowledge has much stronger constraining influence on growth than does the difference between existing and new technical knowledge. It is simply more difficult to learn how to profitably exploit opportunities based on new market knowledge, probably because this will always involve learning about both markets and technology.

While the results confirmed the basic hypothesis that the type of opportunities at start-up moderates the relationship between difficulties in accessing external financing and the probability of attaining substantial growth, the results did not confirm the expected interaction as stated in the hypotheses. In a similar fashion as for the direct effects of differences in the novelty of opportunities, no effects were found for new technical knowledge. For opportunities based on existing market knowledge, irrespective of the newness of technical knowledge, there was no significant relationship between difficulties in getting access to external financing and the probability of becoming medium-sized. For opportunities based on new market knowledge, irrespective of the newness of technical knowledge, there was a significant relationship between difficulties in getting access to external financing and the probability of becoming medium-sized. But instead of this relationship being negative, i.e. that difficulties in getting access to finance would be more constraining for firms seeking opportunities based on new market knowledge, the relationship is positive. Thus, for firms seeking to exploit opportunities based on new market knowledge, the firms that have more difficulty in getting access to finance are more likely to attain substantial growth.

One possible explanation for this positive relationship may be due to measurement problems. There might be a confounding effect of how actively the owner-managers seek external financing in the variable that measures the degree of difficulty in getting access to external financing. Hence, growth-constrained firms, i.e. firms that do not attain substantial growth, may not actively seek external financing even if they need to do so in order to grow. This could be due to the lack of growth intentions, or because owner-managers have a particular reason to avoid seeking external

financing. The latter is more probable, as differences in growth intentions are controlled for in the model. The reasons to avoid seeking external financing could be reluctance to give up control or ownership to equity investors, or reluctance to use debt financing.

Another possible explanation for the lack of support for the proposed hypothesis, about the moderating effects of the type of opportunity on the relationship between the difficulties in getting access to external financing and the probability of attaining substantial growth, is the survivor bias inherent in the data. Firms that experience severe financial limitations due to lack of access to external financing are more likely to fail and disappear from the sample. Hence, firms that experience difficulties in accessing external financing may be underrepresented in a sample of survivors. The effects of the resulting survivor bias might differ for different types of opportunities, being strongest for firms seeking opportunities of highest novelty which are, as shown in the previous section, likely to be most dependent on external financing.

Taken together, the results of this study point to the important distinction between young technology-based firms that seek to exploit opportunities based on new market knowledge and firms that seek to exploit opportunities based on existing market knowledge. Firms that seek to exploit opportunities based on new market knowledge are less likely to attain substantial growth than firms that seek to exploit opportunities based on existing market knowledge. Furthermore, the results from the model, combined with the analysis of complementary data, suggest that firms seeking to exploit opportunities based on new market knowledge are more likely to attain substantial growth if they actively seek external financing. Seeking external financing from multiple sources, including e.g. customers and venture capitalists, not only ensures the financial resources needed for survival, but also may help to obtain other complementary resources and knowledge needed to build up the necessary management competence for attaining substantial growth.

In this paper it has been argued, based on previous theory, that different types of opportunities represent different degrees of learning challenges which face the firm. Further research is

needed in order to understand these different challenges and how firms respond to them. Do firms refine their original product idea, concentrating on building up the complementary resources needed for successful commercialization? Or do firms "innovate away" from their problems, pursuing new product ideas that they judge to be more likely to be accepted in the market? While the acquisition of complementary resources is important for early growth (Garnsey, 1998), the ability to identify new opportunities is crucial for continued growth (Penrose, 1959). Balancing the two is a critical question for management. Without the former, the firm might never enter on the path of growth – and without the latter, the firm is not likely to get very far.

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### Notes

<sup>1</sup> The concept of the young technology-based firm refers to a recently established firm whose competitive strength comes from the knowledge and skills of the employees within the fields of the natural sciences, engineering and medicine, and the subsequent transformation of this knowledge into products and services that can be sold on a market (Klofsten, 1992; Rickne and Jacobsson, 1999). This includes manufacturing firms as well as firms providing industry-related services.

<sup>2</sup> The firms were independent at start-up, but could have been acquired by another firm at the time of data collection.

<sup>3</sup> These industries were ISIC 341, 35, 37, 38, 6112, 72002, 8323, 83249, 83292, 83299 and 932. Special rules were applied in ISIC 61120 and in ISIC 83292 and ISIC 83299 for selecting the relevant firms. See Rickne and Jacobsson (1999) for further details.

<sup>4</sup> The relatively low number of medium-sized firms raises two questions. First, are the medium-sized firms under-represented in the sample? A follow-up study on the size distribution of the original population in 1999 found that 14% of the firms that still existed were medium-sized or larger. This is the same percentage as obtained in the final sample used for estimating the model. Second, how will this relatively low number of medium-sized firms affect the maximum number of parameters in the model? Hosmer and Lemeshow (2000, pp. 346–347) argue that the issue of sample size in logistic regression models is complex and dependent on the characteristics of the data. They suggest as a rule of thumb, which may be too stringent, that 10 events of the least frequent outcome are needed for each parameter. In our case this would mean that the model in this study is constrained to 3–4 parameters. The full model presented in this paper includes 11 parameters, which is 3–4 times larger than recommended by the rule of thumb. To test the robustness of the model, a model with seven parameters (only two categories of opportunities) was tested. The results were stable, suggesting that the problem of underestimation or overestimation due to large model size is not serious.

### References

- Abell, D. F., 1980, *Defining the Business: The Starting Point of Strategic Planning*. Englewood Cliffs, NJ: Prentice-Hall.
- Aldrich, H. and C. M. Fiol, 1994, 'Fools Rush In? The Institutional Context of Industry Creation', *Academy of Management Review* 19(4), 645–670.
- Audretsch, D., 1995, 'Innovation, Growth and Survival', *International Journal of Industrial Organization* 13, 441–457.
- Autio, E. and A. Lumme, 1998, 'Does the Innovator Role Affect the Perceived Potential for Growth? Analysis of Four Types of New, Technology-Based Firms', *Technology Analysis & Strategic Management* 10(1), 41–54.
- Barber, J., S. Metcalfe and M. Porteous, 1989, 'Barriers to Growth: The Acard Study', in J. Barber, S. Metcalfe and M. Porteous (eds.), *Barriers to Growth in Small Firms*. London: Routledge, pp. 1–19.
- Chandler, G. N., 1996, 'Business Similarity as a Moderator of the Relationship between Pre-Ownership Experience and Venture Performance', *Entrepreneurship Theory & Practice* 20 (Spring), 51–65.
- Cooper, A. C., 1986, 'Entrepreneurship and High Technology', in D. L. Sexton and R. W. Smilor (eds.), *The Art and Science of Entrepreneurship*. Cambridge, MA: Ballinger, pp. 153–168.
- Davidsson, P., 1989, 'Entrepreneurship – and After? A Study of Growth Willingness in Small Firms', *Journal of Business Venturing* 4, 211–226.
- Delmar, F., 1997, 'Measuring Growth: Methodological Considerations and Empirical Results', in R. Donckels and A. Miettinen (eds.), *Entrepreneurship and SME Research: On its Way to the Next Millennium*. Aldershot: Ashgate, pp. 199–215.
- Delmar, F., P. Davidsson and W. Gartner, W. (forthcoming),

- 'Arriving at the High-Growth Firm', *Journal of Business Venturing*.
- Eisenhardt, K. M. and C. B. Schoonhoven, 1990, 'Organizational Growth: Linking Founding Team, Strategy, Environment, and Growth among U.S. Semiconductor Ventures, 1978-1988', *Administrative Science Quarterly* 35, 504-529.
- Feeser, H. R. and G. E. Willard, 1990, 'Founding Strategy and Performance: A Comparison of High and Low Growth High Tech Firms', *Strategic Management Journal* 11, 87-98.
- Garnsey, E., 1995, 'High Technology Renewal and the U.K. Investment Problem', *Journal of General Management* 20(4), 1-22.
- Garnsey, E., 1998, 'A Theory of the Early Growth of the Firm', *Industrial and Corporate Change* 13(3), 523-556.
- Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow, 1994, *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: SAGE Publications.
- Hofer, C. W. and R. Charan, 1984, 'The Transition to Professional Management: Mission Impossible', *American Journal of Small Business* 9(1), 1-11.
- Hosmer, D. W. and S. Lemeshow, 2000, *Applied Logistic Regression*. New York: John Wiley & Sons.
- Kirchhoff, B. A., 1994, *Entrepreneurship and Dynamic Capitalism*. Westport: Praeger.
- Klepper, S. and E. Graddy, 1990, 'The Evolution of New Industries and the Determinants of Market Structure', *RAND Journal of Economics* 21, 27-44.
- Klofsten, M., 1992, *Tidiga utvecklingsprocesser i teknikbaserade företag*. Ph.D. Thesis, Department of Management and Economics. Linköping, Linköping University.
- Lindmark, S., 2002, *Evolution of Techno-Economic Systems*. Ph.D. Thesis, Department of Industrial Management and Economics. Göteborg, Chalmers University of Technology.
- Lockett, A., G. Murray and M. Wright, 2002, 'Do U.K. Venture Capitalists Still Have Bias against Investment in New Technology Firms', *Research Policy* 31, 1009-1030.
- Murray, G. C. and J. Lott, 1995, 'Have U.K. Venture Capitalists a Bias against Investment in New Technology-Based Firms?', *Research Policy* 24, 283-299.
- Nelson, R. R., 1994, 'The Co-Evolution of Technology, Industrial Structure and Supporting Institutions', *Industrial and Corporate Change* 3(1), 47-63.
- Oakey, R., 1994, *New Technology-Based Firms in the 1990s*. London: Paul Chapman Publishing Company.
- Oakey, R. P. and S. Y. Cooper, 1991, 'The Relationship between Product Technology and Innovation Performance in High Technology Small Firms', *Technovation* 11(2), 79-92.
- Penrose, E. T., 1959, *The Theory of the Growth of the Firm*. Oxford: Basil Blackwell.
- Rickne, A., 2000, *New Technology-Based Firms and Industrial Dynamics*. Ph.D. Thesis, Industrial Dynamics. Göteborg, Chalmers University of Technology.
- Rickne, A. and S. Jacobsson, 1999, 'New Technology-Based Firms in Sweden: A Study of Their Direct Impact on Industrial Renewal', *Economics of Innovation and New Technology* 8, 197-223.
- Roberts, E. B., 1991, *Entrepreneurs in High Technology: Lessons from MIT and Beyond*. New York: Oxford University Press.
- Shackle, G. L. S., 1955, *Uncertainty in Economics and Other Reflections*. Cambridge: Cambridge University Press.
- Shane, S., 2000, 'Prior Knowledge and the Discovery of Entrepreneurial Opportunities', *Organization Science* 11(4), 448-469.
- Westhead, P. and D. J. Storey, 1997, 'Financial Constraints on the Growth of High Technology Small Firms in the United Kingdom', *Applied Financial Economics* 7, 197-201.

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